



**NATIONAL REPORT  
OF THE REPUBLIC OF BELARUS**

**ON THE IMPLEMENTATION  
OF THE CONVENTION ON NUCLEAR SAFETY**

**MINSK  
2022**

## TABLE OF CONTENTS

ABBREVIATIONS .....	4
INTRODUCTION .....	6
SUMMARY .....	7
ARTICLE 6. EXISTING NUCLEAR INSTALLATIONS .....	10
Scientific nuclear facilities.....	10
Construction and operation of a nuclear power plant in the Republic of Belarus .....	11
ARTICLE 7. LEGISLATIVE AND REGULATORY FRAMEWORK .....	15
Article 7 (1) Establishing and maintaining a legislative and regulatory framework to ensure the safety of nuclear installations .....	16
Article 7 (2) (i) National Safety Requirements and Regulations .....	17
Article 7 (2) (ii) Licensing System .....	18
Article 7 (2) (iii) System of regulatory control and assessment.....	20
Article 7 (2) (iv) Enforcement of applicable regulations and terms of licenses .....	24
ARTICLE 8. REGULATORY BODY .....	26
Article 8 (1) Establishment of a regulatory body.....	26
Article 8 (2) Status of a regulatory body.....	31
ARTICLE 9. RESPONSIBILITY OF THE LICENCE HOLDER .....	33
ARTICLE 10. PRIORITY TO SAFETY .....	35
Licensee's (Belarusian NPP State Enterprise) measures to implement the priority of nuclear safety .....	35
Control and supervision over measures implemented by the Belarusian NPP State Enterprise with the purpose of prioritised attention to safety. ....	38
Safety priority within the regulator's own activities .....	39
ARTICLE 11. FINANCIAL AND HUMAN RESOURCES .....	41
Article 11 (1) Financial Resources.....	41
Article 11 (2) Human Resources.....	42
ARTICLE 12. HUMAN FACTOR.....	46
Regulatory Requirements.....	46
The human factor at nuclear installation design .....	47
Measures of the licensee to take into account the human factor influence in operating and maintaining a nuclear facility .....	47
Regulatory supervision and control activities to consider the human factor influence.....	49
ARTICLE 13. QUALITY ASSURANCE .....	49
The activities in the field of regulatory consideration and control .....	49
Actions of the Operating Organization .....	50
Operating organization Audit Program.....	52
ARTICLE 14. ASSESSMENT AND VERIFICATION OF SAFETY.....	53
14 (1) Safety assessment.....	53
Article 14 (2) Verification of safety.....	56
ARTICLE 15. RADIATION PROTECTION.....	58
Expectations in accordance with the regulatory provisions regarding the processes performed by the license holder to optimize exposure and implement the "as low as reasonably achievable" (ALARA).....	59
Implementing the Belarusian NPP radiation protection program by license holders .....	60
The activities in the field of regulatory consideration and control .....	66
ARTICLE 16. EMERGENCY PREPAREDNESS.....	67
Article 16 (1) Emergency Plans and Programs .....	67
Regulatory Requirements.....	67
Article 16 (2) Informing the Public and Neighboring States .....	69
ARTICLE 17. SITING .....	70
Article 17 (1) Evaluation of site related factors .....	71
Article 17(2) Impact of the installation on individuals, society and environment.....	72
Article 17(3) Re-evaluation of site related factors .....	72
Article 17(4) Consultation with other Contracting Parties likely to be affected by the installation .....	72
ARTICLE 18. DESIGN AND CONSTRUCTION.....	73
Regulatory requirements .....	73
Article 18 (1) Implementation of the "defence-in-depth" concept.....	75
Article 18 (2) Incorporation of proven technologies.....	76
Article 18 (3) Design for reliable, stable and manageable operation.....	76

ARTICLE 19. OPERATION .....	77
Article 19 (1) Initial authorization .....	77
Article 19 (2) Operational limits and conditions .....	80
Article 19 (3) Procedures for operation, maintenance, inspection and testing .....	81
Article 19 (4) Procedures for responding to operational occurrences and accidents .....	83
Article 19 (5) Engineering and technical support .....	84
Article 19 (6) Reporting of incidents significant to safety .....	85
Article 19 (7) Operational experience feedback .....	85
Article 19 (8) SNF and RW management at the site.....	86
CONCLUSION .....	89
REFERENCES .....	90

## ABBREVIATIONS

JSC - Joint Stock Company  
 AMP - Automatic measurement points  
 APC - Automatic power controller  
 AREMS - Automated radiation environment monitoring system  
 NPP - Nuclear Power Plant  
 EHRT - Emergency heat removal tanks  
 SFSP - Spent fuel storage pool  
 MCR - Main control room  
 PSA - Probability safety assessment  
 WANO - World Association of Nuclear Power Operators  
 HLW - High-level radioactive waste  
 WWER - Water-Water Energetic Reactor  
 Gosatomnadzor - Department of Nuclear and Radiation Safety of the Ministry for Emergency Situations of the Republic of Belarus  
 Belarusian NPP State Enterprise - Republican Unitary Enterprise "Belarusian Nuclear Power Plant"  
 SEPCS - State Emergency Prevention and Control System of the Republic of Belarus  
 LRW - Liquid radioactive waste  
 SA - Supervised area  
 BDBA - beyond design basis accident  
 IRS - Sources of ionizing radiation  
 IRG - inert radioactive gases  
 IMS - integrated management system  
 IAEA - International Atomic Energy Agency  
 MES - Ministry for Emergency Situations of the Republic of Belarus  
 LLRW - low-level radioactive waste  
 NZK - non-returnable protective container;  
 Scientific Institution JIPNR Sosny - State Scientific Institution Joint Institute for Power and Nuclear Research Sosny of the National Academy of Sciences of the Republic of Belarus  
 NLA - Normative legal acts  
 EIA - Environmental impact assessment  
 CSTO - Collective Security Treaty Organization  
 VLLRW - very low-level radioactive waste  
 TSO - scientific and technical support organization  
 SAR - Safety Assessment Report  
 GSP NPP - Norms and Rules for ensuring nuclear and radiation safety "General Provisions for Ensuring the Safety of Nuclear Power Plants", approved by Resolution of the Ministry for Emergency Situations of the Republic of Belarus No.15 dated 13.04.2020;  
 CPS CE - reactor control and protection system control elements  
 SNF - spent nuclear fuel  
 SG - Steam generator  
 MEDGS - Mobile emergency diesel generation station  
 RWDF - RW disposal facility  
 FSS - Full-scale simulator  
 NPP QAP - Nuclear Power Plant Quality Assurance Program  
 SO - scheduled outage  
 RW - radioactive waste  
 RM - Radiation monitoring  
 BCP - Backup control panel  
 RS - Reactor system  
 RCMER – Republican Centre for Management and Emergency Response of the Ministry for Emergency Situations of the Republic of Belarus  
 ILRW - intermedium-level RW

PHRS - Passive Heat Removal System

FA – Fuel Assembly

FE - Fuel Element

TCP - Technical code of common practice

SRW - Solid RW

FODMS - facilities of the operational dispatching management system

STC - Simulation training center of RUE "Belarusian NPP"

OO - Operating organization (Operator)

NF - Nuclear Fuel

## INTRODUCTION

The National Report of the Republic of Belarus on the implementation of the Convention on Nuclear Safety (hereinafter referred to as the National Report) has been prepared for the joint 8th and 9th meeting of the Contracting Parties in line with Article 5 of the Convention on Nuclear Safety (hereinafter referred to as the Convention). It illustrates the country's commitments within the Convention in 2017-2022 in light of Belarus' decision to build its own nuclear power plant and the subsequent implementation of this project. The document has been prepared based on the Guidelines for National Reports Submitted in accordance with the Convention (Information circular INFCIRC / 572 / Rev.6 dated February 7, 2017).

The Republic of Belarus joined the Convention in 1998, has prepared and submitted a total of 8 National Reports on the implementation of the Convention (1999, 2001, 2004, 2007, 2011, 2013, 2016, 2019), as well as one extraordinary report on the lessons of the accident at the Fukushima Daiichi nuclear power plant (Japan).

In the Republic of Belarus, Belarusian NPP with 2 power units, the operating organization of which is the State Enterprise "Belarusian NPP" meets the definition of Article 2 of the Convention.

The Republic of Belarus made a decision to implement its own nuclear energy program in early 2008. The previous National Report contained the information on various aspects of ensuring safety during construction of the Belarusian NPP which began in November 2013.

Based on licenses for construction of power units No. 1 and No. 2 issued in 2013-2014 to the operating organization, the construction of the Belarusian NPP, which had started in November 2013, was continued. On June 10, 2021, industrial operation of the power unit No. 1 of the State Enterprise "Belarusian NPP" was launched. The event was preceded by public hearings organized on April 30, 2021 by Gosatomnadzor for the first time in the history of the Belarusian regulatory body, and introducing a new type of activity - operating a nuclear installation - into the Operator's license on June 2, 2021. At the same time, supervision of safety during construction, commissioning and operation of the Belarusian NPP is provided in a permanent mode. Commissioning of power unit No. 2 is scheduled for 2022.

Over 6-year period after submission of the 7th National Report (August 2016), the Republic of Belarus has continued to demonstrate commitment to compliance with the Convention. Given the international requirements and law enforcement practice, the country has adopted a number of fundamental legislative acts in the field of nuclear and radiation safety:

Law of the Republic of Belarus No. 198-3 of June 18, 2019 "On Radiation Safety" [1];  
 the Decree of the President of the Republic of Belarus of 05.04.2021 No. 137 "On Regulation of Activities in the Field of Use of Atomic Energy and Ionizing Radiation Sources" [2];  
 the Decree of the President of the Republic of Belarus No. 427 of November 2, 2021 "On Improving the Radioactive Waste Management System" [3].

At present, a draft Law of the Republic of Belarus "On Safety Regulation in the Use of Atomic Energy" has been prepared.

The development of the nuclear and radiation safety infrastructure and all its components is continuing: the regulatory framework, regulatory infrastructure, state emergency preparedness and response systems, accounting and control of nuclear materials, etc. In December 2021, the IAEA post-mission on the Integrated Assessment of the Regulatory Infrastructure for Nuclear and Radiation Safety found that our country has significantly improved its regulatory infrastructure of nuclear safety.

Therefore, in 2017-2022, the Republic of Belarus planned and implemented activities to further improve the nuclear and radiation safety infrastructure and all its components taking into account the IAEA safety standards, recommendations of international assessment missions and peer reviews, as well as challenges and suggestions established by the 7th Review Meeting of Contracting Parties to the Convention.

The Republic of Belarus at the national level is taking the necessary measures to ensure that fundamental principles of nuclear safety are in place at all stages of the Belarusian NPP life cycle, including recommendations of the IAEA missions conducted in Belarus:

Integrated Nuclear Infrastructure Review (INIR) (2012 and 2020);

Integrated Regulatory Review Service (IRRS mission) (2016, follow – up mission – 2021);  
 Site and External Events Design Review Service (SEED mission) (2017);  
 Emergency Preparedness and Response Review Service (EPREV mission) (2018);  
 Safeguards and SSAC Advisory Service (ISSAS mission) 2019;  
 pre-Operational Safety Review Team (pre-OSART) (2019, follow-up mission – 2021);  
 International Physical Protection Advisory Service (IPPAS) (2021).

## SUMMARY

The facility corresponding to the definition of Article 2 of the Convention in the Republic of Belarus is the Belarusian NPP. The facility is being constructed according to the Russian project AES-2006; the general contractor is ASE EC JSC (Atomstroyexport, Russian Federation), the customer – the Belarusian NPP State Enterprise which is legally defined as the operating organization.

Belarus also has experimental (research) nuclear facilities, the safety issues of which are also reflected in this National Report.

As the implementation of the first nuclear energy program is progressing, improvements in nuclear safety infrastructure have been made. The improvements are based on international recommendations, in particular, the IAEA assessment mission and peer reviews mentioned in the Introduction, as well as Conclusions of the Review Meetings of Contracting Parties to the Convention.

During the consideration of the [7th National Report of the Republic of Belarus on the implementation of the Convention on Nuclear Safety](#) for Belarus, the following 5 challenges were noted:

- 1) finishing the construction and commissioning of new reactors with assuring the VDNS principle 1 implementation;
- 2) further development of TSO system of the regulatory body;
- 3) continue efforts to establish bilateral cooperation on nuclear safety with the Republic of Lithuania, finalizing bilateral agreements, in particular
- 4) preparation and hosting of all planned peer review missions in the conditions of intensive schedule of activities related to the Belarusian NPP, and implementation of the recommendations and suggestions including those from the missions already conducted;
- 5) ensure adequate regulatory review of the application being submitted by licensee and oversight of the entire process of the issuance of the operating license.

In addition, the 7th meeting of the parties to the Convention formulated 2 suggestions:

- 1) have the stress-test report, which is under preparation subject to transparent peer review in accordance with the joint declaration of 2011;
- 2) complete performing a Level-2 PSA, including extreme natural as well as man-made external hazards.

In response to these challenges and suggestions, the Republic of Belarus has taken a number of actions.

Challenge 1. By the time of preparing this National Report, power unit No. 1 of the Belarusian NPP is in commercial operation. Following the updated schedule, commissioning of the power unit No. 2 is planned in 2022 (for detailed information on this issue, see Article 6 "Existing Nuclear Facilities" of this National Report). Therefore, the relevance of this challenge is continuing.

Challenge 2. The Republic of Belarus has developed a system of scientific and technical support for the regulatory body in the field of nuclear and radiation safety, which at the time of preparing this National Report includes 16 leading organizations of the country and the state scientific and technical institution "Centre for Nuclear and Radiation Safety" as a coordinator. Details on this issue are provided in Article 8 "Regulatory Authority" hereof. This challenge can therefore be considered closed.

Challenge 3. The institutionalization of bilateral cooperation on nuclear safety with the Republic of Lithuania has been completed. An agreement between the Ministry for Emergency Situations and the Lithuanian State Nuclear Power Safety Inspectorate (VATESI) on early notification of a nuclear accident and exchange of information on nuclear installations and nuclear activities was

signed on the Belarusian side on May 8, 2020, and on the Lithuanian side on May 25, 2020 (the Agreement became effective on the same date). This challenge can therefore be considered closed.

Challenge 4. In order to assess and improve the nuclear and radiation safety infrastructure in conditions of the intensive schedule of activities related to the Belarusian NPP construction, the Republic of Belarus hosted all key missions the IAEA recommended for newcomer countries to nuclear energy:

Integrated Nuclear Infrastructure Review (INIR) for phases 2 and 3 of the nuclear energy program development (2012 and 2020 respectively);

Integrated Regulatory Review Service (IRRS) (in 2016, follow-up mission – in 2021);

Site and External Events Design Review Service (SEED) (in 2017);

Emergency Preparedness and Response Review Service (EPREV) (in 2018);

Safeguards and SSAC Advisory Service (ISSAS) (in 2019);

pre-Operational Safety Review Team (pre-OSART) (2019, follow-up mission – in 2021);

International Physical Protection Advisory Service (IPPAS) (2021).

Implementing suggestions following the outcomes of peer review missions contributes to further harmonization of the nuclear and radiation safety standards of the Republic of Belarus with international requirements and achieving high safety standards. Administrative mechanism of implementing the recommendations are the relevant national plans that contain activities with realization deadlines. These plans are approved and controlled by the Government of the Republic of Belarus.

This challenge can therefore be considered closed.

Challenge 5. The Belarusian regulatory authority in the field of nuclear and radiation safety organized adequate regulatory review of the application for introducing a new type of activity to the license – operation of Unit 1 of the Belarusian NPP (see Article 7 (2) (ii) “Licensing System” hereof for details) and oversight of the entire process (see Article 7 (2) (iii) “Regulatory Control and Assessment System” hereof for details). On June 2, 2021, additions were made to the license to initiate the industrial operation of power unit No. 1 Regarding power unit No. 2 of the Belarusian NPP, the licensing process of its operation is in progress. Therefore, the relevance of this challenge is continuing.

The license for the operation of power unit No. 1 was issued on June 2, 2021. Regarding power unit No. 2 of the Belarusian NPP, the licensing process of its operation is in progress. Therefore, the relevance of this challenge is continuing.

Suggestion 1. In 2016-2018 the Republic of Belarus performed on voluntary basis stress-tests of the Belarusian NPP according to the methodology of the European Nuclear Safety Regulators Group (ENSREG). At the same time, a relevant ENSREG peer review was organized, following which a peer review report was prepared and approved at the ENSREG plenary session in July 2018. In the course of the peer review, the European experts applied new safety reference levels to the Belarusian NPP developed by the Western European Nuclear Regulators' Association (WENRA) in 2014. The ENSREG Report highlights different good practices and suggests potential improvements in the context of providing continuous safety improvement.

In 2019, Gosatomnadzor, together with the parties involved, taking into account the ENSREG recommendations, prepared a National Action Plan based on the RUE "Belarusian NPP" stress tests results. This document and its implementation were also the subject of the ENSREG Peer Review which ended with the approval of the Peer Review Report at the ENSREG plenary session in November 2021. The ENSREG Report notes that the National Action Plan reflects all ENSREG recommendations of 2018. All actions decided by Gosatomnadzor and the State Enterprise "Belarusian NPP" meet the intent of the ENSREG recommendations. Out of 25 recommendations, 18 have been implemented and 7 are in progress, of which 4 were added in November 2021. Activities related to 5 recommendations are in progress and meet the intent of the ENSREG recommendations. Gosatomnadzor and the State Enterprise "Belarusian NPP" have expedited the implementation of several actions compared to the original schedule.

In view of the above, suggestion 1 can be considered closed.

Suggestion 2. For licensing of operation of power unit No. 1 of the Belarusian NPP, the



operating organization in line with law requirements had elaborated a Level 2 PSA, which was submitted to the regulatory authority within a package of documents for introducing a new type of activity into the license, and addressed adequately. In view of the above, suggestion 2 can be considered closed.

This National Report provides detailed information on the nuclear and radiation safety infrastructure formed in the Republic of Belarus in the period of 2017-2022, actions and events related to the preparation and start of commercial operation of the Belarusian NPP power unit No. 1, as well as the preparation of power unit No. 2 for operation.

The National Report article by article reflects the State's activities to implement the provisions of the Convention. The Report takes into account changes in the legislative and regulatory framework related to ensuring nuclear and radiation safety in the use of atomic energy.

The National Report reflects the work and activities to develop the system of scientific and technical support of the regulatory body in the field of nuclear and radiation safety, training, ensuring the safety priority, implementing radiation protection, organizing emergency preparedness system, etc.

Articles 6, 7, 14, 17, 18 and 19 of the National Report provide information on realizing principles contained in the Vienna Declaration on Nuclear Safety of February 9, 2015.

## ARTICLE 6. EXISTING NUCLEAR INSTALLATIONS

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

Nuclear facilities currently existing in the Republic of Belarus in accordance with Article 2 of 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 shown in Table 1.

**Table 1**  
Nuclear facilities in the Republic of Belarus

1.	Belarusian NPP	Power unit No. 1 of the Belarusian NPP – in operation; Power unit No. 2 of the Belarusian NPP – under construction (is at the stage of commissioning)
2.	Yavar non-irradiated nuclear material storage facility	In operation
3.	SNF storage facility	Decommissioned in 2018 (fuel transferred to the Russian Federation in 2010)
4.	Nuclear material storage facility	The 1st stage in operation, the 2nd stage is under construction
5.	Yalina subcritical test facility	In operation (long-term shutdown)
6.	Giatsint critical test facility	In operation
7.	Kristall critical test facility	In operation (long-term shutdown)

Of the listed facilities, only power units No.1 and No. 2 of the Belarusian NPP meet the definition of Article 2 of the Convention on Nuclear Safety, others are scientific nuclear facilities and are located at the Scientific Institution JIPNR Sosny.

### Scientific nuclear facilities

Such facilities include the following located at the Scientific Institute JIPNR Sosny:

Yavar non-irradiated nuclear material storage facility;  
nuclear material storage facility;  
Yalina subcritical test facility;  
Giatsint critical test facility;  
Kristall critical test facility.

**Yavar non-irradiated nuclear material storage facility** is used to store non-irradiated nuclear material. Nuclear material is delivered to the Giatsint, Kristall critical test facilities and the Yalina subcritical test facility to perform scientific programs.

### **Nuclear material storage facility.**

The facility commissioned in 2020, a license was obtained to operate the first stage of the nuclear materials storage facility in Building 47/23 (storage of items containing depleted uranium). Work on constructing the second stage of a new storage facility for storing Cat.1, 2 nuclear material, is underway.

To obtain a license to operate a storage facility, a package of documents justifying the

provision of nuclear and radiation safety was submitted to Gosatomnadzor. Following the results of safety assessment of the documents and based on findings of the inspection performed by Gosatomnadzor, appropriate amendments have been made to the license.

The *Giatsint critical test facility* is in operation. The Giatsint Critical test facility is intended for research in the physics and safety of neutron multiplication systems and provides an experimental base for solving a wide range of problems in the development of nuclear technologies of a fundamental and applied nature. A system for heating uranium-water critical assemblies to a temperature of 90°C has been developed. Projects of new critical and subcritical assemblies on fast neutrons with nuclear fuel based on uranium zirconium carbonitride (UZrCN) with 19.75% uranium-235 enrichment have been developed to simulate the physical features of a new generation of fast reactors and gas-cooled electronuclear systems. In 2017-2019, experimental studies of uranium-water critical assemblies with 19,75-21, 36 and 90% enrichment in uranium-235 were performed as part of the following programs: State scientific research program "Energy systems, processes and technologies" (subprogram 1.3 "Nuclear energy and nuclear physics technologies") and the State program "High technology and equipment" for 2016-2020 (subprogram 6 "Scientific support for the development of nuclear energy in the Republic of Belarus"). Also, work was implemented at the critical test facility under a contract with Idaho National Laboratory (USA) and research agreements with IAEA.

***Kristall critical test facility.***

A project was developed and modernization of the Kristall critical test facility, including modernization of the control and protection system, are in progress. Projects for new UZrCN-based critical and subcritical assemblies on fast neutrons with 19.75% enrichment in uranium-235, simulating the physical features of a new generation of fast reactors and electronuclear liquid metal-cooled systems, were developed. Work is implemented under a contract with the Idaho National Laboratory (USA).

The *Yalina subcritical test facility* consists of two zero-power subcritical assemblies YALINA-T and YALINA-Booster and the NG-12-1 neutron generator. The basic systems of life support, management, security and physical protection are common to both subcritical assemblies. The Yalina subcritical test facility (YALINA-T, YALINA-BT assemblies) is intended for research in the physics of subcritical systems controlled by external neutron sources, to study transmutation features of long-lived radioactive waste from nuclear power. The facility can be used to solve a number of applied problems - neutron activation analysis of geological samples, research and tests of radiation resistance of materials and products for various purposes.

Research was performed as part of the State Program of Scientific Research for 2016-2020 "Energy Systems, Processes and Technologies", subprogram 1.3 "Nuclear Energy and Nuclear Physics Technologies" and the State Program "Scientific Support for the Development of Nuclear Energy in the Republic of Belarus for 2009-2010 and for the period until 2020".

Currently, research at the facilities is performed within the framework of the subprogram "Nuclear Research and technology (theory, experiment, applications)" of the State Research Program "Energy and Nuclear Processes and Technologies" and the subprogram "Scientific support for the efficient and safe operation of the Belarusian NPP and promising areas of nuclear energy development" of the State Program "High Technologies and Equipment" for 2021-2025.

***SNF storage facility*** The fuel was transferred to the Russian Federation in 2010. The SNF storage facility was decommissioned in March 2018, the operation of the storage facility for the intended design purpose was terminated.

## **Construction and operation of a nuclear power plant in the Republic of Belarus**

In March 2011, an Agreement was signed in Minsk (the Republic of Belarus) between the Government of the Russian Federation and the Government of the Republic of Belarus on cooperation in the construction of a nuclear power plant in the territory of the Republic of Belarus. The agreement provides that the construction of the Belarusian NPP is implemented on a turn-key

basis by the Russian party. The general contractor is ASE JSC, the customer is the State Enterprise "Belarusian NPP" (at the time of signing the agreement - the state institution "Directorate for the Construction of a Nuclear power Plant"), defined as the operating organization.

The Belarusian NPP is constructed as part of two power units with WWER-1200 (V-491) type reactors each and a total electric capacity of turbo generators up to 2400 (2x1200) MW.

For the construction of the Belarusian NPP, the project "AES-2006" of the Joint-Stock Company Saint-Petersburg Research and Design Institute of Energy Technologies ATOMENERGOPROEKT (ATOMENERGOPROEKT JSC) was selected, which is characterized by enhanced safety characteristics and technical and economic parameters. The construction of a nuclear power plant under this project provides:

- creating a 3+ generation nuclear power plant, characterized by a new reactor facility with additional safety systems: PHRS; passive system for filtering leaks into the intershell space; double protective containment; a fuel melt trap in case of a BDBA;

- maximum implementation of the in-depth defense principle - creation of a system of barriers to the spread of ionizing radiation and radioactive substances into the environment and a system of technical and organizational measures to protect the barriers, as well as maintain their effectiveness during direct protection of the population.

The system of barriers for NPP in the "AES-2006" project includes a fuel matrix, shells of fuel elements, the boundary of the reactor coolant circuit, tight enclosure of localizing safety systems.

The barriers ensure safety functions such as reactivity management, removal of residual heat and localization of radioactive materials in operational states, during and after a design-basis event and, as far as practicable, in the event of emergency conditions of beyond-design-basis events.

The main technical characteristics of the power units of the Belarusian NPP are given in Table 2.

**Table 2**

Main technical characteristics of the power unit of the Belarusian NPP with WWER-1200

<b>Parameter</b>	<b>Value</b>
Number of units, pcs.	2
Service life, year: RS	60
steam-turbine plant	50
Power unit capacity, MW:	
electric (gross)	up to 1194
thermal	3200
Power unit heating capacity, MW	46.6
Installed capacity utilization factor, rel. units.	0.9
Electricity consumption for own needs (including costs of circulating water supply and site water supply), %	7.0
Number of fuel assemblies in the core, pcs.	163
Number of fuel assemblies with CPS CE, pcs.	121
Duration of the fuel-element lifetime, years	3-4
Main parameters of the primary coolant (with RS operating at rated capacity):	
temperature at core inlet, °C	298.2
temperature at core outlet, °C	328.6
coolant heating in the core, °C	30.4
coolant flow rate through the reactor, m <sup>3</sup> /h	88000
pressure at core outlet, MPa	16.2
steam pressure at SG outlet, MPa	7.0
SG steam capacity, t/h	1602
feed water temperature, °C	225
steam humidity at SG outlet, %, not more	0.2

Leningrad NPP-2, two power units of which were put into industrial operation on 29.10.2018 and 22.03.2021, is a reference for the Belarusian NPP. In the course of project development, the main characteristics and parameters of the NPP power unit with WWER-1200 were compared to the data of the reference NPP with WWER-1000 (V-428) and foreign NPPs.

The project complies with international norms and IAEA recommendations, as well as principle 1 of the Vienna Declaration on Nuclear Safety of February 9, 2015: "New nuclear power plants are to be designed, sited, and constructed, consistent 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".

In November 2013, Presidential Decree of the Republic of Belarus No. 499 of November 2, 2013 [4] was signed (preceded by issuance of a license to erect foundations and basements of buildings and structures of power unit No. 1 of the Belarusian NPP) and construction works began at the site of power unit No. 1.

In February 2014, a license was obtained to erect foundations and basements of buildings and structures of power unit No. 2 of the Belarusian NPP. In June 2014, construction works began at the site of power unit No. 2.

In April 2014, additions were made to a license regarding power unit No.1 construction (full cycle), and in December 2014 - for power unit No.2 construction (full cycle).

In April 2019, sub-stage A-1 "Testing and inspection of equipment" of commissioning of power unit No. 1 of the Belarusian NPP was started, and in April 2020, amendments and additions were made to the Operator's license regarding the nuclear fuel (fresh NF) management;

In June 2021, amendments were made to the license that allowed to start commercial operation of the power unit No. 1 of the Belarusian NPP. The license for the Belarusian NPP power

unit No.1 operation is valid until December 20, 2051. The decision on amending the license was based on outcomes of safety review of documents justifying nuclear and radiation safety, as well as results of the control and supervisory activities performed by Gosatomnadzor.

Subject to GSP NPP requirements [5], a periodic safety assessment should be carried out every 10 years according to the established procedure. Such safety assessment for the power unit No. 1 of the Belarusian NPP should be implemented not later than 2031.

Power unit No. 1 is in the mode of refueling and routine maintenance within the framework of the first preventative outage scheduled for completion in July 2022. Gosatomnadzor has prepared and is implementing a plan for supervisory activities during the outage. The review of documents justifying the safety of the next fuel load was organized and performed.

At the time of Report publication, power unit No. 2 of the Belarusian NPP is at the stage of commissioning. In 2021, pre-operational control of the base metal, foreign weld metal and welded joints of equipment and pipelines of systems important for NPP safety of power unit No. 2 of the Belarusian NPP was 100% completed. Subject to the Program of commissioning of power unit No. 2 and the developed step-by-step commissioning programs and programs for pre-commissioning on individual systems and RS as a whole, relevant tests are performed at power unit No. 2 of the Belarusian NPP with the results being one of the thematic issues of supervisory activities implemented by Gosatomnadzor within the framework of state supervision. In parallel (given the experience of conducting a safety review at power unit No. 1 of the Belarusian NPP), a step-by-step safety review of documents justifying the nuclear and radiation safety of power unit No. 2 of the Belarusian NPP is performed. The results of the review are considered by Gosatomnadzor as part of making decisions on issuing permits for the transition from one stage of commissioning to the subsequent.

The GSP NPP requirements [5] define that operating organization should implement safety enhancement activities according to plans elaborated taking into account the results of safety analyses and operational experience in order to achieve the NPP safety objectives set by regulatory documents.

The analysis of the need to introduce extra measures to improve safety, including taking into account the results of commissioning, has been performed on an ongoing basis since the start of pre-commissioning, and indicates the absence of urgent need to develop measures to improve the safety of power units No.1 and No.2 of the Belarusian NPP in the context of the Convention or the Vienna Declaration on Nuclear Safety.

As stated in the Summary of this National Report, the Republic of Belarus on voluntary basis performed the stress tests of the Belarusian NPP according to the procedure of the European Nuclear Safety Regulators Group (ENSREG) and the European Commission and had a peer review of their results by the European regulators in the sphere of nuclear safety, during which the European regulators applied new WENRA 2014 safety reference levels to the Belarusian NPP. In 2021, the Republic of Belarus hosted 2 visits of experts from the European Commission and the European Nuclear Safety Regulators Group (ENSREG) as part of the peer review of the National Action Plan based on the Belarusian NPP stress tests results.

Following the results of the targeted reassessment of the safety of the Belarusian NPP and based on ENSREG recommendations received as a result of the peer review, activities were formulated aimed at improving the safety level, which became the basis of the National Action Plan to improve the safety level of Belarusian NPP power units considering the stress tests results. In 2019, Gosatomnadzor sent a prescription on implementing of the National Action Plan to the State Enterprise "Belarusian NPP" . Information on implementing the National Plan is available on the Gosatomnadzor website.

As of May 2022, of 25 recommendations 18 have been implemented and 7 are in progress, of which 4 were added in November 2021. In particular, the following activities were implemented:

- tests were performed on emergency water supply to the EHRT and SFSP using an AC-5.0-50/4 fire truck and the possibility of supplying the design amount of water to the EHRT and SFSP was confirmed;

- the power units of the Belarusian NPP are equipped with a second 500 kW mobile diesel

generator station for use in beyond-design modes;

based on design decisions and taking into account proposals based on the Belarusian NPP stress tests results, the survivability and habitability of control zones (MCR, BCP) was analyzed, which is reflected in the corresponding report;

the PSA of seismic impacts was adjusted considering the updated curves of seismic hazard;

calculations were made for seismic resistance of equipment important for the safety of the power unit No. 1 of the Belarusian NPP based on results of determining the dynamic characteristics of equipment of the Cat. 1 of seismic resistance;

to control the possible geodynamic activity of the Oshmyany fault, the optimal location and resolution of the local network of seismological monitoring in the area of the Belarusian NPP have been estimated;

the assessment of the possibility of providing backup power to a backup auxiliary transformer for own needs through Vilia substation under beyond design conditions, has been performed. The reliability of the power supply of responsible consumers of own needs from the emergency backup transformer of own needs (ARTSN) 110/10 kV has been estimated;

the report "Demonstration of practical exclusion of an early large emergency release taking into account the safety concept of the Belarusian NPP" based on IAEA and WENRA approaches, has been developed;

the sufficiency of the design solution and the inexpediency of ensuring the KLC operation (system of leak containment from the protective shell of the reactor building) in a severe accident combined with complete blackout, is shown;

emergency procedures have been developed and implemented in a symptom-oriented format;

the possibility of water supply in the SG at severe accident development in order to protect the tubes from destruction as a result of high-temperature creep.

The outcome of implementing these measures was evaluated by the ENSREG expert group within the framework of two phases of the peer review, positive assessments of implementing the National Action Plan measures were obtained, which were reflected in the "EU Peer Review Report on Implementation of Belarusian Stress Test National Action Plan . September 2021".

Based on 24.11.2021 ENSREG press release "Comprehensive risk and safety assessments (stress tests) of the Belarusian nuclear power plant. Peer Review of the National Action Plan", the ENSREG team found that the structure and content of the Belarusian National Action Plan were adequate and fulfilled the requirements of the EU stress tests, and also noted progress in the implementation of the National Action Plan.

At the moment, the implementation of the activities of the National Plan is in progress.

## ARTICLE 7. LEGISLATIVE AND REGULATORY FRAMEWORK

*1. Each Contracting Party shall establish and maintain a legislative and regulatory framework to ensure the safety of nuclear installations.*

*2. The legislative and regulatory framework shall provide for:*

*i) introduction of relevant national safety requirements and regulations;*

*ii) a system of licensing with regard to nuclear installations and the prohibition of the operation of a nuclear installation without a license;*

*iii) a system of regulatory inspection and assessment of nuclear installations to ascertain compliance with applicable regulations and the terms of licenses;*

*iv) the enforcement of applicable regulations and of the terms of licenses, including suspension, modification or revocation.*

Legal framework for activities in the field of nuclear and radiation safety is carried out on the basis of international best practices and taking into account the recommendations of the IAEA. Safety principles defined in the IAEA publication No. SF-1 "Safety Fundamentals", as well as main provisions of other IAEA safety standards are addressed in the Law of the Republic of Belarus No.

426-3 of July 30, 2008 “On the Use of Nuclear Energy” [6] and No. 198-3 of June 18, 2019 "On Radiation Safety" [1], regulations on republican government authorities in the field of nuclear energy.

The government declared adopting a global nuclear safety regime, commitment to implementation of the nuclear energy program in compliance with international conventions and treaties [7-15] through their adoption and ratification in Belarus.

**Article 7 (1) Establishing and maintaining a legislative and regulatory framework to ensure the safety of nuclear installations**

Legislation in the field of nuclear and radiation safety has a hierarchical structure and is based on the principle of compliance of regulatory legal acts of lower legal power with the requirements of acts of greater legal power. The system of legislation in nuclear and radiation safety includes:

laws of the Republic of Belarus;

normative legal acts of the President of the Republic of Belarus;

resolutions of the Government of the Republic of Belarus;

Normative legal acts of republican bodies of state administration implementing state regulation of activities to ensure safety in the nuclear energy;

rules and regulations for ensuring nuclear and radiation safety, as well as other technical regulatory legal acts in the field of nuclear energy.

1. After the 2008 decision on the implementation of a nuclear energy program in the Republic of Belarus [16], the normative legal basis in the field of nuclear and radiation safety has undergone substantial adjustments.

The need to improve national legislation on nuclear and radiation safety issues is due to the commissioning of the power unit No. 1 of the Belarusian NPP and the change in the status of the Republic of Belarus from the country embarking on the implementation of the nuclear energy program to the country operating the NPP.

Given the requirements of the time, law enforcement practice, new international requirements, by May 2021 the basis of legislative acts (including laws, decrees of the President of the Republic of Belarus) was formed by:

Law of the Republic of Belarus No. 426-3 of July 30, 2008 “On the Use of Nuclear Energy” [6];

Law of the Republic of Belarus No. 198-3 of June 18, 2019 "On Radiation Safety" [1];

Decree of President of the Republic of Belarus No.62 of February 16, 2015 on Ensuring Safety During the Construction of the Belarusian Nuclear Power Plant [17].

Decree of President of the Republic of Belarus No. 361 of October 5, 2017 “On the Establishment of an Institution” [18];

Decree of the President of the Republic of Belarus No. 279 of May 28, 2010 “On determination of the state body responsible for the implementation of obligations under certain international agreements” [19];

Decree of the President of the Republic of Belarus No. 137 of April 05, 2021 "On regulation of activities in the field of use of atomic energy and ionizing radiation sources" [2];

the Decree of the President of the Republic of Belarus No. 427 of November 2, 2021 "On Improving the Radioactive Waste Management System" [3].

The Law “On the Use of Nuclear Energy” [6] regulates relations connected with the design, location, construction, commissioning, operation, limitation of operational characteristics, extension of service life and decommissioning of a nuclear facility and (or) storage facility, as well as relations connected with handling nuclear materials during the operation of a nuclear facility and (or) storage facility, spent nuclear materials and (or) operational radioactive waste, and other relations in the field of nuclear energy.

In order to comprehensively regulate public relations in ensuring nuclear and radiation safety at all stages of the life cycle of nuclear energy facilities, subject to the Plan for the Preparation of draft legislative acts for 2022 approved by the Decree of the President of the Republic of Belarus, a draft Law of the Republic of Belarus "On safety regulation in the use of atomic energy" has been prepared and adopted in the first reading in May 2022. The draft law endorses the IAEA-recommended



principles on safety in the use of atomic energy, differentiates the functions of state administration and state regulation in the field of safety in the use of atomic energy, stipulates provisions on safety assessment, state supervision in the field of nuclear and radiation safety, licensing activities in the field of atomic energy use, conducting public discussions and hearings, issuing permits to works and services in the field of atomic energy use, as well as nuclear materials management. The law also provides approaches to regulate the issues of licensee's (Operator's) responsibility for ensuring the security of activities in the use of atomic energy. With the entry into force of this draft law, the Law "On the Use of Atomic Energy" will be voided.

The Law "On Radiation Safety" [1] sets the legal basis for the functioning of the radiation safety system, the management of IRS and is aimed at preventing and minimizing the harmful effects of ionizing radiation on human health and the environment.

The Decree of the President of the Republic of Belarus "On regulation of activities in the field of use of atomic energy and ionizing radiation sources" [2] amended the Unified Legal Classifier regarding the consolidation of an independent branch of legislation on nuclear and radiation safety, approved the Regulation on licensing activities in the field of the use of atomic energy and IRS.

The Decree of the President of the Republic of Belarus "On Improving the Radioactive Waste Management System" [3] is aimed at improving the system of public administration in the field of radioactive waste management and radiation safety.

Legal acts in the field of nuclear and radiation safety are available (in Russian) on Gosatomnadzor website at <https://gosatomnadzor.mchs.gov.by/zakonodatelstvo>.

The Republic of Belarus has identified, acceded, ratified and is implementing activities under the following international treaties, agreements and conventions, to which it is a party:

Convention on Nuclear Safety adopted in Vienna on June 17, 1994 (the Republic of Belarus acceded to the Convention by signing the Decree of the President of the Republic of Belarus No. 430 of September 2, 1998) [10];

Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management adopted in Vienna on September 5, 1997 (ratified by the Law of the Republic of Belarus No. 130-3 of July 17, 2002);

Convention on Early Notification of a Nuclear Accident adopted in Vienna on September 26, 1986 (ratified by Decree of the Presidium of the Supreme Council of the Republic of Belarus No. 1216-XI of December 18, 1986) [15];

Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency adopted in Vienna on September 26, 1986 (ratified by Decree of the Presidium of the Supreme Council of the Republic of Belarus No. 1216-XI of December 18, 1986) [8];

Vienna Convention on Civil Liability for Nuclear Damage adopted in Vienna on May 21, 1963 (ratified by the Law of the Republic of Belarus No. 76-3 of November 11, 1997) [11];

Convention on the Physical Protection of Nuclear Material adopted on October 26, 1979 in Vienna (ratified by Decree of the Presidium of the Supreme Council No. 2381-XII of June 14, 1993);

Agreement of 14 April 1995 between the Republic of Belarus and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons [14].

The Republic of Belarus implements multilateral and bilateral cooperation on nuclear and radiation safety issues. Bilateral agreements have been concluded and are implemented with the Russian Federation (the country supplying nuclear technologies to the Republic of Belarus), as well as with Armenia, Austria, France, Germany, Hungary, Latvia, Lithuania, Poland, Slovenia, Slovakia, Ukraine [20-27], regulatory authorities of the Northern Europe countries (Norway, Sweden, Finland).

### **Article 7 (2) (i) National Safety Requirements and Regulations**

In order to implement the norms contained in the laws of the Republic of Belarus and decrees of the Head of State, the following regulatory legal acts were adopted and entered into force from 2020 to May 2022:

three resolutions of the Council of Ministers of the Republic of Belarus:

No. 721 of December 14, 2020 "On Amendments to Resolutions of the Council of Ministers of

the Republic of Belarus No. 79 of January 27, 2004 and No. 991 of December 2, 2016" [28];

No. 497 of August 21, 2020 "On the implementation of the Law of the Republic of Belarus No. 198-3 of June 18, 2019 "On Radiation Safety" [29];

No. 558 of October 6, 2021 "On the implementation of the Decree of the President of the Republic of Belarus No. 137 of April 5, 2021" [30].

The said Government resolutions regulate the following issues:

- determination of the procedure and criteria for RW classifying to radiation hazard classes;
- determination of the procedure for the development and approval of standards for acceptable emissions and radioactive substances discharge into environment for specific radiation facilities;
- certification by Gosatomnadzor of employees, individual entrepreneurs providing consulting services in the field of radiation safety;
- implementation by Gosatomnadzor of the state registration of IRS type;
- monitoring the implementation by licensees of licensing legislation, licensing requirements and conditions for exercising activities in the field of the use of atomic energy and IRS, including special licensing requirements and conditions;
- conducting safety review in the field of nuclear energy and IRS use;
- issue of a radiation dose certificate confirming the recognition of a citizen exposed to ionizing radiation, etc.;
- procedures to be followed during inspection.

At present, the active development of NLAs, including technical ones, is continuing. 37 resolutions of the Ministry for Emergency Situations have been adopted and entered into force, 8 of which approve norms and rules for nuclear and radiation safety assurance.

The technical NLAs are developed by the regulator, including involving TSO, the list of which was approved by the Resolution of the Council of Ministers of the Republic of Belarus No. 991 of December 2, 2016 "On provision of scientific and technical support to the Ministry for Emergency Situations in the field of nuclear and radiation safety" [31].

As part of implementing the activities of the State Program "High Technologies and Equipment" for 2016-2020, the State Program "High Technologies and Equipment" for 2021-2025, five norms and rules for nuclear and radiation safety assurance have been developed and approved by the resolutions of the Ministry for Emergency Situations.

Thus, the adoption and entry into force of the above documents has led to further harmonization of the legal framework of the Republic of Belarus with modern international requirements to achieve high safety standards.

Activities on improving the legal framework in the field of nuclear and radiation safety assurance is implemented as scheduled within annual Plans for organizing NLA development/revision.

The improvement of the legal framework in the field of nuclear and radiation safety in the Republic of Belarus is performed on the basis of regular analysis of the need to develop new and (or) adjust existing NLA at various levels, taking into account the IAEA recommendations. This fact is evidence of compliance with principle 3 of the Vienna Declaration on Nuclear Safety of February 9, 2015: "national requirements and regulations ... 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 CNS."

### **Article 7 (2) (ii) Licensing System**

As part of the improving the licensing procedure for activities in the field of atomic energy and IRS use, the Decree of the President of the Republic of Belarus "On regulation of activities in the field of use of atomic energy and ionizing radiation sources" was adopted [2].

Following the action plan for its implementation, the adoption of resolutions was ensured: of Council of Ministers of the Republic of Belarus "On the implementation of the Decree of the President of the Republic of Belarus No. 137 of April 5, 2021" [30]; of Ministry for Emergency Situations: "On the requirements for the composition and content of the documents justifying nuclear and

radiation safety" [32];

"On amendments to the Resolution of the Ministry for Emergency Situations of April 25, 2019 No. 35" [33];

"On the establishment of application forms and conformity assessment" [34];

"On approval of regulations of administrative procedures" [35].

Subject to the Decree of the President of the Republic of Belarus No. 137 of April 5, 2021 "On regulation of activities in the field of use of atomic energy and ionizing radiation sources" [2], licensed activities implies the following works and (or) services:

1. Operation and decommissioning (or sampling from specified list of works and (or) services) of nuclear installations and facilities;

2. Handling of nuclear materials of the first-third categories in line with the categorization of nuclear material to ensure their physical protection (or sampling from specified list of objects) during their use, processing, transportation and storage (or sampling from specified list of works and (or) services);

3. Design, siting, construction of nuclear installations and storage facilities;

4. Performance of works and provision of services for the Operator which affect the nuclear and radiation safety of nuclear energy facilities, according to the list of such works and services specified by the licensing authority;

5. Design and manufacture of technological equipment for nuclear energy facilities according to the list specified by the licensing authority;

6. Operation, storage of closed IRS included in Cat. 1-3 IRS according to the degree of radiation hazard, including as part of radiation devices;

7. Operation of radiation devices with accelerating voltage over 100 kV, charged particle accelerators, X-ray mammography units;

8. Operation and storage of open IRS, work with which belongs to the I, II classes of work with open IRS;

9. Manufacture (production) of radioactive substances and (or) products based thereon, including their storage;

10. Processing, long-term storage and disposal of RW;

11. Design (construction), manufacture (production), installation, adjustment (except for works and (or) services for adjusting radiation devices performed by representatives of foreign organizations – manufacturers (their authorized suppliers) of these devices), repair and maintenance of radiation devices belonging to the first-fourth categories of IRS according to the degree of radiation hazard;

12. Design, construction and decommissioning of radioactive waste management facilities, except for nuclear energy use facilities;

13. Design of radiation facilities intended for handling of IRS included in the first-fourth categories of IRS according to the degree of radiation hazard;

14. conducting safety expertise in the field of nuclear energy and IRS use.

Implementation of the above-mentioned works and (or) services without a license is illegal and prohibited [2].

From October 10, 2021, Gosatomnadzor accepts licensees' documents and renews licenses issued earlier.

Based on the Regulation on licensing activities in the field of the use of atomic energy and IRS [2], Gosatomnadzor in implementing the procedure for licensing activities related to the use of atomic energy and IRS:

accepts applications for issuing a license, its duplicate, amending it, extending the validity period, renewing, terminating the license and the documents attached thereto;

conducts compliance assessment, appoints safety review;

based on the scope of documents submitted by the license applicant (licensee), sets the deadlines for the compliance assessment, safety review;

notifies the license applicant (licensee) in writing about decisions taken in relation to him by the licensing authority;

issues a license, its duplicate, including after making amendments thereto, to the license applicant (licensee);

ensures that information about issued licenses is entered into the Unified Register of Licenses; monitors the implementation by licensees of licensing legislation, licensing requirements and conditions for exercising activities in the field of the use of atomic energy and IRS, including special licensing requirements and conditions;

issues requirements (prescriptions) to licensees to eliminate the exposed violations of licensing legislation, licensing requirements and conditions, including special licensing requirements and conditions;

forms a commission on licensing activities in the field of the use of atomic energy and IRS, establishes the procedure for its activities and powers;

at the stage of making a decision on issuing a license to the Operator for the placement, construction, operation, decommissioning of nuclear installations (power units) of the Belarusian NPP, organizes and conducts public hearings in compliance with the procedure determined by the Council of Ministers of the Republic of Belarus.

According to [6], public associations and other organizations are entitled to offer their representatives to participate in the safety review at the stage of siting, design, construction, operation, decommissioning or limitation of the operational characteristics of a nuclear installation, as well as to conduct independent examinations.

#### **Article 7 (2) (iii) System of regulatory inspection and assessment**

In 2021, Gosatomnadzor updated and approved, by the decision of the Gosatomnadzor Board of 05.02.2021, the Gosatomnadzor strategy in the field of nuclear and radiation safety for 2021-2025 which defines objectives, challenges and necessary actions to solve them.

The main objectives are:

improving the legislation in the field of nuclear and radiation safety;  
conducting licensing and other permitting activities in the field of atomic energy and IRS use, safety review based on current challenges and the best international practice;

effective implementation of control and supervisory activities in relation to the Belarusian NPP on the basis of recognized international approaches amidst limited resources;

compliance of forms and methods of state supervision in the field of radiation safety of IRS to current challenges and best international practice;

improving law enforcement activities;

ensuring preparedness to respond to nuclear and radiation accidents at all levels;

full implementation of the functions of a regulatory body to inform the Belarusian and international public and professional community about the state of safety of radiation facilities, nuclear installations, nuclear power facilities;

ensuring effective scientific and technical support for the functioning of state regulation in the field of nuclear and radiation safety.

In all of the above areas, by the time the Belarusian NPP unit No. 1 was put into industrial operation, a regulatory framework had been developed and measures had been taken to supply these activities with resources. Implementing measures to achieve the goals set in the strategy lies within the field of improvement and optimization of further work, considering own experience and the best international practices.

At the construction site of the Belarusian NPP, a special procedure has been established for the organization and implementation of safety control during construction and commissioning of the plant [17], which allows all supervisory authorities to implement continuous monitoring (supervision) in their field using sanctions and other enforcement actions. The procedure for its organization and implementation is determined by a separate Regulation, which was approved by the Resolution of the Council of Ministers of the Republic of Belarus of February 25, 2015 No. 133 [36]. The adoption of these documents allowed continuing sequential steps to introduce IAEA recommendations in national legislation to achieve high safety standards. Supervisory activities involve control (supervisory) authorities and their subdivisions presented in Table 3.

Table 3

## Control (supervisory) authorities and their subdivisions

Supervisory authority	Subdivision of the supervisory authority	Subject of state supervision (control)
State Committee for Standardization	Construction Control and Supervision Department (specialized inspectorate)	control over compliance with the requirements of technical NLA during construction, approved design documentation during construction and installation works, as well as compliance of materials, products and structures used in construction with design solutions and requirements of mandatory technical NLA in the field of technical standardization to ensure operational reliability and safety;
	regional (for the Minsk region and the city of Minsk) inspections of state supervision over compliance with the requirements of technical regulations and standards and state metrological supervision	control (supervision) of compliance with the requirements of the legislation on compliance assessment related to mandatory compliance assessment; supervision of compliance with mandatory requirements of technical NLA in the field of technical standardization; state control (supervision) over compliance with the requirements of the technical regulations of the Customs Union, the Eurasian Economic Union; state control (supervision) over compliance with indicators not included in the technical regulations of the Customs Union, the Eurasian Economic Union, but declared by the manufacturer (seller, supplier, importer) of products in contracts for the supply (sale) of products, in its labeling or operational documentation; State metrological supervision;
Ministry of Health		control over the quality of medical care provided to employees of the Belarusian NPP and their family members in medical organizations, as well as conducting medical checks of such employees and their family members;
	State sanitary supervision authorities and institutions	State sanitary supervision of compliance with legislation in the field of sanitary and epidemiological welfare of the population;
Ministry for Emergency Situations:	Department for Supervision of Safe Work in Industry	state supervision in the field of industrial safety
	Gosatomnadzor	supervision of compliance with legislation in the field of nuclear and radiation safety in the implementation of activities for the atomic energy and IRS use;
	state fire control service authorities	state fire control service supervision of compliance with legislation in

		the implementation of fire safety activities;
	bodies and divisions of state supervision and control over activities to protect the population and territories from emergency situations	state supervision and control in the field of protection of the population and territories from natural and man-made emergencies, as well as civil defense;
Ministry of Natural Resources and Environmental Protection	including its territorial units	supervision in the field of environmental protection, rational use of natural resources
Ministry of Labor and Social Protection	State Labour Inspection Department	supervision of compliance with labour legislation and labour protection
Ministry of Energy	state energy and gas supervision bodies	state energy and gas supervision
Ministry of Internal Affairs		control over implementing security activities;
	General Directorate of the Commander of the Internal Military Forces	control over compliance with the requirements of the approved project documentation at construction and installation work on equipping the Belarusian NPP with a complex of engineering and technical means of physical protection

Approaches to implementing inspections in relation to nuclear installations as one of the main tools for control and supervisory activities are constantly improved. In fact, following the outcomes of the IAEA Integrated Regulatory Review Service (IRRS mission) held in the Republic of Belarus in 2016 [<https://gosatomnadzor.mchs.gov.by/upload/iblock/65d/irrs-report.pdf>] and analysis of the Gosatomnadzor-developed practice of control and supervision measures, both types of inspections and approaches to their planning were adjusted. The IAEA IRRS follow-up mission that took place in the Republic of Belarus in 2021 (assessed the results of the country's addressing the recommendations of the 2016 IRRS mission) confirmed that the relevant recommendations on the types of inspections had been implemented.

For all government agencies, two main groups of inspections have been identified at the NPP site – comprehensive inspection and supervision in a permanent mode [36].

Comprehensive inspections are performed jointly by regulatory (supervisory) bodies (each body within its competence). The regulatory bodies in this case are coordinated by a Working Group to coordinate supervision of the Belarusian NPP construction involving top management of such state bodies (state organizations).

Supervision in a permanent mode is performed on scheduled and unscheduled basis (in response to an unplanned situation or when facts affecting safety are discovered). Such inspections are performed by supervisory authorities to promptly assess the safety status so as to prevent and restrain violations and eliminate their consequences at intervals established by supervisory authorities.

Gosatomnadzor, in order to promptly assess the safety status of the Belarusian NPP and to implement constant supervision, has created and organized the work of the corresponding territorial unit - the Division for Supervision of Nuclear and Radiation Safety at the NPP site (6 inspectors).

Supervision at the stage of operation of the Belarusian NPP is implemented in accordance with [37].

Based on the approaches of the IAEA and the country-supplier of technologies in the field of atomic energy use to the Republic of Belarus, Gosatomnadzor has developed and put into practice 3 main forms of state supervision in the field of nuclear and radiation safety, as well as licensing control. These forms include:

inspection – assessing compliance by the inspected entities with the legislation on nuclear and

radiation safety, terms and conditions of permits validity, following the requirements (prescriptions) of Gosatomnadzor with a visit to the facility for a visual inspection of the subject being inspected, objects in its handling and activities performed with them on-site, interviewing responsible officials and personnel, studying documents that confirm the fulfillment of certain established requirements. The inspection can be scheduled, unscheduled, in the mode of permanent supervision (applicable only for nuclear power facilities), announced or unannounced (sudden);

systematic monitoring and analysis of compliance by the audited entities with the legislation on nuclear and radiation safety, terms and conditions of licenses (permits) validity – assessing compliance with the established requirements based on the analysis of the results of inspections and other supervisory activities conducted by Gosatomnadzor, as well as analysis of documents submitted by the audited entity to Gosatomnadzor. Such documents may contain both information about fulfilling the established safety requirements, and information about organizational or technical solutions to be introduced at supervised facilities. To analyze most of these documents, no on-site visit required for Gosatomnadzor employees. Given the large number of documents submitted to Gosatomnadzor with respect to technologically complex facilities for the use of atomic energy or IRS, such work is implemented on an ongoing basis;

preventive and precautionary measures are systematically implemented activities aimed at communicating and clarifying the established safety requirements, as well as timely informing organizations about prerequisites for violating the established requirements at supervised facilities.

In terms of the most technologically complex supervised facility – the State Enterprise "Belarusian NPP", Gosatomnadzor, with the involvement of experts from regulatory authorities of other countries, prepared and implemented in 2021 the NPP Basic Supervision Program at the stage of its operation. The program includes 4 thematic areas with 11 thematic directions of supervision of nuclear power plants. The thematic areas include: NPP project management, operational safety and accounting for operational experience assurance, radiation safety, RW management, emergency preparedness and response, physical protection, accounting and control of nuclear materials, Operator's functioning sustainability, Operator's management systems, safety culture and leadership, personnel training system.

The safety assessment is planned and conducted both as part of the licensing process and as part of the assessment of the actual state of the nuclear installation.

The procedure for the review of documents justifying nuclear and radiation safety in implementing activities in the field of atomic energy and IRS use has been approved by the Government of the Republic of Belarus [30].

The safety review is conducted by expert organizations that have a license to perform works and (or) provide services for conducting a safety examination.

Safety review may involve foreign organizations being TSO of the nuclear technology supplier country, which do not have a license on the territory of the Republic of Belarus and are capable of providing a comprehensive, effective and high-quality safety review (experts thereof having the appropriate access to information of limited distribution (if necessary) under information, informatization, and information protection law).

The expert organization ensures that the safety review is performed in line with the established management system for safety purposes or a management system and (or) quality control of the licensed activity.

Gosatomnadzor publishes on its official website on the global computer network Internet a list of expert organizations and individual entrepreneurs entitled to conduct a safety review, as well as a list of experts who have been granted the right to conduct a safety review.

2 organizations have special permits (licenses) to conduct safety review in the field of atomic energy use in the Republic of Belarus: SSI JIPNR Sosny and the Research Institute for Nuclear Problems of the Belarusian State University (INP BSU).

Gosatomnadzor considers the expert opinion and assesses it for compliance with the requirements of the terms of reference for conducting a safety review. Following the results of the expert opinion consideration, Gosatomnadzor notifies the applicant and the expert organization in writing about admission or rejection of the expert opinion. In case of rejecting the expert opinion due

to its non-compliance with the terms of reference for conducting safety review, Gosatomnadzor returns the expert opinion to the applicant (except operating organization) for revision, stating the reasonable grounds for rejection in writing. The safety review is considered completed after the written notification by Gosatomnadzor of the applicant and the expert organization about the admission of the expert opinion.

The safety assessment of the actual state of the nuclear installation is conducted:

when making amendments to a special permit (license), including in the case of making amendments to documents justifying nuclear and radiation safety, based on the results of consideration of which a decision was made to issue a license [2];

as part of considering reports on the assessment of the current state of security of power units of the Belarusian NPP [2];

as part of considering documents containing the outcomes of the periodic safety assessment of a nuclear installation, storage facility, and justifying the safety of their operation [38];

as part of considering technical solutions and reports attached thereto on justification of modification security [39];

within the framework of control and supervisory measures carried out by Gosatomnadzor [36, 37].

For more detailed information on regulatory assessments and safety inspections, see Article 14.

#### **Article 7 (2) (iv) Enforcement of applicable regulations and terms of licenses**

Subject to the Regulation on Gosatomnadzor [40], Gosatomnadzor is empowered to control the implementation of legislation in the field of nuclear and radiation safety.

Should violations of the legislation are revealed in the course of supervisory activities, an inspection act is drawn up based on the results of the inspection. On the facts of the revealed violations, an administrative offence report (reports) can be drawn up and (or) a ruling in administrative offense case may be issued. Based on the act drawn up, a decision or demand is made to eliminate violations identified during the inspection. The decision on the inspection act, same as demand, is binding.

The legislation provides that in cases when violations constitute a threat to national security, harm to life and health of the population, the environment, a requirement is made to suspend the activities of the inspected entity, production sites, equipment, operation of vehicles, production and sale of goods (works services) on the day when the violation is detected. This requirement must indicate the time period for suspension and the time period for informing the supervisory authority that violations have been eliminated. The presence of facts that indicate signs of a crime gives the right to the supervisory authority to transfer the verification materials to the prosecution authorities.

The inspected entity has the right to appeal the decisions of the supervisory authorities under the inspection act, as well as the requirements to eliminate violations, actions or inaction of the inspectors.

In 2021, approaches to monitoring the implementation by licensees of licensing legislation, licensing requirements and conditions for exercising activities in the field of the use of atomic energy and IRS, including special licensing requirements and conditions [2, 3] were updated. The purpose of this innovation was to expand the forms of supervisory activities for the implementation by licensees-supervised organizations that have licenses. The previous Gosatomnadzor's practice of control and supervisory activities in this area indicated the need to introduce clearer mechanisms for monitoring compliance with licensing requirements, including forms of such control, documenting the evidence base, etc.

According to [2] when Gosatomnadzor reveals a violation by the licensee of licensing legislation, licensing requirements and conditions (hereinafter - violation):

not eliminated at the time of its revealing or during the inspection, Gosatomnadzor, within 15 working days from the date the violation was revealed, shall issues a requirement (prescription) to the licensee to eliminate the revealed violation and sets a deadline for its elimination, which may not exceed six months. In parallel with the issuance of a requirement (prescription) by Gosatomnadzor to



eliminate the revealed flagrant violation, the licensing authority has the right to suspend the license until the violation is eliminated, but not more than for six months;

committed by the licensee within 12 months after notification of the elimination of a similar violation, Gosatomnadzor is entitled to issue a new notice to eliminate the violation, suspend or terminate the license in due order.

Flagrant violations are:

violating established technological regulations, technological processes, instructions and programs, which could lead or has led to, an accident, incident, nuclear or radiation accident and the emergence of an immediate threat to human life or health and (or) the environment;

violating the limits and conditions of safe operation of a nuclear installation, storage facility, IRS determined in safety justifying documents;

failure to submit, untimely submission or submission by the licensee of incomplete or unreliable information about the changed state of safety of the facility that uses atomic energy, as well as concealment of information about the violating the limits and conditions of safe operation of the facility that uses atomic energy, or untimely notification of Gosatomnadzor about such violation, regardless of its consequences;

conducting reconstruction, modernization of the facility that uses atomic energy without making appropriate changes to the approved project and without safety assessment by the licensing authority of the results of making changes and (or) deviation from the approved project in the course of reconstruction, modernization of the facility that uses atomic energy, regardless of the consequences of such violations;

unjustified amending the established deadlines and volumes of periodic operational control of equipment and systems of nuclear energy facilities;

untimely replacement of the end-of-life equipment during operation of an atomic energy facility;

implementing works and (or) services by employees non-compliant with requirements;

implementing works and (or) services not specified in the license;

violating special license requirements and conditions.

Where the licensee has not eliminated the revealed violation within time limits specified in the demand (notice) for the elimination of the revealed violation and (or) failed to notify Gosatomnadzor in writing about elimination thereof, the licensing authority is entitled to decide on suspending the license for up to six months.

If the licensee did not eliminate the violation that has led to suspending the license within the specified time, the licensing authority makes a decision on termination of the license.

Should the fact of the licensee's implementing the licensed activity is revealed during the license suspension period, the licensing authority decides on termination of such license.

Failure to comply with the requirements of the legislation in the field of nuclear and radiation safety, administrative liability is envisaged in accordance with the Code of the Republic of Belarus on Administrative Offenses or criminal liability in accordance with the Criminal Code of the Republic of Belarus [41, 42]. Criminal liability arises when facts that indicate the signs of a crime as defined in the Criminal Code of the Republic of Belarus are established during the inspection.

## ARTICLE 8. REGULATORY BODY

*1. Each Contracting Party shall establish or designate a regulatory body entrusted with the implementation of the legislative and regulatory framework referred to in Article 7, and provided with adequate authority, competence and financial and human resources required to fulfill its assigned responsibilities.*

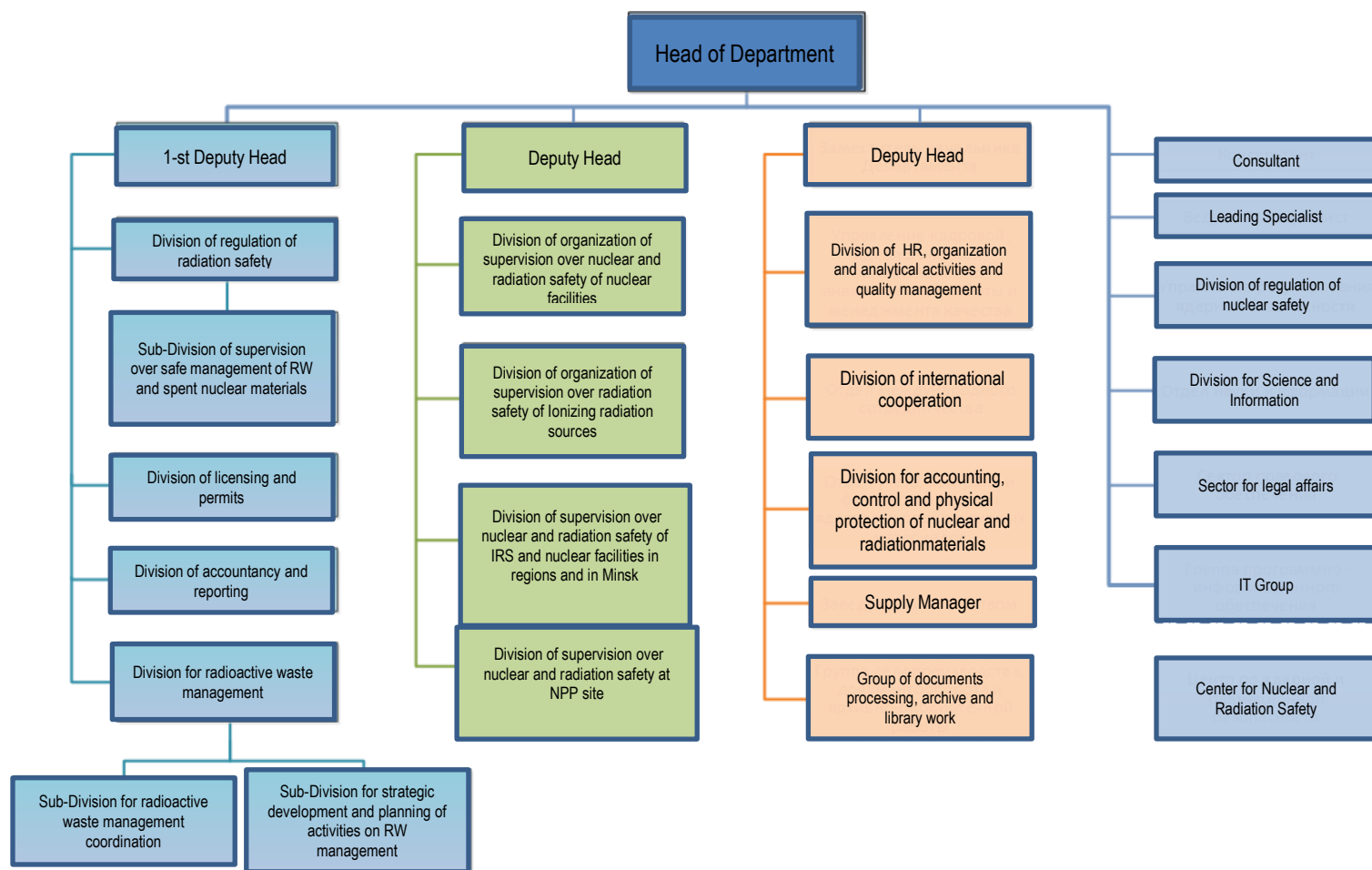
*2. Each Contracting Party shall take the appropriate steps to ensure an effective separation between the functions of the regulatory body and those of any other body or organization concerned with the promotion or utilization of nuclear energy.*

### **Article 8 (1) Establishment of a regulatory body**

In accordance with the Law of the Republic of Belarus "On the Use of Atomic Energy" of July 30, 2008 [6], Decree of the President of the Republic of Belarus No. 756 of December 29, 2006 "On Certain Issues of the Ministry for Emergency Situations" [40] to implement regulatory functions in the field of nuclear and radiation safety, Gosatomnadzor was established in 2007 as part of the MES – a separate structural unit with the rights of a legal entity, whose tasks and functions are enshrined in its Regulations [40]. Gosatomnadzor:

- develops regulatory requirements in the field of nuclear and radiation safety;
- reviews safety justifying documents and prepares draft decisions on the issue of licenses in the field of the use of atomic energy and IRS;
- organizes safety review of nuclear energy facilities and IRS, review of their design and project documentation, including with the involvement of independent experts;
- organizes and implements state supervision in the field of nuclear and radiation safety, supervision of compliance with licensing requirements and conditions;
- organizes scientific research to substantiate nuclear and radiation safety principles and criteria; coordinates the activities on RW management;
- ensures the functioning of the state system for accounting and control of nuclear materials, the unified state system for accounting and control of IRS;
- fulfills the international obligations of the Republic of Belarus to ensure nuclear and radiation safety in the use of atomic energy and IRS;
- participates in planning of protective actions to provide safety of maintenance personnel in case of nuclear and radiation accidents;
- informs the public on issues of nuclear and radiation safety in the country, organizes and conducts public hearings on issues related to regulation.

In the period from 2017 to 2022, the staffing structure of Gosatomnadzor was changing as new tasks and challenges arose. For example, in connection with the preparation of unit No. 1 of the Belarusian NPP for commissioning, the structure of Gosatomnadzor was revised in March 2019 and followed by enhancement of division responsible for organization of supervision over nuclear and radiation safety of nuclear facilities by redeployment of human resources considering existing knowledge and competences (increased by three persons), as well as consolidation of inspection staff in one division of supervision over nuclear and radiation safety of IRS and nuclear facilities in regions and in Minsk. The diagram shows the organizational structure of Gosatomnadzor (as of June 2022):



**Figure 1.** Organizational structure of Gosatomnadzor

The Gosatomnadzor IMS based on a process approach has been developed in line with the tasks and functions of Gosatomnadzor defined by requirements of the legislation of the Republic of Belarus, is evaluated and under continuous improvement.

The IMS introduction and improvement is supported by the Coordination Council chaired by the Head of Gosatomnadzor and deputy heads of Gosatomnadzor being its members.

The IMS requirements are specified in the Regulation on Integrated Management System (approved by the Gosatomnadzor order); the functional responsibilities, subordination, level of authority and interaction are enshrined in provisions on structural divisions, job descriptions, the order of the Head of Gosatomnadzor “On the Distribution of Duties between the Gosatomnadzor Head and Deputies” and other internal documents.

The IMS documents establish the mission and vision, strategic directions. Due to the commissioning and operation of the Belarusian NPP, changes in the legislation, the studied international experience in the field of regulation, the top level strategic documents were updated (the Gosatomnadzor Policy and Strategy in the field of nuclear and radiation safety were updated for 2021-2025 and approved by the decision of the Gosatomnadzor Board, the work was conducted with support of European experts).

In order to achieve the anticipated results of implementing the Regulatory Strategy, strategies in certain areas of activity with the view to optimize and coordinate planned actions, deadlines and use of resources, annual planning of Gosatomnadzor activities is provided using a differentiated approach.

To improve the performance of the functions of Gosatomnadzor, its activities are continuously assessed by the administration of Gosatomnadzor and of the Ministry for Emergency Situations. Gosatomnadzor is continuously improving its activities by utilizing the results of:

internal audits;

analysis of reports from the concerned parties (including claims, reclamations, etc.), requests from the Gosatomnadzor web-site, information obtained at on-site general meetings at the Belarusian NPP construction site, meetings on the issues of nuclear and radiation safety during the construction of the Belarusian NPP;

the study of experience of the regulating authorities in other countries, etc.

The regulating infrastructure is constantly improving in line with the main safety principles and IAEA requirements. There is a wide use of expert assessment instruments: IAEA missions IRRS 2016, EPREV 2018, ISSAS 2019, INIR Phase 3 2020, IPPAS 2021, IRRS Follow-up 2021, following which the Government approves national action plans for implementing recommendations and proposals, provides annual monitoring of their implementation. In particular, the IRRS Follow-up 2021 experts concluded that over the past five years Belarus has significantly improved its regulatory infrastructure for nuclear safety. In addition, when conducting self-assessments prior to the missions, the involved bodies of Belarus identified measures to eliminate gaps and improve activities, the implementation of which starts before obtaining recommendations from missions. For example, the IRRS mission proposals and recommendations coincided with the country self-assessment conducted before, and the draft action plan based on its results, which demonstrates that Belarusian specialists understand the IAEA safety standards and ways to achieve them.

In 2018, a peer review of the stress tests results at the Belarusian NPP was conducted by a group of the European experts ENSREG. The final ENSREG Peer Review Report was reviewed and approved at the ENSREG plenary meeting (24.11.2021). The actions of the Republic of Belarus to implement the ENSREG recommendation were positively assessed.

The allocation of resources in solving the tasks assigned to Gosatomnadzor is based on such aspects as importance for safety, and is commensurate with the complexity of the activity and the associated radiation risks and the ability to control them.

The activity of Gosatomnadzor is financed from the State budget and other sources in accordance with the legislation, irrespective of the funds of organizations and authorities responsible for promotion and implementation of nuclear and radiation technologies.

Financing from the republican budget is annually justified and requested for actions associated with nuclear and radiation safety to ensure the activities of Gosatomnadzor (labour remuneration, business travel expenses, equipment and software procurement, etc.), as well as financing of expert and consulting assistance, arrangement of scientific research, professional development and advanced training of employees.

The Government of the Republic of Belarus supported implementation of important additional national instruments to ensure scientific and technical support in realizing nuclear program, as well professional development of specialists of the regulatory body. These are two state programs with allocating appropriate republican budget:

subprogram 8 "Training of personnel for nuclear power" of the State Program "Education and Youth Policy" for 2021-2025 approved by the Resolution of the Council of Ministers of the Republic of Belarus No. 57 of January 29, 2021 [43] (earlier – the State Program of Personnel Training for Nuclear Power of the Republic of Belarus for 2016-2020).;

subprogram 6 "Scientific support for the development of nuclear energy in the Republic of Belarus" and subprogram 3 "Scientific support for the efficient and safe operation of the Belarusian NPP and prospective areas of nuclear energy development "The State Program "High technologies and Equipment" for 2021-2025 (earlier – the State Program "Scientific support for the Development of Nuclear Energy in the Republic of Belarus for 2016-2020").

At present, the regulatory body has sufficient number of competent and qualified employees commensurate with the character and the number of facilities and the scope of activity for efficient and successful implementation of all relevant types of activities in the fields associated with safety, at a proper time.

There is an ongoing implementation of the complex of planned training activities aimed at acquiring and continuous improvement by employees of knowledge and skills required for the performance of job duties as well as improvement of their qualifications in order to ensure the fulfillment of tasks considering the transition to the stage of operation of the Belarusian NPP units:

areas of professional competence have been identified; job profiles have been developed; individual training plans of employees are developed and implemented annually considering all sources of funding and previous training. Special attention in Gosatomnadzor is given to professional training of the staff engaged in safety analysis and assessment, executing state supervision in the field of nuclear and radiation safety.

The intensive development and maintenance of competencies involves both internal and external sources (the budget of Gosatomnadzor, subprogram 8 "Training of personnel for nuclear power" of the State Program "Education and Youth Policy" for 2021-2025, IAEA and the European Commission projects of international technical assistance).

To improve the efficiency of performing regulatory functions of Gosatomnadzor, training plans for Gosatomnadzor personnel were elaborated and implemented according to the special curricula (study of operation of equipment and systems of Belarusian NPP) in the training center.

The format of international cooperation has been expanded; within the framework of bilateral agreements at the intergovernmental and interdepartmental levels, Gosatomnadzor cooperates with regulatory bodies of countries operating WWER-type reactors: the Russian Federation, Ukraine, Armenia, Hungary, Finland. The implementation of agreements on cooperation in the field of nuclear and radiation safety with countries such as Austria, Latvia, Poland, Slovakia, Slovenia, TSO of the Russian Federation, France, Germany, Ukraine, has been ensured. Interaction was intensified with the regulatory body of the Russian Federation, the nuclear technologies supplying country, Rostehnadzor and its TSO JSC "VO "Safety", Federal Budgetary Institution "Scientific and Engineering Centre for Nuclear and Radiation Safety" (advisory support in implementing individual inspections at the Belarusian NPP construction site, safety assessments, on-the-job training on the issues of supervision at the stages of commissioning and operation of nuclear power plants at Novovoronezh, Leningrad, Balakovo NPP).

There is an ongoing interaction within the framework of the Forum of the State Nuclear Safety Authorities of the Countries Operating WWER Type Reactors (WWER Forum); also, until February 2022, interaction implemented within the framework of the Regulatory Cooperation Forum (RCF), Western European Nuclear Regulators Association (WENRA).

Until 2022, within the framework of the European Commission's project BY3.01/16, an onsite expert mission had been working in the Republic of Belarus, which included representatives from France, Germany, and Ukraine. Mission experts provided assistance to Gosatomnadzor by consulting on strategic and operational issues in all fields of regulatory activities in nuclear and radiation safety.

Subject to the IAEA requirements, the presence of an expert community with a wide range of competencies in the field of nuclear and radiation safety and related fields is considered an integral attribute of regulatory infrastructure in countries with developed energy.

A system of scientific and technical support of the regulatory body in the field of nuclear and radiation safety has been formed to implement international requirements and recommendations regarding the scientific and technical support independence. The Government Decree [31] defines a list of 16 leading organizations of the country to provide scientific and technical support to the regulatory body in the field of nuclear and radiation safety. Based on the Decree of the President of the Republic of Belarus [18], the State Scientific Technical Institution "Centre for Nuclear and Radiation Safety" was created within the structure of the regulatory body to implement coordinating functions between TSO, as well as to ensure a more efficient and responsive scientific and technical support.

In the Republic of Belarus, the right to conduct safety review in the field of atomic energy use was given to 58 experts from the country's leading organizations, 12 experts in the field of the IRS use, 4 experts have permits in both fields. The formation of expert pool by the regulatory authority is ongoing.

Gosatomnadzor annually provides internships, trainings, advanced training of experts and specialists of TSO of the Ministry for Emergency Situations in the field of nuclear and radiation safety according to plans developed in the framework of the European Union's Training and Tutoring Projects (T&T), IAEA regional and national technical assistance projects.

In particular, TSO specialists and experts are trained to methods of software use on the example of COCOSYS, ATHLET, ASTEC, DIN3D, Riskspektrum, Raduga, Jrodos calculation

codes, as well as practical calculations with methodological support from European experts within the framework of the European Union international technical assistance project. The COCOSYS, ATHLET, ASTEC, DIN3D, Serpent program codes were transferred to the Republic of Belarus at no charge, Riskspektrum, Rainbow, RecassNT were financed from the State budget. In the framework of the EU international technical assistance project, a mobile radiation laboratory has been delivered and is currently being used by Gosatomnadzor and the Center.

Due to the long-term nature of the nuclear power program, human resources covering several generations are required, in view of which Gosatomnadzor is working on developing a comprehensive and systematic approach to identify, acquire, create, distribute, use and retain knowledge related to the achievement of goals set in line with the Gosatomnadzor Policy and Strategy.

To ensure the openness and transparency of the activities of the regulatory body, Gosatomnadzor provides public information on safety status of radiation facilities, nuclear installations, and nuclear power facilities according to the Regulations on Gosatomnadzor [40]. For the purpose of strategic planning, the Information and Communication Strategy of Gosatomnadzor was developed in 2013 and updated in 2021. The document provides a detailed description of target audiences, topics, forms and methods of communication, information flows schemes. As part of the Strategy implementation, communication channels have been established and maintained (including the Gosatomnadzor Internet resource <https://gosatomnadzor.mchs.gov.by/>), interaction with media is organized, first of all – with BELTA leading state news agency, regular press events, the release of annual reviews of the state of nuclear and radiation safety in the Republic of Belarus, other information products; the practice of conducting information hours in public administration bodies and organizations of the Republic of Belarus is widely used.

Following the openness and transparency principles, the Ministry for Emergency Situations and Gosatomnadzor publish in the public domain on their Internet resources national reports on the fulfillment of obligations under the Convention, the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, assessment missions and peer review reports, and other official documents.

The country has created a legal framework for organizing and for holding public hearings at the stage of decision-making on regulating activities in the field of safety in the use of atomic energy, affecting the security of the Belarusian NPP, in particular:

Decree of the President of the Republic of Belarus No. 62 of February 16, 2015, as amended on February 18, 2019 [17], which assigned Gosatomnadzor the right to organize and conduct such hearings in the manner and cases determined by the Government;

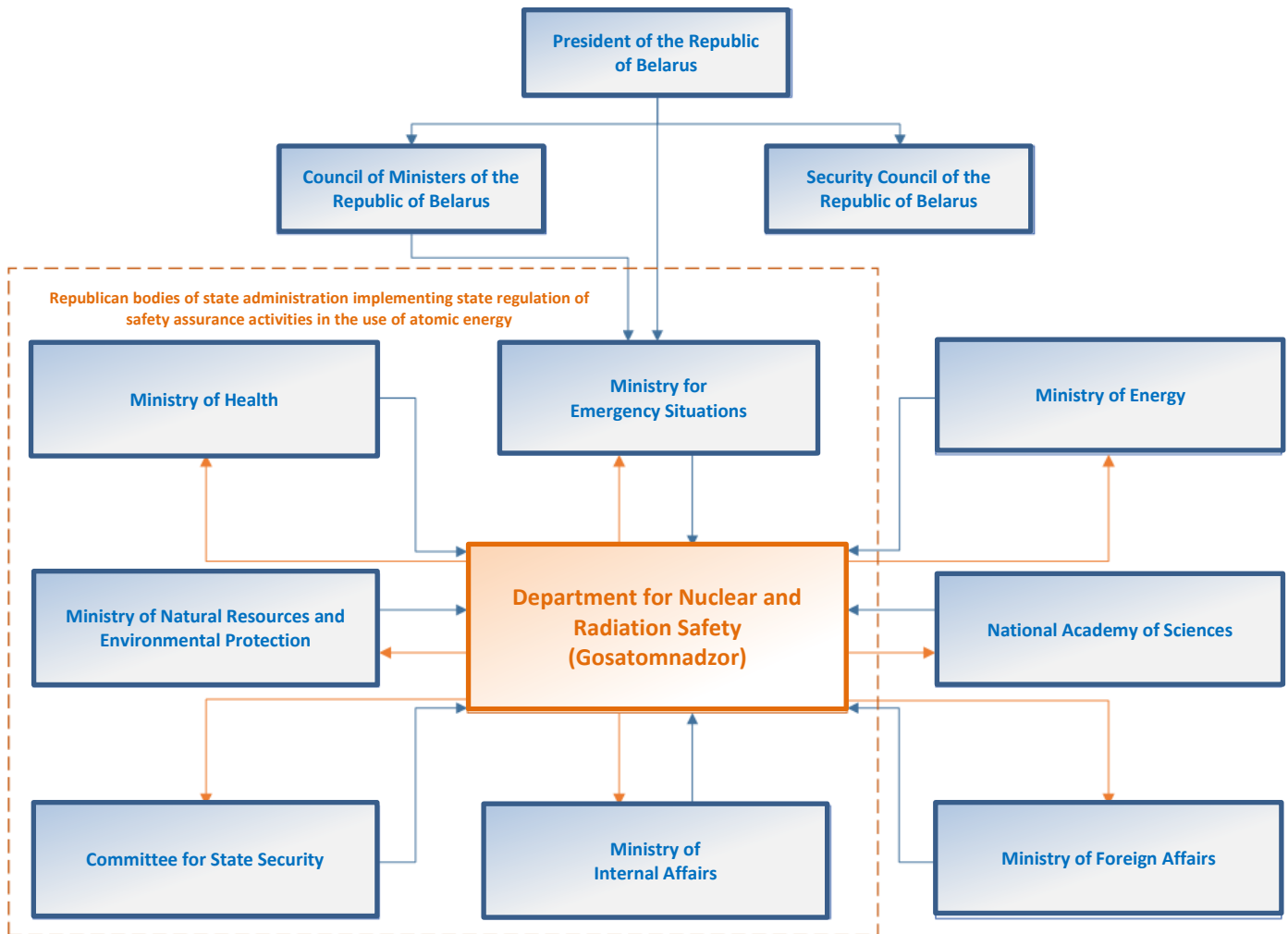
Resolution of the Council of Ministers of the Republic of Belarus No. 258 of April 24, 2019 approving the Regulation on Public Hearings on Safety Regulation of the Belarusian NPP [44].

On April 30, 2021, Gosatomnadzor held the Belarusian regulatory body's first ever public hearings before issuing a license to operate unit No. 1 of the Belarusian NPP. Given the epidemiological situation, public hearings were held in a "hybrid" format using videoconferencing. 9 active studios, the main being in Ostrovets and others being in regional centers and in Minsk, were involved, to which citizens, representatives of organizations and the public were invited. The mass media and representatives of 12 foreign and international organizations, watched the course of the public hearings through videoconferencing. The information obtained in the course of public hearings was taken into account at subsequent preparation and decision-making on the issue of a license for the operation of the Belarusian NPP unit No. 1, the formation of the license terms and conditions.

It is planned to hold public hearings before issuing a license for the operation of power unit No. 2 of the Belarusian NPP.

### Article 8 (2) Status of a regulatory body

The scheme of key public administrative and regulatory authorities involved into nuclear and radiation safety, the use of atomic energy in the Republic of Belarus has not changed and is shown on the figure.



**Figure 2.** Scheme of key public administrative and regulatory authorities involved into nuclear and radiation safety, the use of atomic energy in the Republic of Belarus

The State bodies for safety regulation in the use of atomic energy and IRS in terms of exercising their powers related to state regulation of safety, control and state supervision of activities related to the use of atomic energy and IRS, are independent of the republican bodies of state administration and other state organizations exercising state administration in the field of atomic energy and IRS use [1, 6].

The Ministry for Emergency Situations reports to the Council of Ministers of the Republic of Belarus, inline with its powers in the field of nuclear and radiation safety maintains direct communication with state (governmental) bodies if higher level in cases where such communication may be necessary to effectively exercise the functions of the regulatory body.

Financing and logistical support of the Ministry for Emergency Situations are provided from the republican and local budgets, as well as other sources not prohibited by law.

To fulfil its tasks and functions, the Ministry for Emergency Situations has the right:

to verify compliance by republican state administration bodies, local executive and administrative bodies, other organizations and citizens with legislation in the field of preventing and eliminating emergencies of natural and man-made character and civil defense, ensuring fire, industrial, nuclear and radiation safety, eliminating the Chernobyl disaster consequences, creating and ensuring the safety of the mobilization material reserve, to hear representatives of organizations on issues related to the competence of the Ministry for Emergency Situations, to make mandatory

instructions to address the revealed drawbacks;

to request and receive, in due order, from republican bodies of state administration, local executive and administrative bodies and other organizations, information necessary to fulfill obligations assigned to the Ministry for Emergency Situations.

The direct management of the activities of the Ministry for Emergency Situations is implemented by the Minister for Emergency Situations (hereinafter referred to as the Minister) who is personally responsible for performing obligations assigned to the Ministry for Emergency Situations.

Gosatomnadzor performs regulatory functions in such a way as not to jeopardize its effective independence.

Gosatomnadzor is headed by the Head appointed and dismissed by the President of the Republic of Belarus upon the proposal of the Minister.

Head of Gosatomnadzor is subordinate to the Minister for Emergency Situations, manages Gosatomnadzor activities and is personally liable for implementing its tasks and functions.

Examples demonstrating the independence of Gosatomnadzor in decision-making:

in line with the Regulation on State Supervision in the Field of Nuclear and Radiation Safety [37], state supervision in the field of nuclear and radiation safety is performed by Gosatomnadzor, based on results of which Gosatomnadzor draws up and sends inspection reports to the supervised organizations;

Gosatomnadzor has the right to issue, within its competence, mandatory written instructions to address breaches of the legislation in the field of nuclear and radiation safety, including instructions on the complete or partial suspension of activities for management of IRS, the use of atomic energy, operation of IRS, radiation facilities, facilities for the use of atomic energy, requirements (prescriptoins) to eliminate revealed violations of licensing legislation, licensing requirements and conditions [2, 17, 37, 40];

Gosatomnadzor sets the deadlines for the assessment and (or) examination of the safety of the license applicant based on the scope of documents submitted by them for obtaining a license for the right to implement activities in the field of atomic energy and IRS use [2];

decision-making on licensing issues is performed by the Board of the Ministry for Emergency Situations based on Gosatomnadzor conclusions [2];

when performing a safety review within the licensing process for nuclear facilities, Gosatomnadzor provides for producing a summary report for the public, and after completing the safety review and assessment of the applicant's compliance with licensing requirements and conditions, before making a decision on issuing a license for the operation of a nuclear installation, public hearings are held;

the current legislation grants the regulatory body the right to amend the licensing requirements and conditions, information about which is specified in the license, including on supervision results [17];

based on results of supervision and other regulatory activities, Gosatomnadzor initiates consideration of issues at meetings of the Inter-ministerial Commission for Coordination of the Plan of Basic Organizational Measures for the Construction of a Nuclear Power Plant in the Republic of Belarus, the National Commission for Radiation Protection under the Council of Ministers of the Republic of Belarus, the Working Group for Coordination of Supervision of the Construction of the Belarusian NPP, followed by the adoption of instructions to public administration bodies and organizations, and implementing safety-related activities.

The Republic of Belarus has established a regulatory framework for nuclear and radiation safety meeting the IAEA requirements and recommendations. This system is subject to continuous improvement, taking into account the recommendations of assessment missions and peer reviews, the emergence of new IAEA documents summarizing the experience of participating countries and their own experience.



## ARTICLE 9. RESPONSIBILITY OF THE LICENCE 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 each such license holder meets its responsibility.*

In the Republic of Belarus, licensing of activities in the field of atomic energy and IRS use is governed by the Regulation on licensing activities in the field of the use of atomic energy and IRS [2]. The specifics of the licensing process, as well as the works and (or) services subject to licensing that constitute activities in the field of the use of atomic energy and IRS, are specified in Article 7 (2) (ii) hereof.

In accordance with [6], the operating organization develops and implements measures to maintain and enhance the safety of a nuclear facility, creates, if necessary, appropriate services that monitor safety, and submits information on the state of safety of these facilities to State regulatory authorities when using atomic energy within deadlines set by them.

The operating organization provides:

- use of a nuclear facility and (or) storage facility only for the purposes for which it is intended;
- organization and conduction of work in such volume and quality that meets the requirements of technical NLA at all stages of siting, design, construction, commissioning, operation, limiting operational characteristics, extending the operation lifetime, decommissioning of a nuclear facility and (or) storage point;

- development and implementation of measures to prevent the emergence of a radiation accident at implementing activities for the use of atomic energy and to reduce its negative consequences for employees (personnel), citizens and the environment;

- safe management of nuclear materials, spent nuclear materials and (or) operational radioactive waste for employees (personnel) and citizens;

- formation and targeted use of the decommissioning fund for a nuclear facility and (or) storage facility and the fund for financing work to maintain and improve the safety of a nuclear facility and (or) storage facility;

- realization of the rights of employees (personnel) for social guarantees;

- accounting of individual radiation doses of employees (personnel);

- development and implementation of measures to protect employees (personnel) and citizens in the observation area in case of a radiation accident at implementing activities for the use of atomic energy;

- accounting and control of nuclear materials, spent nuclear materials, operational RW and other IRS;

- implementing physical protection of facilities that use nuclear energy; developing and implementing fire safety measures at a nuclear installation and (or) at a storage facility;

- radiation control and radiation monitoring in the sanitary protection zone and the supervised area;

- selecting, training, retraining and maintaining the appropriate qualifications, as well as the necessary number of employees (personnel);

- informing about the radiation situation of citizens in the supervised area;

- performing other duties established by the legislation.

The operating organization, in accordance with the legislation, is liable for non-compliance with the requirements for ensuring the safety of a nuclear installation and (or) a storage facility.

Where decisions are made in due order on suspending or terminating a special permit (license) giving the right to operate a nuclear facility and (or) a storage facility, the republican government authority or other state organization responsible for these facilities shall take measures to ensure their safety. If renewal of such special permit (license) is not possible, the relevant republican government authority or other state organization in charge of these facilities shall take measures to create a new

operating organization.

Based on licensing legislation [2, 30], control over the implementing by licensees of licensing legislation, licensing requirements and conditions for the performance of activities in the field of atomic energy and IRS use including special licensing requirements and conditions, (hereinafter referred to as license control) is carried out by Gosatomnadzor.

Should special knowledge in the fields of science, technology and other fields is required to solve issues arising during licensing control, Gosatomnadzor has the right to involve experts, specialists, expert organizations to implement licensing control in order to conduct research, testing, technical examinations, examinations, sampling and samples.

Where the application submitted by the license applicant contains false information necessary (relevant) to make a decision on the license issue, the licensing authority decides on refusal of issuing a license to the applicant.

The specifics of law enforcement practice when a licensing or other state authority reveals the breach of licensing legislation or established requirements and conditions for implementing the licensed activity by the licensee, are described in Article 7 (2) (iv) hereof.

The licensee maintains an open and transparent communication with the public through planning and implementing his information activities using various information channels. In particular, RUE "Belarusian NPP" implements it through its own website <http://www.belaes.by/>, information centers in Ostrovets and Minsk, through interaction with media, participation in information and other events.

## ARTICLE 10. PRIORITY TO SAFETY

*Each Contracting Party shall take the 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.*

### *Legislative framework*

The principles of performing activities on the use of atomic energy are defined in the Law of the Republic of Belarus "On the Use of Atomic Energy" [6]:

the priority of protecting the life and health of present and future generations of citizens, environmental protection over all other aspects of the use of nuclear energy;

ensuring the excess of benefits for citizens and society from the use of atomic energy over the harm that might be caused by activities for the use of atomic energy;

nuclear and radiation safety assurance;

compensation for damage caused by the harmful impact of IRS or activities related to the use of atomic energy;

providing complete, reliable and timely information related to the use of atomic energy, if the same does not contain information constituting state secrets or does not relate to information dissemination and (or) provision of which is limited;

ban on the production of nuclear weapons and other nuclear explosives.

The General Safety Provisions (GSP NPP) [5] defines that the operating organization ensures the NPP safety including measures to prevent accidents and reduce their consequences, accounting and control, physical protection of nuclear materials, radioactive substances and radioactive waste, radiation control and monitoring of the state of the environment in the sanitary protection zone and the supervised area, and also ensures the use of the NPP only for purposes for which it was designed and constructed. The operating organization is fully responsible for the safety of the NPP. The liability of the operating organization is not removed in connection with the independent activity and responsibility of organizations that perform work or provide services for NPP, as well as the activities of government bodies exercising state regulation of safety activities in the use of atomic energy.

The regulatory body has established requirements for the formation and maintenance of a safety culture in the operating organization, as well as for the integration of such activities with operating organization management systems [5, 45]. Besides, the regulator has issued a safety manual offering ways to meet the established requirements [46].

All employees and organizations involved in placement, construction, operation and decommissioning of nuclear power plants, design, construction and manufacture of their systems and elements should develop and maintain safety culture.

The operating organization should implement management to ensure safety.

### **Licensee's (Belarusian NPP State Enterprise) measures to implement the priority of nuclear safety**

Based on the Decree of the President of the Republic of Belarus No. 124 of March 29, 2011 "On measures for the implementation of international treaties in the field of civil liability for nuclear damage" [47], the Belarusian NPP State Enterprise is the operator (operating organization) of nuclear facilities - power units No. 1 and No. 2 of the Belarusian NPP. The main objectives of this enterprise as an operator are to implement activities for siting, construction, commissioning, operation and decommissioning of nuclear power plant, and other activities as envisaged by the Law of the Republic of Belarus of July 30, 2008. "On the Use of Atomic Energy" [6].

The highest priority principle in ensuring safety has been declared by the management of the State Enterprise "Belarusian NPP" in the State Enterprise "Belarusian NPP" Safety Policy.

Nuclear safety presumes the fulfillment of a set of organizational and technical requirements and measures to exclude the possibility of a nuclear accident. Its aim is to protect citizens and the environment from the harmful effects of ionizing radiation by ensuring the proper operating

conditions of the nuclear facility and (or) storage facility, as well as proper handling of nuclear materials and used nuclear materials.

For the construction of the Belarusian NPP, a project was selected that corresponds to the modern level of development of nuclear energy and meets the modern safety requirements. The project was developed in line with the requirements of the regulatory documents in the field of the use of atomic energy of the Russian Federation that are binding in design, construction and operation of NPPs. International experience in operating WWER-1000 type reactors, the IAEA recommendations and safety standards, the requirements of European operating organizations for new generation nuclear power plant designs with LWR reactors, as well as the NRC materials, were used. The Belarusian NPP was designed to be resistant to the impacts similar to those at Fukushima Daiichi NPP.

The design of the Belarusian NPP provides for the availability of safety systems and involves engineering solutions and the system of necessary measures applying which in the accidents within and beyond the design brings the reactor unit into a controlled state characterized by stabilization of its parameters. The use of special technical systems and tools allowed by the project makes it possible to reserve the basic safety functions and ensure the appropriate level of nuclear safety of the Belarusian NPP. Such systems include:

- passive residual heat removal system from containment;
- passive residual heat removal system via steam generators;
- core melt localization device;
- containment hydrogen control system.

The project stipulates a double containment dome, which together with other localizing systems provides reliable retention of radioactive products during normal operation, anticipated operational occurrences, accidents within and beyond the design.

Based on the set requirements [32], the operator has developed and submitted to Gosatomnadzor documents justifying nuclear and radiation safety, including SAR, technological regulations for the safe operation of the power unit, PSA, instructions for accident management, accident response instructions, instructions, programs and schedules for maintenance, repair, testing and inspections of systems important for security, etc.

At the stage of licensing the operation of power units of the Belarusian NPP, the following have been developed: "Final SAR (preliminary edition)", providing information corresponding to the actual state of the NPP according to the results of construction, manufacture, installation, pre-commissioning and inspections at the power unit; "Level 1 PSA for internal initial events, internal fires and flooding, external extreme impacts of natural and man-made nature, seismic impacts"; "Level 2 PSA for internal initial events, internal fires and flooding, external extreme impacts of natural and man-made nature".

Based on the results of the analysis of thebdba modes of the Belarusian NPP outlined in the SAR (preliminary edition), the ability to manage beyond design accidents has been demonstrated, which in turn allows to effectively limit their consequences. The project takes into account significant external impacts: explosions; floods; air crashes; hurricanes, whirlwinds, tornadoes; snow and ice loading; seismic effects. In performing the safety analysis of the Belarusian NPP, the considered basic list of possible initiating emergency events, based on the requirements of regulatory documents, was expanded taking into account:

- design features of the NPP under construction; configuration of safety systems in the project of the NPP under construction; many years of experience in designing and operating existing NPP power units with WWER reactors;
- licensing projects for power units with the WWER reactors in the Russian Federation;
- IAEA recommendations;
- results of the PSA of levels 1 and 2.

Based on the obtained results of the quantitative assessment performed within the Levels 1 and 2 PSA for nuclear fuel in the core and the SNF cooling pool, when operating at the nominal power level, reduced power levels and shutdown state: the probability of severe accidents for 1 year is  $8.57 \cdot 10^{-7}$  (1/year), the average value of the total probability of a large accidental emission in 1 year is  $8,61 \cdot 10^{-8}$  (1/year). The PSA was made given the primary initiating events, primary fires and floods,

external extreme influences of the natural and man-made character and seismic effects during the unit operation at nominal power level, reduced power levels and in the shutdown state for the nuclear fuel in the core and in the SNF cooling pool. This parameter corresponds to the 3+ generation reactors (reactors with passive safety systems).

As part of the preparation for industrial operation the State Enterprise "Belarusian NPP" elaborated a Plan for the implementation of a system of measures for sustainable independent functioning of the State Enterprise "Belarusian NPP" as an operator. The plan includes measures, including further improvement of: approaches to demonstrating leadership in safety issues, the level of safety culture, the efficiency and effectiveness of the IMS, personnel training system, ensuring interaction with WANO structures, international organizations, TSO, etc.

Based on the GSP NPP requirements [5], Gosatomnadzor has submitted the final SAR of the Belarusian NPP unit No. 1, adjusted taking into account the results of pre-commissioning, physical and power start-ups, pilot operation. Changes based on the results of pre-commissioning affecting the operating conditions of the power unit, were previously made to the preliminary edition of the SAR and passed a safety assessment by the time the license for the operation of unit No. 1 of the Belarusian NPP was issued.

#### *Safety culture*

The system of measures aimed at maintaining and continuous improving the level of safety culture in the operating organization comprises the following main activities:

continuous personnel training on safety culture issues;

formation of commitment to a safety culture in day-to-day activities of operator's units;

the safety culture monitoring;

annual assessment of the state of safety culture in the form of the final day of safety culture;

developing and implementing measures to improve the safety culture on an annual basis.

In fact, the operator's local legal acts establish mandatory training and knowledge inspection of newly accepted employees according to the curriculum "Safety Culture". The level of personnel safety culture in performing their routine work is assessed regularly. Improving the safety culture of personnel is provided as part of implementing programs to maintain and improve the skills of NPP employees.

In order to create the necessary conditions for the continuous improvement of the safety culture, both at the organizational level and at individual level, to promote adherence to the safety culture among employees, to maintain an atmosphere of trust and openness in safety issues, an advisory coordinating body was created under Director General of the operating organization - the Council for Safety Culture of the State Enterprise "Belarusian NPP".

In order to facilitate the effective functioning of the system for formation and maintenance of the safety culture, executives in charge of safety culture were appointed in the structural units of the Belarusian NPP.

Based on the assessments and monitoring of the state of culture in accordance with the Regulations on the formation and maintenance of the safety culture of the State Enterprise "Belarusian NPP", the "Action Plan for the formation and maintenance of the safety culture at the State Company "Belarusian NPP" for the current year is developed and approved at the level of the Director General.

#### *Independent Safety Assessments:*

For continuous improvement of safety of the Belarusian NPP independent supervisory commissions are invited for the consideration of separate issues of safety provision, including those under the IAEA auspices:

October 2016 – Integrated Regulatory Review Service (IRRS);

January 2017 – Site and External Events Design Review Service (SEED);

October 2018 – Emergency Preparedness and Response Review Service (EPREV);

May 2019 – Safeguards and SSAC Advisory Service (ISSAS);

August 2019 and October 2021 – Operational Safety Review Team (OSART);

June-July 2021 - International Physical Protection Advisory Service (IPPAS).

Targeted implementing of recommendations and consideration of mission suggestions has

been ensured.

In 2016-2018, stress tests were conducted at the Belarusian NPP by the procedure of the European Nuclear Safety Regulators Group (ENSREG). The Peer Review of their results was conducted by European Nuclear Safety Regulators. In 2021, the Republic of Belarus hosted 2 visits of experts from the European Commission and the European Nuclear Safety Regulators Group (ENSREG) as part of the peer review of the National Action Plan based on the Belarusian NPP stress tests results.

### **Control and supervision over measures implemented by the Belarusian NPP State Enterprise with the purpose of prioritized attention to safety**

At nuclear energy use facilities Gosatomnadzor, with the view to increase the effectiveness of control and supervisory measures, initiated and subsequently enshrined in law the implementation of inspections in a permanent supervision mode – without any restrictions on the frequency and duration of such inspections [17, 36, 37]. To ensure that, Gosatomnadzor has created and provided the work of inspection unit directly on site of the Belarusian NPP in the number of 6 employees. Various types of control and supervisory tools are provided for inspection, including scheduled and unscheduled inspections, walkdown inspections, announced and unannounced inspections. The legislative powers of the inspectors ensure unfettered access at any time to the NPP site.

The Gosatomnadzor inspection program includes all aspects of the operator's activities that can affect or directly affect safety – both organizational aspects related to the functioning of enterprise management systems, and technical ones related to the organization of work with specific equipment on site, as well as the condition of such equipment.

At the most significant (*regarding the basis laid for the subsequent safe operation of the facility*) stage of the NPP life cycle – construction and commissioning of power units – the permanent supervision mode is enshrined in law [17] and for other (except Gosatomnadzor) state bodies (organizations) implementing types of control and supervisory activities in the Republic of Belarus related to the provision of various aspects of safety. A tool is provided for organizing interaction and coordination of their activities on site – a Working Group involving the top management of such state bodies (state organizations), as well as a separate type of inspections – comprehensive inspections [36] performed with the participation of all or most of these state bodies. This approach was subsequently noted by the IAEA peer review [<https://gosatomnadzor.mchs.gov.by/upload/iblock/65d/irrs-report.pdf>] as a "good practice" – to recommend its use in other countries with a nuclear program.

In the time of construction and commissioning of the Belarusian NPP, Gosatomnadzor also conducted inspections of manufacturers and suppliers of key equipment important for safety with a visit directly to production facilities.

In terms of the most technologically complex supervised facility – the State Enterprise "Belarusian NPP", Gosatomnadzor, with the involvement of experts from regulatory authorities of other countries, prepared and implemented in 2021 Basic Program for the NPP Supervision at the Stage of its Operation. The program includes 4 thematic areas and 11 thematic directions of supervision of nuclear power plants.

Performing control and supervisory measures involves a differentiated approach aimed at prioritized allocation of resources of the regulatory body for assessing the most potentially dangerous (in terms of the consequences of non-compliance with the established safety requirements) aspects. At the moment, work is underway to improve the graded approach, in particular, in terms of introducing a risk-oriented model of planning and conducting control and supervisory measures based on NPP safety indicators. The work is performed with the involvement of TSO as part of scientific activities.

Following the initiative of Gosatomnadzor, in 2021, in the legal field of the Republic of Belarus [2], licensing control was defined as a separate type of control and supervisory activity – control over implementation by licensees of licensing legislation, licensing requirements and conditions for activities in the field of atomic energy and IRS use, including special licensing requirements and conditions. Before, such activities were carried out as part of state supervision in the field of nuclear and radiation safety.

A requirement of annual safety assessment by the operating organization is established, as well as by organizations involved in work and providing services to the operating organization, including an appropriate report submission to the regulating body. Assessment of the submitted reports is implemented by Gosatomnadzor with the involvement of the State Scientific Technical Institution "Centre for Nuclear and Radiation Safety". The outcomes of such assessment are the basis for the development and adoption by Gosatomnadzor of appropriate regulatory measures.

The requirement for reporting on issues of aging management, performing work on systems important for safety (modifications, welding, etc.) are identified by Gosatomnadzor in special licensing requirements and conditions of the operating organization.

The requirements of the Nuclear Safety Rules of the NPP reactor system [48] identify that prior to the inspection of the Gosatomnadzor with regard to the operating organization, self-checks of readiness for the transition from one stage of commissioning to another are performed, the frequency of internal inspections of the operating organization is established. In addition, the EA prepares and provides self-verification certificates as part of the RS transition from one state to another. The submitted self-verification acts are considered by Gosatomnadzor, among other documents within the framework of control and supervisory activities and licensing and permitting activities.

The operating organization, in accordance with the special licensing requirements and conditions established by Gosatomnadzor, analyzes the impact on safety of identified deviations from new requirements, develops and implements measures to eliminate and (or) compensate for deviations affecting safety.

The regulating authority is continuously assessing measures providing the management systems operation, leadership, safety culture through the analysis of results of the inspections conducted.

In 2021, Gosatomnadzor developed and put into effect the norms and rules for ensuring nuclear and radiation safety "General requirements for the operating organization management systems in order to ensure nuclear and radiation safety [45]. These norms and rules establish general technical requirements for the constituent elements, the procedure for the functioning and improvement of administrative systems of the operating organization in terms of ensuring nuclear and radiation safety at all stages of the life cycle of nuclear energy facilities.

In addition, in 2022 Gosatomnadzor approved the guidelines on nuclear and radiation safety "Ensuring a safety culture at all stages of the life cycle of the Belarusian NPP" [46] comprising recommendations on development and maintenance of a safety culture at all stages of the NPP life cycle.

The key principle of developing compensatory measures when identifying discrepancies with regulatory requirements, design and other documentation is the licensee's assessment of the impact on safety. Engineering solutions containing such assessments are subject to consideration by the regulating authority prior to their implementation.

Safety issues are the key issues during regular meetings of the regulating authority officials and the management of the operating organization.

Based on the targeted safety re-assessment by the operating organization, stress tests, a National Action Plan has been prepared aimed at increasing the safety level at the Belarusian NPP. Actions from the mentioned Plan are under control by the regulatory body by establishing the regulatory requirements for the operating organization.

### **Safety priority within the regulator's own activities**

The high priority of safety is established at the level of the laws of the Republic of Belarus "On the Use of Atomic Energy" and "On Radiation Safety" [1, 6], is expressed in the strategic documents of Gosatomnadzor (Gosatomnadzor Policy and Strategy approved by the decisions of the Gosatomnadzor Board).

The priority of safety is the basis of the regulatory body's activities within the framework of implementing functions and tasks assigned thereto, including in terms of:

- developing norms and rules to ensure nuclear and radiation safety;
- implementing state supervision in the field of nuclear and radiation safety;

preparing decisions on issuing a license, introducing or rejecting to introduce amendments thereto, extending or refusing to extend the validity period, suspension, renewal, termination, cancellation of the license based on the results of consideration of received documents, conformity assessment and safety examination;

issuing permits for the right to conduct work at implementing activities in the field of atomic energy use and for the realization of educational programs for advanced training of managers and specialists on nuclear and (or) radiation safety;

license control;

safety assessment, etc.

Gosatomnadzor consistently implements IMS, one of the tasks of which is to increase own level of safety culture of its employees. The principles of the Gosatomnadzor safety culture and its attributes were formed with the participation of all Gosatomnadzor employees, enshrined in the Regulation on the IMS of Gosatomnadzor (approved by the order of the Head of Gosatomnadzor).

Gosatomnadzor is continuously developing the safety culture within organization using the outcomes of external audits (the IAEA missions, inspections of Gosatomnadzor activities by the Ministry for Emergency Situations, other competent authorities of the Republic of Belarus), of the analysis of the Gosatomnadzor activities to provide its efficiency (including as part of self-assessments conducted by the Gosatomnadzor administration and heads of its structural divisions) and through detecting non-compliance and elaborating the prompt measures for the improvement of activities, accounting of the experience of the foreign regulating authorities.

A systematic development of competencies of the Gosatomnadzor employees is arranged (including that for the administration of Gosatomnadzor and the Ministry for Emergency Situations). Safety culture issues are included in mandatory training, knowledge inspection of newly accepted employees (the module "Safety Culture", which studies the basic principles of safety culture, commitment to safety culture at all levels, the role of the human factor in safety culture assurance).

Special events are organized for younger Gosatomnadzor employees (information hours with the Head of Gosatomnadzor, professional skills contests, training, etc.) to show commitment to the safety culture at all levels.

As part of this activity, the Code of Professional Conduct of a Gosatomnadzor employee was adopted, which represents a set of general principles of professional ethics and basic rules of conduct that should guide Gosatomnadzor employees in performing their work duties in order to implement faithfully, properly, effectively and at a high professional level their professional activities and contribute to strengthening the image of Gosatomnadzor. Familiarization with the Code of newly accepted employees of Gosatomnadzor is mandatory.

In order to define the state of the safety culture in Gosatomnadzor, timely identification of problematic issues, negative trends and positive practices in the field of safety culture to make decisions aimed at developing a safety culture, a self-assessment of safety culture was organized in 2021 based on Guidelines for Safety Culture Self-Assessment for the Regulatory Body (IAEA Services Series 40, Vienna, September 2019): training of Gosatomnadzor employees was organised, an IAEA expert mission was conducted to provide methodological assistance in preparing for self-assessment, a basis for self-assessment was created (a working group was created, the procedure for conducting was approved, methodological materials were developed), self-assessment was conducted using all methods recommended by the IAEA, measures to develop a safety culture were developed.

For the collective discussion of critical issues, a Board was established at Gosatomnadzor comprising of the Head of Gosatomnadzor (Chair of the Board), his deputies and other administrative staff of Gosatomnadzor.

To discuss current safety issues, Gosatomnadzor, if necessary, initiates consideration of safety issues at meetings of the National Commission of Belarus for Radiation Protection under the Council of Ministers of the Republic of Belarus, meetings of the Interdepartmental Commission for coordinating the plan of basic organizational measures for the construction of Nuclear Power Plant in the Republic of Belarus and monitoring its implementation, the working group for coordinating the supervision of the Belarusian NPP construction, operational headquarters at the NPP construction site



involving a wide range of specialists from government bodies of public administration, scientific organizations and enterprises engaged in activities in the field of atomic energy and IRS use.

The most relevant issues of nuclear and radiation safety and significant regulatory decisions are highlighted by Gosatomnadzor in the mass media and the official Internet resource of Gosatomnadzor.

## ARTICLE 11. FINANCIAL AND HUMAN RESOURCES

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

*2. Each Contracting Party shall take the appropriate steps to ensure that sufficient number 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.*

### **Article 11 (1) Financial Resources**

Financing of the NPP construction in the Republic of Belarus is implemented by attracting credit resources, as well as funds from the republican budget. The operator provides organization and conduction of work in volume and quality that meet the requirements of technical NLA at all stages of siting, design, construction, commissioning, operation, limiting operational characteristics, extending the operation lifetime, decommissioning of a nuclear facility and (or) storage facility.

The GSP NPP requirements [5] established that the operating organization creates structural units to perform activities directly at the NPP site for the construction and safe operation of NPP, giving them the necessary rights, financial assets, logistics and manpower, and supervises these activities.

The operating organization created structural units to manage and supervise the construction and operation of the NPP. Structural units are empowered with the necessary rights, financial assets, logistics and manpower.

Financing of building stock construction, housing, transport and industrial infrastructure of the nuclear power plant is implemented from republican budget within the framework of the State Investment Program, which is approved annually by the Decree of the President of the Republic of Belarus, in line with applications submitted.

Financing of NPP construction in the Republic of Belarus involves the following:

90% of the cost of the contract for NPP construction is funded from the loan provided in accordance with the Agreement between the Government of the Republic of Belarus and the Government of the Russian Federation of November 25, 2011 on granting the Government of the Republic of Belarus a state export loan for the constructing a nuclear power plant on the territory of the Republic of Belarus;

10% of the cost of the contract for NPP construction (financing of advance payments) is funded from the loan provided in accordance with the Loan Agreement between the Government of the Republic of Belarus (as a borrower), state corporation "Bank for Development and Foreign Economic Affairs" (Vnesheconombank) (as a lender) and Belvnesheconombank Open Joint Stock Company (as a settlement bank) of May 15, 2014, as well as from republican budget.

Financing of the operator's economic activity is implemented from funds received from the sale of electric energy produced by the Belarusian NPP, and sources permitted by law. Based on Decree of the President of the Republic of Belarus "On the Funds of the Belarusian NPP" [49], a fund for financing the NPP decommissioning and a fund for financing the NPP maintenance and safety improvement, have been established financing the following activities:

- developing technical regulatory legal acts,
- research and development activities aimed at creating new technologies and equipment, improving the safety of decommissioning, early decommissioning or limiting the NPP operational characteristics;

- development of pre-project (pre-investment), project documentation, including a comprehensive engineering survey of the NPP, conducting preparatory work and technical activities

during decommissioning, early decommissioning, limiting the NPP operational characteristics;  
 procurement of equipment;  
 RW recycling or disposal;  
 work performance on NF, SNF management;  
 maintenance of employees (personnel) and NPP facilities after the decision on decommissioning, early decommissioning or limitation of the NPP operational characteristics;  
 ensuring physical protection of the NPP, nuclear and radiation materials, RW;  
 emergency preparedness of the State Enterprise "Belarusian Nuclear Power Plant";  
 scientific support for NPP safety maintenance and improvement;  
 performing works to improve nuclear, radiation, fire, industrial and environmental safety of the NPP;

financing of expenditures relating to handling spent nuclear fuel after its delivery to the cumulative facility;  
 maintenance and improvement of systems for the management of RW and SNF generated during the operation of the NPP, its physical protection systems and emergency preparedness and response systems;  
 siting, design and construction of RW, SNF storage (disposal) facilities, disposal (long-term storage) of RW, returned SNF processing waste,  
 modernization of systems and equipment, introducing new equipment to maintain and improve the NPP safety, acquiring and updating computational and analytical systems and software to perform NPP safety assessments.

The source for capitalizing the funds of the Belarusian NPP will be the profit from the sale of electric energy from the NPP. Contributions to the Belarusian NPP funds will be made from the month following the month of the date of power unit No. 2 commissioning.

In line with the Resolution of the Council of Ministers of the Republic of Belarus of April 23, 2021, the state program "High Technologies and Equipment" for 2021-2025 was adopted with one of the tasks of which being the development of scientific support for the efficiency and safe operation of the Belarusian NPP throughout its life cycle, the management of RW and SNF, as well as scientific support for the development of promising areas of use of nuclear power energy for peaceful purposes. A similar program was implemented in the period of 2016-2020.

In order to create a mechanism of financial accountability for nuclear damage in implementing activities on atomic energy use in the Republic of Belarus, the Decree of the President of the Republic of Belarus No.15 of January 14, 2019 "On liability for nuclear damage" was adopted. According to the Decree, the form of financial accountability for nuclear damage of the Belarusian NPP is civil liability insurance.

Therefore, sufficient financial resources have been provided for the implementation of the nuclear energy project.

### **Article 11 (2) Human Resources**

Following Article 32 of the Law of the Republic of Belarus "On the Use of Atomic Energy" [6], the operator should ensure the selection, training, retraining and advanced training of employees (personnel), as well as maintaining their required number.

GSP NPP [5] additionally established the following:

The NPP must be staffed with personnel with appropriate qualifications and are allowed for unsupervised work in accordance with procedures established by the operating organization, before nuclear fuel is delivered to the NPP;

at the time of NPP operation, the personnel allowed for unsupervised work in relevant capacities must be at workplaces; the minimum requirements for the number and composition of the staff are specified in the NPP project, expressed in NPP SAR and Technological Regulation on the NPP unit operation.

specific kinds of activities in the field of atomic energy use is performed by persons from the NPP staff providing they have permits issued by the regulatory body.

selection, training, admission to independent work and maintenance of the qualification of NPP personnel is provided by the operating organization. The system of selection and training of the NPP personnel is aimed at achieving, monitoring and maintaining the level of its qualification required to ensure the safe NPP operation in all modes, as well as to take actions aimed at mitigating the consequences of accidents when they occur. An integral element to training should be the formation of a safety culture among NPP personnel;

during the professional training of the NPP personnel, technical means shall be used to work out practical skills of NPP operation, including various simulators admitted to train the NPP staff. Special attention must be paid to work out actions in case of possible violations, including accidents, in the NPP operation, considering the operating experience.

Qualification requirements for NPP staff are established by issue 12 of the Unified Qualification Directory of Service Post "Positions of Personnel in the Nuclear Power Industry", approved by Resolution of the Ministry of Labor and Social Protection of the Republic of Belarus No.56 of May 29, 2020.

The national training system has been formed in the Republic of Belarus essential to provide nuclear energy field with highly qualified specialists, as well as to further maintain an appropriate level of knowledge for the safe, reliable and efficient operation of the nuclear power plant. The system of staff training includes a set of actions implemented, including public administration bodies, by institutions of higher and secondary special education, institutions of additional education, and other organizations.

In order to organize a system of comprehensive personnel training, ensuring the acquisition of knowledge and skills necessary for safe and reliable NPP operation, ensuring nuclear and radiation safety, safety of personnel, population and the environment, the Republic of Belarus implements a set of activities under subprogram 8 "Training of personnel for nuclear energy" of the State Program "Education and Youth Policy" for 2021-2025 approved by Resolution of the Council of Ministers of the Republic of Belarus No. 57 of January 29, 2021 (previously, from 2008 to March 2016 - the State Program of Personnel Training for Nuclear Energy, from 2016 to 2020 - subprogram 10 "Training of personnel for nuclear energy" of the State Program "Education and Youth Policy" for 2016-2020) [43].

Based on the needs (applications submitted), a state order for staff training was formed: a year-by-year scope of training, retraining, advanced training (support) of specialists, scientists of higher qualification according to specialties and employees' needs is determined; educational institutions currently engaged in staff training; plans of yearly training in the appropriate educational institutions are finalized. The following works are performed as part of subprogram:

in higher and secondary specialized educational institutions of the country (educational institution "Belarusian National Technical University", "Belarusian State University of Informatics and Radio Electronics", "Belarusian State University", "International State Ecological Institute named after A.D. Sakharov of the Belarusian State University" (in the past - "International Ecological University named after A.D. Sakharov") "Minsk State Power Engineering College") students are trained in 6 specialties in the field of nuclear energy, including "Nuclear Physics and Technology", "High-Energy Chemistry", "Steam turbine installations of nuclear power plants" (since 2020, a new specialty is introduced instead of this specialty - "Design and Operation of nuclear power plants"), "Electronic and information control systems of physical installations", "Nuclear and radiation safety", "Power plants";

fellowships for teachers and scientific workers of higher educational institutions abroad, fellowships for students in countries with developed nuclear energy are organized;

further training, internships and training seminars are available for specialists of the regulatory authority in the field of nuclear and health physics; state bodies performing control (supervision) over activities all stages of the life cycle of the Belarusian NPP, as well as their subordinate organizations and territorial authorities. The training program for specialists with higher education involved in NPP operation includes basic (5-5.5 years) training at universities in the Republic of Belarus, including practical training abroad, special (0.5-3 years) training at foreign universities for specialists with work experience in power enterprises of the Republic of Belarus, fellowships at existing nuclear facilities

abroad, individual training programs at the educational center of the Belarusian nuclear power plant.

Based on the paramount importance of staff training for the nuclear energy program, the Republic of Belarus, in addition to the above activities, extensively uses the IAEA technical assistance (technical cooperation programs) to train specialists for the nuclear energy program. These programs provide expert and advisory assistance on the establishing a staff training system for nuclear energy considering international experience and IAEA recommendations. Programs include seminars and training sessions, visits by Belarusian scientists and university professors to the NPP Training Center and foreign research institutes, visits by Belarusian specialists to existing and nuclear power plants under construction, as well as the development and supply of computer training systems for organizations involved in implementing the Belarusian NPP project.

Within the framework of the IAEA technical cooperation project BYE/0/006 “Developing Human Resources and a Training System for the Nuclear Power Program”, an applied computer training system and the necessary software for the training of Belarusian specialists involved in the nuclear energy development program, which was tested and implemented in the Republic of Belarus and introduced in the Belarusian NPP since March 2016.

Since 2015, the State Enterprise "Belarusian NPP" has been a WANO NPP member, which implies:

- conducting peer reviews involving NPP experts from all over the world;
- support in preparing for expert missions;
- participation in NPP technical support missions organized and conducted by WANO;
- receiving information about operational experience of all nuclear power plants worldwide;
- participating in programs of technical visits to other nuclear power plants;
- participating in emergency response training as part of the Regional Crisis Center;
- participating in training workshops held by WANO.

Large-scale cooperation with the IAEA, other organizations and international associations is also implemented in terms of improving the competencies of the Belarusian regulatory body in the framework of technical cooperation projects and programs, as well as through the sharing regulatory experience within the framework of the Forum of the State Nuclear Safety Authorities of the Countries Operating WWER Type Reactors (until February 2022, interaction implemented within the framework of the Regulatory Cooperation Forum (RCF), Western European Nuclear Regulators Association (WENRA)).

The selection, training, permission to work unsupervised and maintaining the qualifications of operating personnel are provided by the State Enterprise "Belarusian NPP". The Director General of the Enterprise is the chief administrator personally liable for nuclear safety and provides general guidance on its assurance, including general guidance on the NPP staff training. Administration is subordinate to the Director General. The First Deputy General Director – NPP Chief Engineer is the technical manager of the nuclear power plant and reports to the Director General. The Deputy Chief Engineer for NPP Personnel Training – Head of the Training Center organizes work on training, maintenance and advanced training of personnel to ensure safe and reliable NPP operation.

Training of the Belarusian NPP personnel is implemented in the following main areas:

- within the framework of subprogram 10 "Training of personnel for nuclear energy" of the State Program "Education and Youth Policy" for 2016-2020 (training in this area was completed in 2020);
- within the framework of contractual obligations for the construction of the Belarusian NPP (General Contract for the Belarusian NPP construction No. 77-598/1110700 of 18.07.2012 (hereinafter referred to as the General Contract), concluded between the State Enterprise "Belarusian NPP" and ASE JSC), (training in this area was completed in 2021);
- within the framework of subprogram 8 "Training of personnel for nuclear energy" of the State Program "Education and Youth Policy" for 2021-2025;
- at workplaces in structural divisions and at the Training Center;
- in third-party educational institutions of the Republic of Belarus and the Russian Federation.

In the framework of the State Program “Education and Youth Policy” for 2016-2020, Subprogram 10 “Training of personnel for nuclear energy”, professional retraining of the Belarusian NPP specialists in the specialty “Nuclear Power Plants and Installations” (direction “NPP Operation”)

was conducted at Obninsk Institute of Atomic Energy, a branch of the National Research Nuclear University MEPhI, (OINPE NRNU MEPhI) and the Federal State Budgetary Educational Institution of Higher Education “Ivanovo State Energy University named after Lenin”.

As part of the General Contract implementation, 600 specialists were trained, including theoretical training, fellowships at the operating NPP power units of the Russian Federation and training at the FSS and analytical simulators, provided by the State Atomic Energy Corporation Rosatom. The training was conducted by instructors of the Novovoronezh Training Centre of JSC "Atomtehenergo" in accordance with the Generalized Training Schedule for the Operational Staff of the Belarusian NPP for 2015-2019 and annual training schedules developed on its basis.

Training of personnel in structural divisions and Training Center is performed under guidance of qualified managers and specialists. Training is organized taking into account the qualifications of specialists (based on the results of the incoming knowledge control) and is implemented according to individual training programs. The Training Center has modern equipment, including simulators, computer training systems, visual materials (posters, models, stands, etc.), educational and methodological materials, which contribute significantly to improving the training effectiveness.

Employees engaged in activities in the field of atomic energy and IRS use are trained and test (evaluate) their knowledge on nuclear and radiation safety according to procedure established by Instructions on the procedure for training and testing (evaluation) of knowledge on nuclear and radiation safety [52]. Specialists are trained in educational institutions having a permit issued by Gosatomnadzor in the framework of administrative procedures for implementing relevant educational programs.

Annually, events are organized and held to train and improve the skills of employees in third-party educational institutions, including on nuclear and radiation safety.

363 and 542 employees of the enterprise took part in training seminars and training courses conducted by third-party organizations in various areas of activity, respectively.

The minimum requirements for the number and composition of personnel are set in the NPP project and provided in the NPP SAR and the technological regulations for the NPP power unit safe operation. The issue of personnel sufficiency assessment has been one of the issues of the conducted safety assessment of SAR and the technological regulations for safe operation, based on the results of which it was decided to issue a license for the construction of power units No. 1 and No. 2 and operation of power unit No. 1 of the Belarusian NPP.

The number of industrial production personnel of the two power units of the State Enterprise "Belarusian NPP" is 2,543 people. The management of the State Enterprise "Belarusian NPP" and the operational workshops are staffed by qualified employees according to the qualification requirements set by NLA. When calculating the number of operational personnel, the following was taken into account:

- three-shift work schedule;
- rest days, annual leaves and sick leaves;
- the need for continuous training (maintenance and professional improvement, advanced training, etc.).

Given the need for a reserve of operational personnel, one operational workplace is staffed by five to eight employees (depending on the position/profession). The exact number of employees is set by the staffing table considering the requirements for the number of personnel defined by SAR.

The key positions of the MCR operational personnel of power units No. 1, 2 of the Belarusian NPP, as well as the heads of NPP shifts with long training periods are staffed by qualified specialists who have been trained, including practical training with working out interaction as part of shifts at the FSS of the Belarusian NPP, had their knowledge inspected (assessed) by the Gosatomnadzor Commission, obtained permits to run the technological process when implementing activities on the use of atomic energy.

Since early 2019, the procedure for issuing permits by Gosatomnadzor to the personnel of the Belarusian NPP to conduct work in implementing activities on the use of atomic energy has been carried out according to the List of positions of employees (personnel) of the State Enterprise "Belarusian NPP", who have to obtain permits to conduct work in implementing activities on the use

of atomic energy. Based on the mentioned list [53].

Maintaining the qualifications of NPP personnel is ensured by including topics on the study of operational experience in the thematic plans of training and maintenance programs (including information on the results of analyzing internal and external operational experience, the results of modifications at the NPP and making appropriate changes to technical and operational documentation). In addition, Gosatomnadzor, within the framework of crime prevention, takes measures to clarify the requirements of regulatory documents, including those based on the results of previous inspections and the results of the safety assessment of submitted documents.

The State Enterprise "Belarusian NPP" has developed and approved a road map of measures for the technical support of the FSS and analytical simulators of the Training Center, including work on FSS update and periodic confirmation of FSS compliance with MCR of power unit No. 1 (subject to Program for maintaining and improving the safety of nuclear power plant for the period of operation of power units No. 1, 2 of the Belarusian NPP). Currently, the implementation of the measures provided for in the roadmap is underway.

Following the special licensing requirements and license conditions established by Gosatomnadzor, including taking into account the sanitary and epidemiological situation related to the spread of COVID-19, the State Enterprise "Belarusian NPP" has prepared a Regulation on the safe termination of nuclear-hazardous and other hazardous work in conditions of reducing the number of administrative, technical and/or operational personnel below the minimum feasible. This regulation establishes the procedure for actions in the conditions of abnormal events, including poor sanitary and epidemiological situation in the State Enterprise "Belarusian NPP", with a decrease in the number of administrative, technical and/or operational personnel below the minimum feasible number capable of ensuring the reliable and safe operation of the NPP and mandatory supervision of systems and equipment important for safety of power units No. 1 and No. 2 of the Belarusian NPP in all operating modes.

## ARTICLE 12. HUMAN FACTOR

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

### **Regulatory Requirements**

In the Republic of Belarus, the regulatory requirements for taking into account the human factor in terms of its impact on nuclear and radiation safety are established both in relation to the activities in the field of atomic energy use and in relation to the design basis of a nuclear facility.

Following Article 11 of the Law of the Republic of Belarus "On the Use of Atomic Energy" [6], key (in terms of safety impact) types of work can be performed by employees (personnel) of the operating organization and organizations involved in work and (or) providing services in implementing activities on the use of atomic energy if these employees (personnel) have permits to perform work in implementing activities for the use of atomic energy issued by an authorized state body for safety regulation in the use of atomic energy.

The list of types of work for which employees (personnel) of organizations specified in the Law "On the Use of Atomic Energy" need to obtain permits to perform work in implementing activities for the use of atomic energy, the requirements for these employees (personnel), including education, as well as the procedure for obtaining these permits are defined by the Decree of the Government of the Republic of Belarus. At the same time, the issue of such permit is possible only if an employee complies with qualification requirements set in the Unified Qualification Directory of Service Post, approved by the resolution of the Ministry of Labor and Social Protection of the Republic of Belarus No. 56 of May 29, 2020, absence of medical contraindications, passing a psycho-physiological examination, appropriate training for the position and knowledge inspection (assessment) [51].

Reducing the influence of the human factor is performed by selecting NPP personnel and ensuring the its necessary level of qualification in order to exclude the negative impact of personnel

actions on safety. At the same time, the formation of a safety culture, as a set of actions to eliminate the negative impact on safety, is one of the requirements for the operator within the concept of defense in depth (level 1). The regulatory requirements identified the components of the formation and maintenance of a safety culture, the basis of which also lies in the plane of the employee's influence on safety, accounting and timely elimination of the consequences of mistakes made by such employee [5]. In 2021, the regulator enforced the requirements for the IMS of the operator in terms of their contribution to the formation and maintenance of a safety culture, including through providing personnel with the required resources, interaction tools for unconditional compliance with safety requirements, etc. [45].

The impact of the human factor is taken into account within the operational experience analysis and in the event of irregularities in the NPP work [88, 93].

The adopted document contributed to the consistent improvement of legal norms aimed at considering the human factor in implementing activities in the field of nuclear energy use and its maximum possible reduction.

### **The human factor at nuclear installation design**

Regulatory requirements have also been established to take into account the human factor influence at the stage of NPP design. For instance, the NPP project should imply measures to facilitate the adoption by the personnel of the right decisions and impede the adoption of the wrong ones, provide technical means to detect, correct and compensate for errors. The reliability assurance system should ensure the protection of the nuclear power plant against employee error, minimize the likelihood of negative consequences of the error. The NPP should be insensitive to personnel errors, in particular, due to triggering of automatic control or protection systems designed taking into account the human factor. The personnel interference into the NPP work in this case is allowed only if there is enough time for diagnostics and correcting actions [101].

In particular, the design solutions of the power unit stipulate measures to prevent possible personnel errors disrupting its normal operation and to limit their consequences. Technical measures are provided to prevent and limit the consequences of incorrect manipulations of the personnel that disrupt safety functions and can lead to accidents.

### **Measures of the licensee to take into account the human factor influence in operating and maintaining a nuclear facility**

The presence of qualified personnel conscientious about their duties, place, role and responsibility in the entire production and safety process is a critical condition for the implementing the Licensee's Nuclear Power Plant Quality Assurance Program. Therefore, one of the ways to reduce the human factor influence on safety assurance are quality assurance activities in selecting and training of the personnel. NPP QAP (G) establishes the requirements for the said activity, as well as the basic principles, directions for its implementation and responsibility for its result.

#### *General requirements for personnel*

The organization of work and personnel recruitment are determined taking into account the requirements of the NLA of the Republic of Belarus, recommendations of international organizations, international experience and local legal acts of the State Enterprise "Belarusian NPP". The quality of work is ensured by trained and allowed for unsupervised work operational personnel, as well as personnel of contracting organizations with practical skills, possessing the necessary qualifications. Works have been organized and are being performed to form a safety culture for all personnel involved in work at the enterprise. Continuous training is conducted on the basis of the Training Center including on the topics: "Safety Culture General Provisions", "Organization of Work on Safety Culture Formation", "The Human Factor Influence on the NPP Safety and General Principles of Error Prevention", "Tools for Preventing Personnel Errors", "Monitoring the Personnel Performance", "Leadership in Nuclear Energy", etc.

#### *Medical requirements for personnel*

Operator's personnel who has the right to conduct work in implementing activities for the use of atomic energy, personnel performing work in harmful and (or) dangerous working conditions, pass

mandatory preliminary (upon admission to work) and periodic (according to approved schedule) medical examinations.

Medical examinations are conducted to ensure occupational safety, prevent occupational diseases, and protect the health of workers.

*Requirements for knowledge inspection (assessment)*

The staff of the State Enterprise "Belarusian NPP" has their knowledge inspected (assessed) as set by the Regulation on the Procedure for Knowledge Inspection and Special Instructions for NPP Employees, approved by the Order of the Director General Director No. 191 of April 07, 2021, the Instruction on the Procedure for Training, Internship, Instructing and Knowledge Inspection on Occupational Safety Issues, approved by the Resolution of the Ministry of Labor and Social Protection of the Republic of Belarus No.175 of November 28, 2022, as well as the Regulation on the Procedure for Organizing and Conducting Knowledge Inspection (Assessment) on Nuclear and Radiation Safety, approved by the Order of the Director General No.179 of March 31, 2021. The administrations of organizations involved in the work at the Belarusian NPP should ensure personnel training and knowledge inspection (assessment) in their organizations, including on nuclear and radiation safety issues. The outcomes of knowledge inspections (assessments) are recorded in relevant protocols.

When implementing work at the Belarusian NPP site, the personnel should have a certificate containing information of successful knowledge inspections (assessments) and provide it to the controlling persons upon their demand.

Knowledge inspections (assessments) are held depending on the post (profession) of an employee in the following areas (areas are identified by job (work) descriptions):

occupational safety and electrical safety;

fire safety;

radiation safety

nuclear safety;

industrial safety;

special rules for nuclear energy facilities;

rules of technical operation or knowledge assessment of job (work) descriptions.

*Responsibility of organizations for personnel composition and placement*

The quantitative and qualitative composition of the personnel, their assignment is defined by the administration of organizations involved in the commissioning of the Belarusian NPP power units. Organizations involved in power units commissioning are liable for qualification and compliance of their personnel with rules, regulations and production instructions.

*Operating personnel*

The administration of the State Enterprise "Belarusian NPP" organizes work with personnel, the main forms of which are selection, training, maintenance and advanced training according to No. 432/44PO "Regulations on the organization of work with personnel of the State Enterprise "Belarusian NPP". The selection of personnel involved in the power unit commissioning is implemented based on requirements of the Unified Rates and Qualifications Directory of Jobs and Professions, the Unified Qualification Directory of Service Post.

Prior to the start of each stage of power unit commissioning, the workplaces must be completely staffed with the operational personnel according to the approved number. The administration of the State Enterprise "Belarusian NPP" ensured the staffing of the Enterprise before the beginning of work on commissioning the power units of the Belarusian NPP.

The operational personnel of the Belarusian NPP, prior to their permit to work unsupervised, undergo knowledge inspection to the extent necessary for the position held.

Heads of all ranks in charge for the safe operation of the Belarusian NPP or providing departmental safety control, as well as installation operators must undergo a medical and psycho-physiological examination and have special permits to perform works in implementing the use of atomic energy.

*Personnel of commissioning organizations*

Training the staff of contractors involved in the Belarusian NPP commissioning and repair work includes training and knowledge inspection, taking into account the schedule of work at the NPP.



Staff training is performed according to job descriptions, standards, diagrams and other effective regulatory and technical documentation on the profile of the staff. In addition, personnel involved in implementing work at the NPP are trained on the premises of the Training Center, including, among others, training on safety culture.

### **Regulatory supervision and control activities to consider the human factor influence**

Assessment of the human factor influence on safety is conducted by the regulator both within licensing and permitting activities, and during inspections.

For instance, as part of safety review of documents justifying nuclear and radiation safety, the regulator assesses the compliance of project basis with the NLA requirements, including on issues related to consideration of human factor.

One of the components of regulatory supervision is the procedures for issuing personal permits to perform work in implementing activities for the use of atomic energy. In the course of such procedures, apart from medical component, the regulator evaluates the training of personnel, both in the form of testing and in the form of an interview - additionally for senior officials of the licensee, providing a demonstration of leadership in safety issues. Such additional interview assesses the candidate's commitment to safety issues, if necessary, additional requirements are established, which are contained in the issued personal permit.

One of the components in the issue of personal permits is the positive result of knowledge inspection (assessment) on nuclear and radiation safety, which is conducted by the Regulator Commission.

Within the framework of inspection activities, the revealed violation of requirements in the field of nuclear and radiation safety are assessed and analyzed, including from the perspective of the human factor influence on their occurrence. Should such influence is revealed, specific employees who have committed violations are listed in reports on results of inspections, which subsequently allows the licensee to more fully conduct a detailed analysis and search for the root cause of the violation. In addition, as a rule, targeted inspections of the operator's IMS functioning are performed annually in terms of ensuring safety requirements, as well as checks of the state of affairs to maintain and improve the safety culture level. During such inspections, key attention is paid to personnel. When detecting clear signs of insufficient level of safety culture among employees who have committed violations of the NLA requirements, technical NLA in the field of nuclear and radiation safety, extra training and extraordinary knowledge inspection (assessments) are performed in order to exclude further potential impact on the entire level of safety. If necessary, the regulator also requests disciplinary measures against such workers.

Given the transition of the Belarusian NPP to the operational stage, the regulator adopted a Basic Supervision Program, which, among other things, includes the following areas of regulatory assessments on personnel-related issues: "Operator Management System", "Safety Culture and Leadership", "Personnel Training System".

Therefore, the actions taken by the regulator are generally enough to provide regulatory supervision over consideration of human factor influence on nuclear and radiation safety by the licensees.

## **ARTICLE 13. QUALITY ASSURANCE**

*Each Contracting Party shall take the 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 activities in the field of regulatory consideration and control**

The requirements for ensuring high-quality performance of work that meets the established

requirements of technical NLA at all stages of the life cycle of a nuclear installation are specified in the Law of the Republic of Belarus "On the Use of Atomic Energy" [6]. Such requirement is established both for operating organization and for any organizations providing services at implementing activities on nuclear energy use.

Based on Decree of the President of the Republic of Belarus [2], one of the licensing requirements and conditions for implementing activities in the field of the use of atomic energy is to ensure the management system operation for safety purposes or the management system and (or) quality control of the licensed activities regarding compliance with the requirements in the field of nuclear and radiation safety, as well as their improvement on a permanent basis. The said license requirement is assessed by the regulatory body both at the stage of assessing the license applicant compliance with license requirements and conditions prior to the license issue, and at implementing activity in the field of nuclear energy use by the licensee. At the same time, such assessments of compliance with licensing requirements and conditions for licensees are conducted, as a rule, on an annual basis.

General requirement for quality assurance of the NPP systems (elements) and works performed is enshrined, including at the level of technical NLA. In particular, this requirement is one of the components of the first level of the defense-in-depth concept applied in the Belarusian NPP project [5].

Direct requirements for the organization of the quality system as an integral element of the overall management system for the construction and operation of a nuclear power plant are established by [55]. The said document established the system of quality assurance programs covering all stages of the nuclear facility life cycle. The programs are developed by all organizations involved in the construction and operation of a nuclear installation and have a hierarchy and a structure established by the requirements.

The general NPP QAP being the main document defining principles, purposes and general provisions of the operator's activities regarding developing and implementing the QA program at all stages of the NPP life cycle, as well as the requirements to quality assurance by other organizations involved in works of the NPP life cycle is subject to approval by the regulatory body [55].

The operating organization annually provides the Report to the regulatory body on assessment of current state of safety of the nuclear facility which also contains data on actions taken in the field of quality and their efficacy. The regulatory body takes such information into consideration when planning supervisory activities regarding both the operating organization directly, and subcontracting organizations. If necessary, the regulatory body has is empowered to take actions in the context of law enforcement practice to review such report.

In 2021, the regulatory body issued general requirements for the operator's management systems in order to ensure nuclear and radiation safety [45]. The document implies the integration of all operator's processes including the quality management system, in such a way as to prioritize the assurance of safety requirements and account for the existence of requirements in other areas of the operator's activities (including those not related to security).

*Therefore, the requirements for operator's compliance with the quality in relation to all aspects of safety-affecting activities have been introduced are being implemented.*

### **Actions of the Operating Organization**

To ensure the quality of the NPP construction, the State Enterprise "Belarusian NPP" has adopted organizational and technical solutions aimed at both creating an infrastructure for quality assurance control and ensuring the functioning of such infrastructure by documenting the procedures of the quality management system, training and evaluating the knowledge of personnel, establishing responsibility for the implementing measures on quality assurance.

Safety assurance in implementing activities is defined by the policy of the integrated management system of the State Enterprise "Belarusian NPP" as the top priority.

Currently, the Belarusian NPP State Enterprise has created and operates an IMS, which is a set of interrelated documented and managed processes aimed at achieving targeted indicators that are implemented in line with the established requirements.

The IMS of the Belarusian NPP State Enterprise has integrated such safety aspects as nuclear safety, radiation safety, industrial safety, fire safety, technical safety, physical nuclear safety, environmental safety, labor protection through allocation of appropriate processes, as well as such elements as quality assurance, human and organizational factors, social and economic aspects. Safety assurance is the top priority of the enterprise activity.

To date, within the IMS framework, the State Enterprise "Belarusian NPP" has introduced, is operating and maintaining up-to-date, as well as certified in the National Conformity Assessment System of the Republic of Belarus:

- quality management system for producing electrical and thermal energy, performing functions of a customer, builder, providing engineering services when implementing activities in the field of constructing facilities of the 1-4 degree of complexity, for compliance with the requirements of STB ISO 9001-2015 "Quality management systems. Requirements" (Certificate of Conformity No. BY/112 05.01.003.01.0098 of 10.06.2021, valid until 01.12.2022);

- health and safety management system in the occupational activity of electric and thermal energy production for compliance with the requirements of STB ISO 45001-2020 "Health and safety management systems in occupational activity. Requirements and application guidelines" (Certificate of Conformity No. BY/112 05.04. 003.01.00051 of 28.04.2021, valid until 28.04.2024);

- environmental management system for the production of electrical and thermal energy for compliance with the requirements of STB ISO 14001-2017 "Environmental management systems. Requirements and application guidelines" (Certificate of Conformity No. BY/112 05.04. 003.01.00051 of 28.04.2021, valid until 28.04.2024);

As part of the effective IMS, the policy and goals in the field of IMS have been adopted.

IMS Policy:

- obligations of the top management to maintain and improve the IMS have been established;

- an administration representative for IMS has been appointed;

- the organizational structure and staffing have been identified;

The IMS Coordination Council has been established and is operating, the main tasks of which are to coordinate the work of the enterprise within the IMS, to maintain and continuously improve the IMS, to monitor the execution of decisions taken at the Coordination Council meetings;

- authorized representatives for IMS have been appointed within structural divisions of the enterprise to ensure the IMS operation;

IMS documents have been elaborated in various areas of the enterprise activities (policies, guidelines, standards of the enterprise, regulations, process passports, quality assurance programs (the general quality assurance program NPP QAP (G), during operation of the power units of the Belarusian NPP QAP (O), in handling nuclear materials (nuclear fuel) QAP (NM (NF)), in handling operational radioactive waste QAP (RWO), in handling ionizing radiation sources QAP (IRS)) and others);

- the development of programs to ensure the quality of the General Contractor's activities in implementing the Belarusian NPP project NPP QAP (O1), during design NPP QAP (D), during construction and installation works NPP QAP (CI), during commissioning of the power units of the Belarusian NPP POKAS (C);

- IMS processes are defined; process owners and their responsibilities;

- the analysis and assessment of process risks are being implemented, risk registers and risk management programs of IMS processes have been developed;

- there are internal IMS audits, including checks of compliance with the requirements of quality assurance programs with preparation of relevant documentation (programs, plans, reports, corrective action plans); external audits of suppliers' management systems, including checks of compliance with the requirements of quality assurance programs, with preparation of relevant documents (programs, plans, reports, corrective actions plans);

- the existing IMS processes are monitored with the established frequency;

- an analysis from the management side is implemented;

- measures to improve the IMS are determined on an ongoing basis.

### **Operating organization Audit Program**

Assessing the effectiveness of the quality systems of the general contractor and subcontractors is one of the aspects of the operator's activities in the field of quality.

To verify the NPP QAP implementation and assess their effectiveness, the State Enterprise "Belarusian NPP" and contractors conduct internal and external (in the case of contracts with subcontractors) audits of quality assurance programs. The results of the audits are documented. Based on the results of the audits, corrective measures are developed to eliminate the identified discrepancies.

Quality assurance programs of the general contractor and subcontractors are monitored in the following areas:

- document control (to ensure that all documents used for work performance and verification are under constant control at the stage of preparation, approval, release and application);

- design control (to guarantee that design documentation has been executed by design organizations licensed by national supervisory authorities for design, meets the requirements of investment justifications in the construction of a nuclear power plant and regulatory documents, has passed the necessary checks, approval and expertise; approved in accordance with the established procedure);

- supply control (performed to ensure that the supply of materials, equipment and services meet the requirements of regulatory documents, projects and specifications, work assignments and terms and conditions of the agreement/contract);

- product inspection (performed to identify materials, equipment, products and their components during their manufacture, installation and use);

- control of technological processes (performed to ensure that all technological processes, the quality of which cannot be checked upon installation completion, are properly implemented and possible violations that may lead to inconsistencies of products, equipment and services are revealed and eliminated at an early stage);

- inspections and control over testing (verification at any stage of the process of designing, developing and manufacturing equipment, construction, installation, commissioning and operation of nuclear power plants; correctness of the technological process (compliance with all requirements) and the quality of products and services);

- control over non-compliance with regulatory requirements (performed to control the correctness of procedures for identifying nonconformities, timely documentation, accounting, analysis and elimination in the required time, control over nonconformities elimination, identifying the causes of nonconformities, developing measures to prevent their re-occurrence).

Information on such audits is also submitted to the regulatory body as part of the procedure for submitting a Safety Assessment Report on the current safety status of NPP power units.

The operating organization performs an annual IMS analysis, inside which the achievement of IMS goals and the effectiveness of IMS processes are assessed.

On the part of the regulator, assessments are conducted both through targeted inspections and as part of the reviewing the annual report on assessing the current state of safety of NPP power units.

In addition, systematic inspections of the general contractor for the construction of the Belarusian NPP and subcontracting organizations - licensees, are performed in the field of the use of atomic energy on the functioning of their quality management systems in terms of compliance with safety requirements. As a rule, inspections are held annually (given the nature of the work performed by the licensee).

Therefore, actions taken by the regulator are in general sufficient to ensure regulatory supervision over quality assurance at Belarusian NPP site in terms of activity important to ensure nuclear and radiation safety.

## ARTICLE 14. ASSESSMENT AND VERIFICATION OF SAFETY

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

*i) 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;*

*ii) verification by analysis, 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.*

### **14 (1) Safety assessment**

According to [2], all stages of the life cycle of a nuclear installation, including design, siting, construction, operation and decommissioning, are subject to licensing.

According to the requirements of [5, 48]:

the first NF delivery to the NPP site is allowed after checking the NPP readiness for the NF delivery in the presence of plans for personnel and the population protection in the event of an accident at the NPP and ensuring the readiness of their implementation and obtaining a license issued by the republican body of state administration implementing state regulation of safety activities in the field of nuclear energy use;

the first loading of the intended core, RS testing in a subcritical state, performing physical experiments at a minimally controlled level, power start-up and pilot operation are allowed after checking the readiness for the appropriate stages of the NPP unit commissioning and obtaining licenses issued by the republican body of state administration implementing state regulation of safety activities in the field of nuclear energy use;

the operation of the NPP power unit is allowed after obtaining a license issued by the republican body of state administration implementing state regulation of safety activities in the field of nuclear energy use, upon completion of the NPP unit commissioning prior to the beginning of the work of the State Acceptance Commission for the commissioning the completed facility construction in accordance with the legislation.

In order to obtain a license and (or) modify it, the license applicant must submit to Gosatomnadzor a package of documents justifying the provision of nuclear and radiation safety. The list of such documents was updated in 2021 (taking into account the studied experience of other regulatory bodies and in the framework of licensing system improvement) and is established for each type of work (services) that make up the licensed activity. [32].

Based on submitted documents, Gosatomnadzor performs a safety assessment which includes an appointment and conduct of a safety review. The decision on appointing a safety review is made by Gosatomnadzor after a preliminary revision of documents submitted by the applicant, including determining whether the composition and content thereof meet the established requirements. Once a decision to conduct a safety review is made, Gosatomnadzor develops and approves the terms of reference, which is the basis for its conduct.

Safety expertise in accordance with [2] is an assessment of safety justification of facilities using atomic energy, IRS, radiation facilities, including those for RW management and (or) work and (or) services performed, the subject of which is the analysis of safety justifying documents and identifying the conformity of safety justifying documents to the NLA requirements, including those mandatory for compliance with technical NLA, in the field of nuclear and radiation safety.

The procedure for conducting a safety review is established in [30]. The safety review is conducted by expert organizations that have a license to perform works and (or) provide services for conducting a safety review. The expert organization ensures that the safety review is performed in line with the established management system for security purposes or a management system and (or) quality control of the licensed activity.

The period of safety review is set by Gosatomnadzor independently.

Gosatomnadzor publishes on its official website on the global computer network Internet a list of expert organizations and individual entrepreneurs entitled to conduct a security examination, as

well as a list of experts who have been granted the right to conduct a safety review

The requirements for maintaining the SAR of the NPP power unit with a WWER-type reactor are established separately. Based on information contained in the SAR, the regulatory body should be able to assess the sufficiency of justifications for the siting, construction, commissioning, operation and decommissioning of NPP power units at a specific NPP site. Works on SAR preparation, formation, consideration and revision should be implemented at all NPP life cycle stages.

Deterministic and probability safety analyses should be provided in SAR of the NPP power unit. Safety analyses should be performed for all operational conditions of the NPP power unit and take into account all locations of nuclear materials, radioactive substances and RW materials available at the NPP power unit, in which a violation of the normal NPP operation may occur. Deterministic safety analyses should be executed based on a conservative approach. Probabilistic safety analyses should include probability estimate of large accidental emission. Safety analyses should be accompanied by estimates of errors and uncertainties of the results obtained. The software used in safety case should be certified.

On October 20, 2017, Gosatomnadzor accepted for consideration the application of the State Enterprise "Belarusian NPP" with the attachment of the necessary documents for obtaining a license to operate a nuclear installation (power unit No. 1 of the Belarusian NPP); handling of nuclear materials, nuclear fuel, spent nuclear materials, spent nuclear fuel, operational RW.

The decision to issue a license is made by the Board of the Ministry for Emergency Situations taking into account the safety review results and assessment of the applicant's compliance with licensing requirements and conditions performed by Gosatomnadzor.

As part of the licensing procedure there was conducted a review of documents justifying the provision of nuclear and radiation safety in implementing activities in the field of the use of atomic energy in terms of the nuclear installation operation (power unit No. 1 of the Belarusian NPP), handling of nuclear materials, spent nuclear materials, nuclear fuel, spent nuclear fuel, operational RW (hereinafter referred to as examination of documents), in accordance with the terms of reference prepared by Gosatomnadzor and approved by the Head of Gosatomnadzor on November 17, 2017.

Review of documents justifying nuclear and radiation safety is implemented by SSI JIPNR Sosny which is the owner of the license to conduct safety review in the field of nuclear energy use. Also, other organizations that are part of the TSO of the Ministry of Emergency Situations are involved in the safety review in accordance with [31].

Safety review is implemented taking into account and based on the achieved level of science and technology development. The review takes into consideration the operation experience of the Russian and foreign nuclear facilities; all available data on the events which took place at the Russian and foreign nuclear- and radiation-hazardous facilities; assessment of sufficiency of actions for nuclear and radiation safety assurance in implementing activities on peaceful use of atomic energy.

The organizational and legal foundations of the expert assessment system in the Republic of Belarus continue to improve. As stated in Article 8 (1) hereof, the strategy for improving the technical support of the regulatory body is to transit from the only TSO - the Scientific Institution "JIPNR-Sosny" - to a system comprising 16 organizations and the State Scientific Technical Institution "Centre for Nuclear and Radiation Safety" as a coordinator incorporating scientific and expert potential available in the Republic Belarus.

In 2021, Gosatomnadzor issued a license to conduct safety review in the field of the use of atomic energy and IRS to the State Scientific Technical Institution "Centre for Nuclear and Radiation Safety" – a scientific and technical support organization of the Ministry for Emergency Situations, in the field of nuclear and radiation safety, a license to conduct safety review in the field of the use of atomic energy – to the Research Institute for Nuclear Problems of the Belarusian State University. Earlier, the INP BSU received a license to conduct a safety examination in the field of IRS use.

In 2016-2022, Gosatomnadzor monitored the fulfillment of the terms and conditions of the license issued to the State Enterprise "Belarusian NPP" for the right to construct nuclear installations (power units No. 1 and No. 2), operation of the power unit No. 2 of the Belarusian NPP. Simultaneously, the process of licensing the operation of power units No. 1 and No. 2 was in progress.

In 2021, the procedure for licensing the operation of a nuclear installation (power unit No. 1 of

the Belarusian NPP) was completed.

Based on the conclusion of Gosatomnadzor, taking into account the positive results of the review of safety justifying documents, on June 02, 2021, the Board of the Ministry for Emergency Situations made a positive decision to make an addition to the license of the State Enterprise "Belarusian NPP" allowing to launch an commercial operation of the power unit No. 1 of the Belarusian NPP. Prior to adopting this decision, public hearings were held for the first time on April 30, 2021.

Since 2021, the Scientific Institution "JIPNR-Sosny" has been conducting a review of documents justifying nuclear and radiation safety provision in implementing by the State Enterprise "Belarusian NPP" of activities in the field of the use of atomic energy in terms of the operation of a nuclear installation (power unit No. 2 of the Belarusian NPP). Safety review is conducted based on the technical task of Gosatomnadzor with the allocation of the following stages:

- prior to physical start-up;
- prior to energy start-up;
- prior to start of pilot operation;
- prior to start of the comprehensive testing of the power unit at 100% capacity of the reactor system;
- upon completion of pilot operation.

After completion of each stage of the review an expert opinion is submitted to Gosatomnadzor with results of the review on the safe commissioning of the power unit No. 2 of the Belarusian NPP. Based on expert opinions, as well as on the results of inspection activities, Gosatomnadzor issues a written permit for the start of the relevant stages/sub-stages/phases of commissioning of power unit No. 2.

On December 21, 2021, the Board of the Ministry for Emergency Situations decided to make amendments to the license of the State Enterprise "Belarusian NPP" which gives the right to proceed to stage B "Physical start-up" of commissioning of the power unit No. 2 of the Belarusian NPP.

During operation of nuclear installations, a safety assessment according to the requirements of regulatory documents is performed:

- when making amendments to a license, including in the case of making amendments to documents justifying nuclear and radiation safety, based on the results of consideration of which a decision was made to issue a license [2];

- as part of considering reports on the assessment of the current state of safety of power units of the Belarusian NPP [2];

- as part of considering documents that contain the outcomes of the periodic safety assessment of a nuclear installation, storage facility, and justifying the safety of their operation [38]; According to [2], documents must be submitted to Gosatomnadzor not later than 12 months before the expiration of 10 years from the date of their operation, or from the date of the end of the last periodic safety assessment;

- as part of considering technical solutions and the SAR of modifications attached thereto [39].

The procedure for conducting a periodic safety assessment of a nuclear installation, as well as the requirements for the composition and content of documents containing the results of a periodic safety assessment, were developed by Gosatomnadzor and approved in 2021 [38]. The requirements for the periodic safety assessment established that each subsequent periodic safety assessment shall be made taking into account the changes that arose after previous periodic safety assessment, the NLA requirements including mandatory technical NLA in the field of nuclear and radiation safety, the current state of the nuclear installation, as well as taking into account the experience of operation of the NPP power unit, and all modifications implemented at the NPP power unit during the specified period.

According to [38], internal and external impacts on the NPP power unit at various states of the nuclear installation, as well as their possible combinations, should be included in the list of initiating events for safety functions analysis. When determining the list of initiating events, approaches are used, including: the use of analytical methods (analysis of impacts and operability, analysis of failures and their consequences, building logical diagrams); comparison with the list of initiating events for

other nuclear power plants (if any); analysis of operational experience (internal and external), including taking into consideration the IAEA recommendations. Deterministic and probabilistic safety analyses, as well as the results of engineering assessments, are used to determine possible combinations of initiating events.

Gosatomnadzor has defined the requirements for modifications at the NPP power unit [39], and together with European experts developed a manual on nuclear and radiation safety [56], containing explanations and recommendations for establishing uniform approaches to the organization and conduct of safety assessment of modifications at nuclear power plants.

Implementing modifications at the NPP is allowed only after safety assessment of the provided technical solutions and the SAR of these modifications. To assess the safety of these documents, the regulator on an ongoing basis involves the State Scientific Technical Institution "Centre for Nuclear and Radiation Safety" and other TSO (by concluding long-term agreements for consulting services).

Reports on assessment of the current safety state of the Belarusian NPP units are submitted to Gosatomnadzor annually. Materials presented in this report are assessed by the regulatory body taking into account the results of control and supervisory activities for the previous period, with the involvement of the State Scientific Technical Institution "Centre for Nuclear and Radiation Safety". The results of the assessment are the basis for taking regulatory measures defined by law.

Safety assessment in relation to research nuclear installations is carried out within the framework of the licensing process and as part of the implementing control and supervisory activities. In 2021, Gosatomnadzor, based on the results of consideration of documents justifying nuclear and radiation safety in implementing by the Scientific Institution "JIPNR-Sosny" of activities in the field of the use of atomic energy in terms of a nuclear installation operation (subcritical stand "Yalina"), elaborated an opinion on possible amendments to the license.

In 2016-2018, the Republic of Belarus voluntarily conducted stress tests of the Belarusian NPP (targeted assessment of the NPP resistance related to extreme external natural impacts and their combination in the light of the accident at the Fukushima Daiichi NPP in Japan) according to the methodology of the European Commission and the European Nuclear Safety Regulators Group (ENSREG) and the European Commission and passed a peer review of their results by European regulators in the field of nuclear safety. Stress tests are an additional tool designed to assess the safety margins of nuclear power plants above the established by legislation. During the stress-tests, safety margins with regard to the extreme natural impact typical for the area of the NPP location, were assessed, as well as the design and organizational measures sufficiency at full power blackout and for the event of heat removal (water) loss to prevent BDBA and for its successful elimination if this occurs.

Peer Review outcomes (Peer Review Report, Summary Conclusions, Joint Press Release of Gosatomnadzor and ENSREG) has in general a positive character. It emphasizes various good practices and also suggests future potential improvements in the context of continuous safety improvement that were recommended during the review considering the new WENRA reference safety levels.

Gosatomnadzor has prepared a National Action Plan based on stress-tests results (identified a set of measures to improve NPP safety and implementation deadlines) and together with the Belarusian NPP and other parties involved proceeded to its realization. For more detailed information, see Article 6 of this Report.

#### **Article 14 (2) Verification of safety**

Regulatory documents [5, 45, 48] establish the following requirements:

the systems and elements of the NPP power unit that are important for safety must undergo a direct and complete check for compliance with the design characteristics during their commissioning, after repair, maintenance or modification, and periodically throughout the life of the NPP power unit.

the design of the NPP power unit should provide for the possibility of technical diagnostics (inspection) of the state of safety systems, special technical means for controlling BDBA, as well as elements of normal operation that are important for safety, classified as safety category 1 and 2, and



the possibility of their representative tests;

to support safety systems performance and prevent failures in safety-important systems, their maintenance, repair, tests and inspections shall be performed.

More detailed information on the procedure for work implemented, developed documents and regulations, the procedure for conducting departmental control, the procedure for conducting tests and submitting their results to Gosatomnadzor is given in Article 19 hereof.

Upon request of an authorized body for state regulation of safety activities in the field of nuclear energy use, the operating organization must conduct extraordinary performance inspections of safety systems, special technical means for managing BDBA, as well as extraordinary monitoring of the condition of the base metal and welded joints of systems and elements of the NPP power unit that are important for safety.

To check the correctness of technological process performance (compliance with its all requirements) and quality of products and services at any stage of design, development and production of the equipment, construction, installation, commissioning and operation of Belarusian NPP, the operating organization should implement control by conducting inspections [5].

The OO organizes periodic (at least once every two years) inspections of compliance with nuclear safety requirements and establishes the procedure for inspecting the status of nuclear safety of the Belarusian NPP structural units by internal commissions. The inspection results are submitted to the regulatory body.

Information on control and supervisory measures by the regulatory body is provided in articles 7, 10 and 19 hereof.

TSO and Gosatomnadzor specialists and experts are trained to methods of COCOSYS, ATHLET, ASTEC, DIN3D, Riskspektrum, Raduga, JRodoscal software use, as well to practical calculations with methodological support from European experts within the framework of the European Union international project of technical assistance. The COCOSYS, ATHLET, ASTEC, DIN3D, Serpent software products were transferred to the Republic of Belarus at no charge, Riskspektrum, Rainbow, Recass\_NT were purchased from the State budget.

Within the framework of the state program "High Technologies and Equipment" for 2016-2020, the State Scientific and Technical Institution "Center for Nuclear and Radiation Safety" and the Scientific Institution "JIPNR-Sosny" performed a number of works related to calculations and analyses using software tools.

The requirements [5] established that no discrepancies are allowed affecting the safety of the NPP unit between the information contained in the SAR of the NPP power unit and in the NPP power unit project, or discrepancies of the NPP power unit project with its implementation. The compliance of SAR of the NPP power unit with real state of the NPP power unit should be maintained by the operator throughout the whole service life of the NPP power unit. As part of the control and supervision activities conducted by Gosatomnadzor, the issue of compliance of the actual state of the NPP power unit with the requirements of regulatory documents and documents justifying nuclear and radiation safety is one of the priorities.

To manage the processes of degradation of elements and structures important for safety, as well as to control and maintain the operability and reliability of safety-important systems in the course of operation, the State Enterprise "Belarusian NPP" in accordance with [57] developed a Program for the NPP aging management and a Program for managing equipment resource; measures are implemented to realize these programs.

Activities in aging management are a key element of the safe and reliable operation of the Belarusian NPP. To achieve this goal, a number of organizational, technical and operational measures have been identified to control degradation due to aging and wear, in particular: defining the list of systems, elements and structures subject to aging management; developing an aging management program for individual elements of the power unit and degradation mechanisms (if necessary); developing preventive measures to minimize and control degradation due to aging; detection and study of aging mechanisms; monitoring and analysis of aging effects; implementing activities to mitigate degradation; determination of acceptance criteria; developing corrective measures; accounting for operation experience; ensuring the quality of work.

Scientific support of the Belarusian NPP in the field of safety assessment (development of analytical reports to support and improve the operation process, in particular, design and experimental support of the reactor core, resource management and aging of NPP equipment, equipment defect management) are the main areas for improving the NPP safety, included in the program for maintaining and improving the safe operation of the nuclear power plant.

The requirements of [57] and special licensing requirements and conditions define the procedure for reporting to Gosatomnadzor on implementing activities in aging management at nuclear power plant. Over the reporting period, actions of aging mechanisms in the course of operation that would limit the possibility of operating the main equipment of the RS or NPP power unit, were not found.

Gosatomnadzor has prepared and discussed draft guidelines on ensuring nuclear and radiation safety in terms of establishing and monitoring methods for the resource characteristics of NPP pipelines and equipment. The draft guidelines, according to the practice established in Gosatomnadzor, were sent for proposals to the State Enterprise "Belarusian NPP" for comprehensive consideration and preparing proposals for the timely settlement of certain issues.

Thus, in the Republic of Belarus, appropriate measures have been enshrined in regulatory documents and implemented in practice to ensure that comprehensive safety assessments are conducted throughout the life cycle of the Belarusian NPP, which determine the compliance of the current safety state of a nuclear installation with the requirements of regulatory documents and documents justifying nuclear and radiation safety.

## ARTICLE 15. RADIATION PROTECTION

*Each Contracting Party shall take appropriate steps to ensure that in all operational states the radiation exposure to the workers and the public 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.*

### **Regulatory Requirements**

The main principles and requirements to radiation protection assurance are defined in the laws of the Republic of Belarus "On Radiation Safety" and "On the Use of Atomic Energy" [1, 6].

Radiation safety requirements for situations of planned, emergency and existing exposure, applied to ensure human safety in all conditions of exposure to ionizing radiation of artificial or natural origin, are established by Sanitary Norms and Rules "Requirements for Radiation Safety" and Hygienic Standard "Criteria for assessing radiation exposure" [58, 59]. The documents have been developed in accordance with the IAEA requirements «Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards. General Safety Requirements Part 3». Three classes of regulatory standards are established: basic dose limits and dose constraints (for planned exposure), reference levels (for accidental and existing exposure) and permissible levels of monofactor exposure.

Radiation safety of personnel and population is considered ensured if the main principles of radiation safety (normalization, substantiation, optimization) and the requirements of the legislation of the Republic of Belarus are observed. The documents [58, 59] contain the concept of a representative person (corresponding to ICRP Publication 101), determines the use of dose limits and reference levels, determine the levels of exemption and release from regulatory control, establishes general criteria for responding to nuclear and radiological emergencies, criteria for radiation protection of emergency workers, introduces reference levels of radionuclides in drinking water.

Sanitary norms, rules and hygienic standards "Hygienic requirements for the design and operation of nuclear power plants" [60] establish requirements for ensuring the radiation safety of personnel, public, and environmental protection during siting, design, construction, commissioning and operation of nuclear power plants. NPP radiation safety is ensured by implementing a set of special measures:

establishing and implementing radiation safety requirements at the industrial site of NPP and adjacent territories;

control of the state of the NPP protective barrier on the path of the spread of ionizing radiation and radioactive agents;

confinement of localisation of radiation impact sources and protection of personnel and population during normal operation and in case of accident at the NPP.

The content and the volume of special actions is provided in the design and in operational documentation for the NPP.

The requirements and approaches, recommended by publications of the IAEA safety standards series, are also considered in the following documents:

Sanitary regulations and rules "Requirements to radiation safety assurance of personnel and population when exercising an activity on use of nuclear energy and ionizing radiation sources" [61];

Regulation on the procedure and criteria for classifying RW to radiation hazard classes [29];

Regulation on the procedure for development and approval of standards for acceptable emissions and discharges of radioactive substances into the environment [29];

Norms and rules for nuclear and radiation safety assurance "Safety in radioactive waste management. General provisions" [62];

Norms and rules for nuclear and radiation safety assurance "Safety rules in radioactive waste management of nuclear power plants" [63]. The document sets the safety assurance requirements implemented during design and operation of radioactive waste management systems at nuclear power plants. Norms and rules have been introduced instead of previous TCP 565-2015 "Safety rules in radioactive waste management of nuclear power plants";

The Technical Code of Practice "Safety assurance of SNF dry storage facilities" [64]. The documents sets the safety assurance requirements implemented during design, construction, operation and decommissioning of SNF dry storage facilities;

Sanitary regulations and rules "Requirements to radiation safety assurance of personnel and population in radioactive waste management" [65]. The document has been developed in line with the requirements of IAEA Safety Standards Series No.GSG-1 and No.SSR-5; introduced instead of previous Sanitary rules for radioactive waste management "CIIPOPO -2005" and sets the criteria for waste classification to RW, as well as the general RW classification based on their long-term safety assurance upon disposal;

Norms and rules for nuclear and radiation safety assurance "NPP safety in the sanitary protection zone and the supervised area. Requirements for RM organization and assurance" [66];

Norms and rules for nuclear and radiation safety assurance "Safety in IRS management. General provisions" [67];

Regulation on the procedure for accounting exposure received by the population and personnel [68];

Instructions on the procedure for accounting and control of IRS [69].

**Expectations in accordance with the regulatory provisions regarding the processes performed by the license holder to optimize exposure and implement the "as low as reasonably achievable" (ALARA) principle**

The priority of using the ALARA methodology is established by the Law of the Republic of Belarus "On Radiation Safety" [1], sanitary rules and norms. The main regulatory requirements that must be followed in normal operation of ionizing radiation sources and facilities for the use of nuclear energy are:

non-exceeding, in the situation of planned exposure (with the exception of medical exposure), the limits of doses of occupational exposure and exposure of the population from all IRS (the principle of rationing);

the prohibition of IRS management activities at which benefits received for a human and society do not exceed the risk of possible harm caused by radiation exceeding the natural radiation background (the principle of justification);

maintaining at the lowest achievable level the individual radiation doses and the number of exposed persons, taking into account economic and social factors, when using any sources of ionizing radiation (the principle of optimization).

To ensure the implementation of the principle of radiation safety optimization, in 2020, a Regulation on the procedure for establishing and applying dose constraints and reference levels (Order of the Ministry of Health of the Republic of Belarus No. 88 of August 31, 2020) was developed and put into effect, defining liabilities and requirements for establishing radiation dose limits and reference levels by nuclear energy use facilities and IRS users. The dose constraints of the population are established by state sanitary supervision institutions for the value of the individual effective radiation dose of a representative person for the following facilities discharge radioactive substances into the environment:

- radiation facilities with radiation exposure received by the population exceeding 10 mSv/year through all irradiation routes;

- facilities for the use of atomic energy.

The dose constraints of personnel are established by IRS users in coordination with the State Sanitary Supervision institutions for nuclear energy use facilities and radiation facilities that handle open IRS of I and II class of work or closed IRS of categories I, II according to the degree of radiation hazard. The dose constraints values can be revised at the initiative of the State Sanitary Supervision institutions or the operating organization taking into account the possibility of further reduction of the doses of the population or occupational exposure through introducing measures to optimize radiation protection.

Based on non-exceeding the dose limits, there was introduced a system of controlled parameters, which are the derivative standards from the dose constraints. The IRS user (operating organization) is obliged to ensure the development of controlled parameters of the radiation impact at the radiation facility and in the supervised area, which are established for operational radiation monitoring of compliance with the dose constraint, ensuring non-exceeding the radiation doses of personnel and the population, radioactive contamination of the environment. In establishing limit dose, the IRS user (operating organization) should proceed from the principle of optimization, taking into account:

- operational experience of similar installations and (or) radiation facilities, facilities for the use of atomic energy and (or) activities;

- SAR of a radiation facility or SAR of an atomic energy use facility, which includes the results of assessment of the radiation doses of personnel and the population (population and personnel exposure assessment);

- the effectiveness of protective measures to improve the radiation situation.

### **Implementing the Belarusian NPP radiation protection program by license holders**

Currently, the power unit No. 1 of the Belarusian NPP is at the operational stage, and the power unit No. 2 is at the commissioning stage.

The radiation protection program of the State Enterprise "Belarusian NPP" includes the following documents:

- Radiation Safety Policy of the Belarusian NPP;

- Quality Manual;

- The procedure for organizing and implementing production control over radiation safety of the Belarusian NPP;

- Regulations of radiation control of the Belarusian NPP;

- Instructions on radiation safety during operation of the Belarusian NPP.

The said documents have passed the state safety review as part of the licensing process of the Belarusian NPP.

The documents cover the elements of the radiation protection program given in the recommendations of the IAEA GSG-7 "Occupational Radiation Protection":

- distribution of responsibilities in the field of radiation safety among Belarusian NPP employees ;

- organizational and technical activities to ensure radiation safety and the procedure for work supervision under conditions of IRS exposure;

organization of the radiation control system at the Belarusian NPP;  
 education and training programs in the field of radiation safety;  
 requirements for the quality and improvement of the radiation protection program;  
 the procedure for identifying drawbacks and the procedure for corrective measures, and other elements.

The program for monitoring compliance with radiation safety at the Belarusian NPP is implemented through:

conducting radiation monitoring;  
 systematic inspections in the structural divisions of the Belarusian NPP and contracting organizations, analysis of their results and monitoring of the implementation of measures to eliminate the identified observations.

Radiation control at the Belarusian NPP is implemented according to Regulations of Radiation Control of the Belarusian NPP and is divided into:

technological radiation survey;  
 dosimetry radiation monitoring;  
 radiation survey of premises and industrial sites;  
 radiation monitoring of the non-proliferation of radioactive contamination;  
 radiation monitoring of the environment;  
 radiation monitoring in case of accidents.

The systematic inspections at the Belarusian NPP are regulated by the Procedure for the Organization and Implementation of Production Control over Radiation Safety. Based on purpose and volume, production reviews are divided into:

operational inspections. They are performed by inspection of workplaces operating under impact of ionizing radiation;

targeted inspections. Those are implemented by inspecting divisions in accordance with pre-developed programs, which include verification of divisions documentation of divisions, inspection of assigned premises and workplaces.

#### **Compliance with the dose limits, main results regarding doses received by the exposed workers**

The Belarusian NPP implements an individual dosimetric monitoring and accounting of radiation doses received by both the personnel of the State Enterprise "Belarusian NPP" and external (including contracting) organizations.

Information on personnel exposure doses of the General Contractor personnel exposure (ASE JSC), received when using IRS during performing work at power units № 1 and № 2 is shown in Table 4.

**Table 4**

Year	Employees, people	Collective dose, person*mSv	Average individual dose, mSv	Maximum individual dose, mSv
2017	105	63.066	0.601	3.670
2018	173	185.966	1.075	5.510
2019	194	261.084	1.346	11.180
2020	92	255.290	2.770	11.800
2021	59	95.690	1.622	9.050

Information on the exposure of the personnel of the state enterprise "Belarusian NPP" and external (contracting) organizations received during the commissioning of power units No. 1 and No. 2, as well as during the operation of power unit No. 1, is given in Table 5.

**Table 5**

Year	Employees, people	Collective dose, person*mSv	Average individual dose, mSv	Maximum individual dose, mSv
2019	145	0.040	0.005	0.011
2020	2817	99.606	0.036	1.064
2021	3161	436.509	0.150	4.983
2022 (01.01-01.06)	3290	366.193	0.140	4.032

### **Conditions of release of radioactive substances emission into environment**

Based on terms of reference for the Belarusian NPP in the Republic of Belarus for the emissions and discharges into the environment during normal operation and violations of normal operation, taking into account the achieved level of safety in the existing NPPs with WWER reactors, the following target limits are set:

the annual gas-aerosol emission of IRG into the environment during normal operation and violations of normal operation should not exceed 40 TBq per unit per year;

the annual emission of aerosols and iodine into the environment during normal operation and violations of normal operation should not exceed 0.8 GBq per unit per year;

the annual discharge of radionuclides (excluding tritium) during normal operation and violations of normal operation should not exceed 10 GBq per unit per year.

In order to prevent exceeding the limit of the dose of man-made radiation to the population, Sanitary norms and rules "Hygienic requirements for the design and operation of nuclear power plants" [60], as well as [58] established a quota (dose constraints) for the exposure of the population from the impact of the Belarusian NPP - 100 mSv per year. This quota (dose constraints) is set for the total exposure of the population from all sources of radioactive gas-aerosol emissions into the atmospheric air and liquid discharges into surface waters, regardless of the number of power units at the industrial site. At the same time, the quota value is considered as the upper limit of the possible public exposure from radioactive emissions and discharges from the NPP while optimizing radiation protection of the population during normal operation of the NPP. The values of the corresponding dose constraints for public exposure are used to calculate the maximum acceptable emissions of radionuclides of nuclear power plants into the atmospheric air and the maximum acceptable discharges of radionuclides into surface waters. Maximum permissible emissions and maximum permissible discharges are the upper limits for gas aerosol emissions and liquid discharges of radionuclides into the environment during normal operation of the NPP.

In addition to the above-mentioned quotas, to optimize the radiation protection of the population during normal operation of the nuclear power plant, a minimum significant dose of 10  $\mu$ Sv per year was taken as the lower limit of the radiation dose. The values of the corresponding minimum significant public exposure dose are used to calculate the acceptable emissions of radionuclides into the air and the acceptable discharges of radionuclides into surface waters.

Following the Regulation on the Procedure for the Development and Approval of Standards for acceptable Emissions and Discharges of Radioactive Substances into the Environment, approved by Resolution of the Council of Ministers of the Republic of Belarus No. 497 of August 21, 2020, draft standards for acceptable emissions and discharges are developed and approved by Belarusian NPP users in coordination with the Ministry for Emergency Situations, the Ministry of Health and the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus.

### **Processes and measures implemented to ensure that radiation exposure is maintained at**

### **reasonably achievable low level in all operational stages**

The Terms of Reference for the Belarusian NPP set the following target dose criteria: collective effective dose of personnel — 5 person-Sv/year per one GW of installed electric capacity; collective effective dose during routine maintenance related to dose costs during dismantling, assembly of the reactor and refueling on average for the entire design life is 0.5 person-Sv/year per unit.

Based on the documents justifying the safety of the Belarusian NPP, when performing main technological operations, the maximum predicted collective doses of the personnel of the Belarusian NPP, received on average per year, are: disassembly-assembly of the reactor and refueling – 330 person-mSv/year; control of the technical condition of the reactor equipment – 480 person-mSv/year; SG maintenance – 92 person-mSv/year; maintenance of the main circulation pumping units – 6.1 person-mSv/year; maintenance of the main circulation pipeline – 100 person-mSv/year; maintenance of the pressure compensator – 280 person-mSv/year.

The maximum value of the annual collective dose per unit is about 1.3 person-Sv/year, which does not exceed the target limit of 5 person-Sv/year per 1 GW of the installed capacity set in the Terms of Reference for the Belarusian NPP.

When operating power unit No. 1 and commissioning power unit No. 2 of the Belarusian NPP, maintenance of radiation doses at a reasonably achievable low level is ensured by reducing the content of radioactive substances in the media of NPP technological systems, reducing radioactive contamination of equipment and premises of the controlled access area, reducing emissions and discharges of radioactive substances into the environment, reducing the amount of RW formation.

Optimization is carried out by planning, monitoring non-exceeding of the established levels, analyzing the results and improving the system of measures aimed at reducing personnel and public exposure.

In order to implement the optimization principle, a dose constraints for personnel has been established at the Belarusian NPP, the values of which are lower than the main radiation dose limit. Additionally, in order not to exceed the dose limit, criteria for controlled radiation parameters (control levels) have been established.

To perform work in which personnel can receive an individual dose of more than 0.2 mSv, a permit is issued to perform this work (a radiological work permit), in preparation of which measures to ensure radiation safety are indicated. Each issued radiological work permit is assigned a classification code with a description of the equipment on which the work is performed, a description of the work performed. The database of classified work permits allows to analyze collective and individual doses of the personnel and plan future activities on their optimization.

To implement activities planned to optimize and improve radiation protection, the Belarusian NPP has an ALARA committee consisting of the NPP management and heads of structural units. The meetings of the Committee are formalized by minutes of the meeting with the appointment of responsible persons.

### **Environmental monitoring**

Based on the Regulation on the procedure for conducting radiation monitoring as part of the national environmental monitoring system in the Republic of Belarus and the use of its data, approved by Resolution of the Council of Ministers of the Republic of Belarus No 576 of May 17, 2004, by the State Institution "Republican Centre for Hydrometeorology, Radioactive Contamination Control and Environmental Monitoring" of the Ministry of Natural Resources and Environmental Protection (Belgidromet) has been implementing radiation monitoring of environmental objects at 120 observation points throughout the country. Since 2017, RM is conducted in the area of the Belarusian NPP.

The network of RM observation points in the impact zone of the Belarusian NPP was created to monitor its operation, timely detect changes in the radiation situation, assess and predict possible consequences of radiation exposure on public health and the environment, as well as (if necessary) promptly take measures to prevent or reduce radiation exposure.

The RM objects are:  
atmospheric air;

surface waters (including bottom sediments);  
 underground water;  
 soil.

The network of RM observation points in the area of the Belarusian NPP location includes stationary observation points for the radioactive aerosols presence in the air with sampling by means of filter ventilation units at the weather stations closest to the Belarusian NPP: Lyntupy, Oshmyany, Naroch. Since 2017, observations of the radioactive contamination of surface waters have been implemented at three observation points: Viliya river (Bystritsa village), Lake Svir, Lake Naroch. RM of soils is performed at four observation points: Bystrica Bystritsa locality), Kemelishki (Kemelishki locality), Gudogai (Gudogai village), Svir (Svir village).

Observations at these points are performed by the following parameters:

atmospheric air: measurement of the ambient dose equivalent of gamma radiation, total beta activity, activity of gamma-emitting radionuclides, activity of strontium-90;

surface waters: measurements of total alpha and beta activity, activity of caesium-137, strontium-90; measurement of activity of caesium-137, strontium-90 in bottom sediments;

soil: measurement of the ambient dose equivalent of gamma radiation, layered in 1 cm pitch distribution of caesium-137 and strontium-90 activity in soil at a depth of 10 cm.

The monitoring results obtained so far show that levels of radioactive contamination of environmental components in the area of the Belarusian NPP correspond to the levels of global radionuclides fallouts due to nuclear weapons tests in the 60s of the last century, observed before the Chernobyl accident, taking into account their natural decay.

Since 2016, AREMS has been operating in the area of the Belarusian NPP location. The system comprises ten AMPs, three of which are located in the supervised area of the Belarusian NPP, seven – beyond the supervised area. AMPs are equipped with gamma radiation dose rate measurement sensors, spectrometric sensors that allow measuring the gamma radiation spectrum with subsequent identification of radionuclide composition, and, in part, measurement sensors of meteorological parameters. Information about the power levels of the ambient equivalent of the gamma radiation dose, gamma radiation spectra and meteorological data are transmitted continuously to the Belgidromet.

The results are recorded in the RM databases (the database of radioactive contamination of the surface atmospheric stratum at the RM observation points of atmospheric air of the Republic of Belarus; the database "Monitoring and analysis of gamma radiation dose rate measurements"; the database "Landscape-geochemical polygons"; the database "RM of surface waters", the database of monitoring of the reference network of the Republic Belarus). Collection and accumulation of AREMS data and the results of determining the levels of natural and man-made radionuclides in environmental objects in the area of the Belarusian NPP is performed to monitor the radiation background in the area of exposure by a potential source of radioactive contamination, including assessing transboundary transfer of radioactive substances.

Also, the Ministry of Natural Resources and Belgidromet are currently implementing the international technical assistance project of the IAEA BYE/9/025/ "Improvement of RM measures in the Belarusian NPP influence area" (2022-2023), the results of which will allow to assess the sufficiency of the RM implemented in the Belarusian NPP influence area and, if necessary, to determine the directions of its possible expansion.

### **Belarusian NPP**

Requirements for the operating organization for implementing RM are established by the Law of the Republic of Belarus "On the Use of Atomic Energy", norms and rules for ensuring nuclear and radiation safety "Safety of nuclear power plants in the sanitary protection zone and supervised area. Requirements for the organization and provision of radiation monitoring" [6, 66].

The purpose of the radiation monitoring of the environment is to assess the radiation situation within the sanitary protection zone and supervised area and to establish its trends under normal (accident-free) operation of the Belarusian NPP.

The main tasks of the RM of environmental objects are:



continuous systematic monitoring of the level of radioactive contamination of environmental objects in the sanitary protection zone and the supervised area;

obtaining necessary, sufficient and reliable information about the radiation situation in the sanitary protection zone and the supervised area;

assessing the current state of the RM environmental objects in the sanitary protection zone and the supervised area and analysis of the dynamics of its changes;

assessing external exposure of the population residing on the territory of the supervised area; forecasting changes in the radiation situation in the sanitary protection zone and the supervised area;

collection, generalization and transfer to interested bodies and departments of information about radiation situation and the state of environmental objects in the sanitary protection zone and supervised area and about the forecast of its change.

The RM objects in the sanitary protection zone and supervised area of the Belarusian NPP are:

aerosols in surface atmospheric air;

atmospheric precipitation, including snow cover;

surface waters;

groundwater, including potable water;

bottom sediments;

aquatic and coastal aquatic vegetation;

ichthyofauna, including predatory and bottom commercial fish species;

soils, including arable and meadow lands;

ground vegetation;

components of agricultural ecosystems and agricultural products.

During construction, RM in the sanitary protection zone and the SA of the Belarusian NPP was conducted in line with the Program for radiation monitoring of the environment for the construction period, and from the moment of the physical start-up of the power unit No. 1 of the Belarusian NPP – in accordance with the Program for radiation monitoring of the environment in the sanitary protection zone and the SA of the Belarusian NPP and the Regulations of Radiation Control of the Belarusian NPP.

The RM in the sanitary protection zone and SA of the Belarusian NPP at the construction stage was implemented by ASE JSC which concluded agreements with contractors accredited in the National Accreditation System of the Republic of Belarus. From the moment of commissioning of the power unit No. 1 of the Belarusian NPP, RM in the sanitary protection zone and SA implemented by the operating organization and Belgidromet involved in RM work on the basis of an agreement with ASE JSC.

In order to continuously monitor the radiation situation at the SA of the Belarusian NPP in all NPP operating modes including design and beyond design basis accidents, as well as to predict the impact of increased gas-aerosol emission from the NPP into the environment, the AREMS of the Belarusian NPP was created and put into operation.

AREMS provides for 10 radiation monitoring posts, 1 automatic meteorological station, 2 mobile radiometric laboratories, 7 filter ventilation units. At the same time, 9 radiation monitoring posts are located in the SA of the Belarusian NPP (the localities of Vornyan, Vorona, Podoltsy, Rymdyuny, Goza, Chekhi, Markuny, Chernishki, Olkhovka), and 1 radiation control post has been organised outside the SA territory and is located in the locality of Svir (Minsk region, Myadel district).

The AREMS radiation monitoring posts in the localities of Vornyan, Goza, Chekhi, and Markuny are additionally equipped with spectrometric sensors designed to identify the radionuclide composition of the gas-aerosol emission of the Belarusian NPP.

The project documentation at the AREMS of the Belarusian NPP provides for and performs data exchange on the radiation situation with the AREMS of the Belgidromet.

In order to assess meteorological conditions in the Belarusian NPP area in Vornyan locality, an automatic weather station equipped with MK-15 meteorological complexes has been installed.

To predict the impact of increased gas-aerosol emissions of the nuclear power plant into environment, RECESS computer system of information support for decision-making is applied as part

of AREMS. The RECASS software allows calculating the content of radioactive substances in the atmospheric air and the underlying surface, the values of dosimetric values characterizing the impact of radioactive substances on the population due to emission, to identify zones of measures to protect the population taking into account the current NLA, based on decision-making criteria in the initial period of a radiation accident.

The analysis of the dynamics of trends in the radiation situation in the sanitary protection zone and SA of the Belarusian NPP is conducted by comparing the measurement results of the controlled parameters with the established normative and reference levels, the measurement results of the "zero" radiation background and similar radiation parameters for each RM facility obtained during previous observation periods. The report on the initial radiation state of the environment (the Report on the "zero" radiation background) has passed an expert assessment and is an integral part to the documents justifying the safety of the Belarusian NPP.

The results of the RM in the SA of the Belarusian NPP over the reporting period indicate that the radiation situation in the Belarusian NPP area remains stable, the levels of contamination of environmental components, agroecosystems and agricultural products with technogenic radionuclides on the territory of the Belarusian NPP SA meet the levels of global precipitation of these radionuclides following nuclear weapons tests in the 60s of the last century, observed before the Chernobyl accident.

Current information on the state of the radiation situation in the Belarusian NPP SA is posted on the Internet on the official website of the State Enterprise "Belarusian NPP" ([www.belaes.by](http://www.belaes.by)).

Thus, the Belarusian NPP during construction, commissioning and operation of power unit No. 1 does not affect the radiation situation in the region, problematic environmental situations caused by the radiation factor have not been identified.

### **The activities in the field of regulatory consideration and control**

The objectives and procedure for regulatory review and control are defined by Chapter 7 of the Law of the Republic of Belarus "On Radiation Safety" [1]: "State supervision in the field of radiation safety, state sanitary supervision in terms of radiation safety. Responsibility for violation of legislation on radiation safety".

State supervision in radiation safety is organized and implemented in order to prevent, detect, and suppress violations of the legislation on radiation safety, includes supervision of compliance with the requirements in the field of radiation safety established by legal acts, NLA of the Council of Ministers of the Republic of Belarus, Ministry for Emergency Situations, Ministry of Architecture and Construction.

State supervision in nuclear and radiation safety is implemented in accordance with the procedure established in Regulation on State Supervision in the field of nuclear and radiation safety [37].

State sanitary supervision in terms of radiation safety assurance is implemented in line with the procedure established by the law on control (supervisory) activities and legislation in the field of sanitary and epidemiological welfare of the population, includes supervision of compliance with sanitary and epidemiological requirements, hygienic standards, as well as other legal acts in the field of sanitary and epidemiological welfare of the population, including exposure to ionizing radiation in implementing works with IRS and RW management.

When performing state supervision in the field of radiation safety, state sanitary supervision in terms of radiation safety, a graded approach is used which comprises the application of surveillance measures commensurate with the degree of radiation hazard of the IRS, including the risk to the life and health of personnel and the public.

The procedure for conducting regulatory assessments and regulatory control is described in articles 7 and 14 hereof.

## ARTICLE 16. EMERGENCY PREPAREDNESS

*1. 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.*

*For any new nuclear installation, such plans shall be prepared and tested before it commences operation above a low power level agreed by the regulatory body.*

*2. Each Contracting Party shall take the appropriate steps to ensure that, insofar as they are likely to be affected by a radiological emergency, its own population and the competent authorities of the States in the vicinity of the nuclear installation are provided with appropriate information for emergency planning and response.*

*3. Contracting Parties which do not have a nuclear installation on their territory, insofar as they are likely to be affected in the event of a radiological emergency at a nuclear installation in the vicinity, shall take the appropriate steps for the preparation and testing of emergency plans for their territory that cover the activities to be carried out in the event of such an emergency.*

### **Article 16 (1) Emergency Plans and Programs**

#### **Regulatory Requirements**

The legislation defines the requirements for developing measures to ensure emergency preparedness and response in the event of accidents at nuclear installations [6]. Measures to ensure emergency preparedness and emergency response in the event of accidents at nuclear installations are established by off-site and on-site emergency plans [70].

Regulatory requirements for emergency preparedness and response have been established taking into account current international approaches, including those set out in the IAEA Safety Standards GSR Part 7. The requirements for categorizing emergency planning in the event of a nuclear or radiological emergency have been established in [71]. A graded approach to the development of emergency planning measures has been introduced depending on the hazard category of the facility (practical activity). Requirements have been established for the composition and content of action plans in the event of an accident at a nuclear power plant, at a research nuclear installation [72, 73].

Regulatory requirements for assigning an emergency class, the procedure for announcing emergency situation, and the prompt information transfer in the event of a nuclear and (or) radiation emergency at a nuclear power plant have been developed and implemented taking into account IAEA documents [54]. The document takes into account the approaches of IAEA outlined in the Safety Standards GSR Part 7 "Preparedness and Response for a Nuclear or Radiological Emergency", GSG-2 "Criteria for Use in Preparedness and Response for a Nuclear or Radiological Emergency", and GS-G-2.1 "Arrangements for Preparedness for a Nuclear or Radiological Emergency." Following the IAEA recommendations, an approach has been implemented to classify emergencies based on technological and radiation parameters analysis. In order to identify, accept and establish the emergency class in a timely manner, requirements have been introduced to determine specific, predetermined and observed criteria - levels of actions in emergency situations.

The Resolution of the Ministry for Emergency Situations establishes requirements for the RM planning and implementing in the event of a nuclear or radiological emergency at a nuclear power plant [74].

#### **Implementation of Measures to Improve Emergency Preparedness**

In the Republic of Belarus, the preparedness system of response to nuclear and radiation accidents is integrated into the National Emergency Response System in accordance with [22, 39]. The State Emergency Prevention and Control System of the Republic of Belarus (SEPCS) has been established and is operating. The main requirements for this system are defined in [1, 75].

Actions of republican bodies of state administration, local government and self-government bodies, state and other organizations, citizens on protecting their life and health, environmental protection and property protection in the event of a radiation accident at a nuclear installation and (or)

at a storage facility located outside the territory of the Republic of Belarus closer than 100 km from the State Border of the Republic of Belarus, are implemented in accordance with the Radiation Accident Protection Plan being one of the sections of the Plan for the Protection of the Population and Territories of the Republic of Belarus from Natural and Man-made Emergencies.

On-site and off-site emergency plans for the Belarusian NPP have been developed and approved.

On-site Emergency Plan was approved by the Director General of the State Enterprise "Belarusian NPP" in May 2018 (the current version – version No. 2. Amendment No. 3 was approved on December 13, 2021).

The on-site Emergency Plan provides for the scope, period and procedure for implementing activities for protecting NPP personnel in case of a man-made emergency, organizing and conducting emergency rescue and other urgent work, as well as forces and means to be involved.

The off-site Emergency Plan (the Plan of protective measures in case of a radiation accident at the Belarusian NPP) was approved by the Decree of the Government of the Republic of Belarus No. 211 of March 22, 2018.

The off-site Emergency Plan was developed to organize and ensure timely measures to protect the population and territories in the event of a threat or emergency situations at the Belarusian NPP associated with the release of radioactive substances beyond its industrial site. When developing the plan, the international standards for emergency response contained in the documents of the IAEA, Association of the Heads of the European Radiological protection Competent Authorities (HERCA) and the Western European Nuclear Regulators Association (WENRA) were taken into account.

Off-site Emergency Plan established:

- a list of measures to ensure emergency preparedness and emergency response in the event of nuclear and radiation accidents at the Belarusian NPP at the national level;

- coordination and interaction mechanisms of the republican bodies of state administration, local authorities, governmental and other organizations, citizens in implementing measures to protect the population and territories in the event of nuclear and radiation accidents at the Belarusian NPP;

- measures to protect the population and territories in the event of nuclear and radiation accidents at the Belarusian NPP;

- emergency response zones and actions of republican bodies of state administrations, local government and self-government bodies, state and other organizations, citizens in order to protect their life and health, environmental protection and property protection in the event of nuclear and radiation accidents at the Belarusian NPP.

On October 18-19, 2017, at the stage of the Off-Site Emergency Plan development, its practical testing was implemented in Ostrovets District of the Grodno Region as part of the republican staff-command exercise with the management bodies and SEPCS forces to respond to radiation accidents and incidents.

The exercise was attended by international observers from Latvia and Poland, representatives of the CSTO member states, as well as international organizations (IAEA, International Red Cross, CSTO). The experts had the opportunity to see the work of the State authorities and SEPCS forces, both at the republican and local levels.

In October 2018, following the Belarusian invitation, the IAEA conducted a mission to assess preparedness for a response to nuclear and radiation emergencies (EPREV mission). In the course of its work, the EPREV mission assessed various aspects of preparedness and response to nuclear and radiological emergencies at the NPP, including those provoked by extreme environmental impacts.

Experts of the mission arrived at the conclusion that Belarus had effective and reliable mechanisms in the field of emergency preparedness and response, highlighted good and applicable practices, identified strengths, as well as areas of further improvement.

Based on the results of the mission, experts noted good practices, as well as made suggestions and recommendations with regard to the improvement of the emergency preparedness and response system in accordance with the current international approaches. [The report on the results of the EPREV mission](#) is available in the public domain.

In order to implement the suggestions and recommendations of the EPREV mission, the

Government of the Republic of Belarus developed and approved the Action Plan for the Implementation of Recommendations and Suggestions of the IAEA EPREV Mission to Belarus. The implementation of the plan was completed in 2021.

In order to implement EPREV suggestions, a comprehensive exercise was held in October 2019 to work out the on-site and off-site plans of the Belarusian NPP and their coherence.

Emergency response training, including station-wide, is conducted regularly at the Belarusian NPP in accordance with the annual plans for emergency response training. Gosatomnadzor monitors and evaluates the effectiveness of emergency training and exercises in accordance with the developed procedures.

In order to check and further improve the emergency preparedness and response system at the Belarusian NPP, a general emergency training was held in April 2022 on the topic "Working out an action plan to protect personnel in the event of an accident at the Belarusian NPP (on-site emergency plan)". A comprehensive emergency response exercise at the Belarusian NPP has been scheduled for October 2022.

### **Article 16 (2) Informing the Public and Neighboring States**

Based on the Law of the Republic of Belarus "On the Protection of the Population and Territories from Natural and Technogenic Emergency Situations" [76], the republican body of state administration for emergency situations, other republican bodies of state administration, other state organizations subordinate to the Council of Ministers of the Republic of Belarus, local executive and administrative bodies and other organizations are required to promptly and reliably inform the population through the mass media and other channels about the state of protecting the population and territories from emergency situations, about ways and methods of protecting the population from them.

Concealment, untimely provision or provision by officials of deliberately false information in the field of protection of the population and territories from emergency situations is subject to liability in accordance with the legislation of the Republic of Belarus.

The procedure for informing the population about the threat of occurrence or occurrence of emergency situations, including the transfer of information about predicted and occurred emergencies, their consequences, and radiation safety in the relevant territories, is established by a Decree of the Government of the Republic of Belarus [77].

The operation of the information management system of the SEPCS and providing information in the field of protection of the population and territories from natural and man-made emergencies is performed according to resolutions of the Ministry for Emergency Situations [78, 79].

The Resolution of the Government of the Republic of Belarus No. 1118 of November 28, 2014 approved the Regulations on the Alert System for the Population, Governing Authorities and SEPCS forces and Civil Defense. The Regulation identifies defines the tasks, the procedure for use and maintenance of the alert system of the population, governing authorities and SEPCS forces and Civil Defense in constant readiness.

The Joint Resolution of the Ministry for Emergency Situations, the Ministry of Communications and Informatization and the Ministry of Information of the Republic of Belarus No. 42/27/9 of December 7, 2015 established a list of entities of the Alert System at the national level. The Resolution of the Ministry for Emergency Situations No. 44 of December 18, 2015 approved the Instructions on implementation and operation of the local alert systems in areas of hazardous industrial facilities location.

The operability of the automated system of centralized alerting of the public, enterprises and government agencies is tested regularly (according to the approved schedules) In the course of trainings the issues of public warning in case of radiation accidents are worked out.

The decision on public warning of the radiation accident and the recommended actions is taken by:

at all levels - the Prime Minister of the Republic of Belarus and his deputies, the Minister for Emergency Situations, in case of his absence - a person performing his functions;

at the territorial and lower levels - the chairperson of the regional Executive Committee (Minsk City Executive Committee), the head of the regional (Minsk city) Department of the Ministry for Emergency Situations, in case of their absence - persons performing their functions;

at the local and lower levels - the head of the local executive and administrative body, the head of the city (district) department for emergency situations, in case of their absence - persons performing their functions;

at the facility or local levels - the head of the organization operating the facility (hazardous production facility), in case of his absence - a person performing his functions; on-duty dispatcher.

Public warning is made through an automated centralized alert system as follows:

activation of the electrical alarm systems and loudspeaking units;

transmitting voice information transmission using radio-/TV-broadcasting stations;

voice information transmission using wireless broadcasting units and local alerting systems of the potentially hazardous and heavily trafficked facilities;

voice information transmission using the fire rescue systems, vehicles of the Ministry of Internal Affairs and other special vehicles equipped with signal loudspeaking systems, in underpopulated areas, and horticultural societies beyond the electrical alarm announcement area;

transmission of text information using SMS messages from mobile operators;

publication of relevant information on the popular web-sites;

transmission of text, voice, video information via TV mass communication media.

The automated centralized alert system is regularly tested (according to the established schedules). During this tests the public is informed of the radiation accident.

The Republic of Belarus has ratified a number of international conventions, including Convention on Early Notification of a Nuclear Accident. The Government of the Republic of Belarus has signed 49 bilateral agreements on assistance and/or exchange of information/notifications, including with the neighboring countries (the Republic of Latvia, the Republic of Lithuania, the Republic of Poland, the Russian Federation, Ukraine), which is noted as a good practice by the 2018 EPREV mission.

RCMER acts as a contact point for notification in the event of an accident and providing support in accordance with the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency. The round-the-clock RCMER operation allows receiving any notifications and promptly respond or confirm information.

In case of nuclear or radiation accidents (incidents), RCMER informs the IAEA by fax, through the official web portal (USIE) and by phone.

In case of threat or occurrence of radiation accidents, foreign countries are immediately informed through direct information exchange between the executive officers of the RCMER duty shift and the corresponding crisis centers of the foreign countries. Official information is also sent to the foreign countries through the Ministry of Internal Affairs of the Republic of Belarus according to the procedure established by the international agreements.

## ARTICLE 17. SITING

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

*i) evaluating all relevant site-related factors likely to affect the safety of a nuclear installation for its projected lifetime;*

*ii) evaluating the likely safety impact of a proposed nuclear installation on individuals, society and the environment;*

*iii) re-evaluating as necessary all relevant factors referred to in sub-paragraphs (i) and (ii) so as to ensure the continued safety acceptability of the nuclear installation;*

*iv) 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.*

From the date of the previous National Report, no site selection for locating new nuclear installations meeting the definition of Chapter 2 of the Convention on Nuclear Safety was exercised in the Republic of Belarus, the legal framework regulating sites selection for location of nuclear installations remained unchanged. For this reason, Article 17 (1, 2, 4) contains summary information already discussed during the meetings of the Contracting Parties to the Convention.

#### **Article 17 (1) Evaluation of site related factors**

The decision on site selection for the Belarusian NPP was taken in accordance with [80-82] which define:

key criteria and requirements regulating location of the NPP in the Republic of Belarus considering the impact of processes, events and factors of natural and man-made origin and the NPP impact on the public and the environment;

key requirements to composition and scope of investigations and research for site selection for the NPP location in the Republic of Belarus;

requirements for development and contents of the EIA report, justification of the environmental safety of the NPP.

At the stage of site selection for NPP construction, observations of the state of the natural environment, agricultural and forest lands were made to obtain "background" data on radioactive and chemical contamination as a basis for subsequent assessments of the operating NPP impact on the public and the environment.

*The said main criteria and requirements governing the NPP siting on the territory of the Republic of Belarus considering the influence of processes, phenomena and factors of natural and man-made nature and the NPP impact on the population and the environment and their implementation in determining the site location for the Belarusian NPP, allow us to declare compliance with principle 1 of the Vienna Declaration on Nuclear Safety of February 9, 2015: "New nuclear power plants are to be designed, sited, and constructed, consistent 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".*

The site selection for the Belarusian NPP was made following the IAEA recommendations. Survey materials were examined with the participation of agency experts during special expert missions in 2008.

At the stage of site selection for the future NPP, Belarus, in line with its international obligations and the national legislation, performed a comprehensive environmental impact assessment and all necessary risk and safety assessments. Based on NPP EIA, Belarus in 2009-2013 conducted transboundary consultations with Austria, Latvia, Lithuania, Poland and Ukraine as well as discussions with the public involved.

In November 2013, after the completion of interstate consultations, the Head of State decided to build a Belarusian nuclear power plant at the Ostrovets site. This decision was made based on EIA results including the results of transboundary consultations, the approved project documentation, as well as approvals and conclusions provided for by the national legislation. The EIA materials and conclusions showed the absence of significant harmful transboundary impact of the Belarusian NPP project. Neither country which had been involved in transboundary consultations provided any evidence of possible significant harmful impact on the environment as a result of project implementation.

In 2017, the IAEA SEED mission confirmed that Belarus had taken the necessary steps to ensure the safety of the Belarusian NPP in the event of the worst possible external event and that external threats typical of the site (earthquakes, floods and extreme weather conditions as well as

human-caused events) had been properly addressed in the NPP design and measures had been taken in the light of the lessons of the accident at the Fukushima-Daiichi NPP.

At the stage of site selection for the Belarusian NPP location, Gosatomnadzor performed continuous monitoring of compliance of the work executed by all organizations of the Republic of Belarus taking part in site selection. Their compliance with the requirements of technical NLA was considered. Based on inspection results, notices were issued to organizations with deadlines to eliminate violations. All violations were eliminated.

### **Article 17(2) Impact of the installation on individuals, society and environment**

On the basis of the results of studies of the NPP environmental impact, the following was established.

The NPP produces no significant impact on the geological environment, and the engineering solutions including foundation of the nuclear building and other 24 important buildings and facilities ensure their stability under any influences stipulated by the regulatory requirements (seismic activity, shock wave, etc.).

The costs associated with withdrawal of the land parcel for the construction of the nuclear power plant are fully accounted for in the project.

The nuclear power plant will be supplied with process water through the recycling system using cooling towers and spray ponds. No changes in the microclimate parameters and atmospheric processes in the area of the nuclear power plant location related to emissions of heat and moisture from these facilities will be observed.

The process water supply system will be fed from the Viliya river. The water scarcity of the Viliya river is not expected.

Under normal operating conditions:

the main radiation impact on the environment from gas-aerosol emissions during the operation of the NPP unit is caused by IRG due to external irradiation. During the NPP operation the background radiation level will not increase. The radiation dose rate in the NPP area at the height of 1 m from the soil surface is within 0.10-0.17  $\mu\text{Sv/h}$ ;

chemical substances emitted by auxiliary structures produce no harmful impact on the population for their maximum ground level concentration considering background contamination is lower than MAC even in the sanitary buffer area;

process emissions of the NPP will produce no negative impact on the soil, surface and ground waters, flora and fauna.

The NPP operation will not affect the state of the groundwater within 30 km; the water quality (chemical, bacteriological characteristics) of the artesian water intakes does not depend on the NPP operation.

### **Article 17(3) Re-evaluation of site related factors**

During construction of the Belarusian NPP, surveillance over the state of the environment in the region of the NPP is continued.

For the purposes of controlling the state of the environment, the operating organization implements the Integrated Ecological Monitoring Program of the region and the site of the Belarusian NPP to investigate the dynamics of change in parameters and characteristics of natural processes and events in this region. The following types of surveillance over the environmental status are performed: radiation monitoring; seismological monitoring; geodetic monitoring of the present-day crustal motion; monitoring of meteorological processes, events and factors; climate monitoring; aerological monitoring; groundwater monitoring; hydrological monitoring (monitoring of the surface water regime); geotechnical control (monitoring of the yield of foundation of buildings and facilities).

The results of the investigation did not reveal deviations from the design indicators of the NPP impact on the environment.

### **Article 17(4) Consultation with other Contracting Parties likely to be affected**



### **by the installation**

In 2009-2013, Belarus conducted transboundary consultations with Austria, Latvia, Lithuania, Poland and Ukraine as part of the procedure for assessing the environmental impact of the Belarusian NPP.

Neither country which had been involved in transboundary consultations provided any evidence of possible significant harmful impact on the environment as a result of project implementation.

Belarus invited these countries to take part in the subsequent post-project analysis and consultations concerning its program.

Information on Belarusian NPP environmental impact assessment is published on the web-sites of the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus <http://www.minpriroda.by/> and State Enterprise "Belarusian NPP" <http://www.belaes.by/>, EIA report of the Belarusian NPP is published in the section "[NPP ecology](#)" of the website of the State Enterprise "Belarusian NPP". The regulatory body, other state administration bodies and organizations of the Republic of Belarus, within their competence, constantly inform the public involved, the professional community, about nuclear and radiation safety activities in the context of the implementation of the first nuclear energy program in the Republic of Belarus, including during events in the framework of bilateral and multilateral cooperation, including the activities of the IAEA, the Regulatory Cooperation Forum (RCF), Western European Nuclear Regulators Association (WENRA), the Forum of the State Nuclear Safety Authorities of the Countries Operating WWER Type Reactors (WWER Forum).

## **ARTICLE 18. DESIGN AND CONSTRUCTION**

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

*i) the design and construction of a nuclear installation provides for several reliable levels and methods of protection (defense-in-depth) against the emission of radioactive substances, with a view to preventing the occurrence of accidents and to mitigating their radiological consequences should they occur;*

*ii) the technologies incorporated in the design and construction of a nuclear installation are proven by experience or qualified by testing or analysis;*

*iii) the design of a nuclear installation allows for reliable, stable and easily manageable operation, with specific consideration of human factors and the man-machine interface.*

### **Regulatory requirements**

Regulatory documents define the requirements for the design of nuclear power plants, including requirements for individual systems and elements, as well as functions they perform. According to the requirements of [5, 48]:

the safety of the nuclear power plant is achieved through high-quality design, construction and manufacture of equipment, placement, construction and operation of nuclear power plant through compliance with the requirements of regulatory documents, formation and maintenance of safety culture, taking into account the operational experience and the current level of science and technology development;

the safety of nuclear power plants should be ensured through the consistent implementation of defense-in-depth based on the use of a physical barriers system to the spread of ionizing radiation and radioactive substances into the environment, and a system of technical and organizational measures to protect barriers and retain their effectiveness, as well as to protect personnel, the public, and the environment;

The NPP should provide for safety systems designed to perform the following basic safety functions: emergency shutdown of the reactor and maintaining it in a subcritical state; emergency heat removal from the reactor; radioactive substances retention within established limits. Mutual influence of safety systems preventing their execution of safety functions should be excluded;

the NPP project should provide for special technical means to ensure BDBA management;

systems and elements important for safety should be able to perform their functions in the scope established by the NPP project, taking into account external natural influences;

the NPP project should consider and justify measures to protect safety systems and elements, as well as systems and elements of special technical means for managing accidents from failures due to common reason through implementing the principles of diversity, redundancy and independence;

when designing NPP and RS systems (elements), preference should be given to systems (elements), the design of which is based on the passive principle of operation and the properties of internal self-protection (self-regulation, thermal inertia, natural circulation and other natural processes), as well as on the implementation of the principle of safe failure;

the NPP project should provide for means to prevent errors of the personnel prevented or mitigate their consequences, including during maintenance and repair;

the controlling safety systems should be designed in such a way as to prevent the possibility of disabling safety systems by operational personnel within 10-30 minutes after their automatic start, but not to interfere with the correct actions of the operator in the event of an accident, provided for by the technological regulations, accident management instructions, BDBA management guidelines;

the NPP project should provide for technical means for monitoring the NPP and RS state in the conditions of accidents, including severe accidents, as well as means of post-accident monitoring;

Regulatory documents define the requirements for the design of nuclear power plants, including requirements for individual systems and elements, as well as functions they perform.

The design and construction of nuclear installations are licensed activities according to the Regulation on licensing activities in the field of the use of atomic energy and IRS [2]. The issue of a license to carry out these types of work is preceded by a safety review of a full set of documents justifying the safety of work, the list of which is established in the norms and rules for nuclear and radiation safety "Requirements for the composition and content of documents justifying nuclear and radiation safety" [32].

Safety review is performed in relation to a nuclear installation and documents justifying nuclear and radiation safety, in order to assess their compliance with regulatory documents, the current level of development of science, technology and production. The results of the safety review and the Gosatomnadzor own safety assessment of the submitted documents were the basis for issuing an appropriate license and performing work on design and construction of the Belarusian NPP.

At the stage of preparatory work for the construction of a nuclear power plant in the Republic of Belarus, one of the most important tasks was selecting a reliable, safe and economical NPP project and, accordingly, the company that would implement this project with the supply of equipment for the NPP. Taking into account the comprehensive analysis performed, the choice was made on the Russian NPP-2006 project, which is currently being implemented. The development of the Belarusian NPP project was performed following the NLA requirements, including technical NLA, of the Republic of Belarus, the Russian Federation, and the IAEA recommendations. The principal characteristics of the Belarusian NPP are provided in [Article 6](#) of this National Report.

Construction of the NPP according to the "AES-2006" design project enables:

creating a 3+ generation nuclear power plant, characterized by a new reactor system with additional safety systems: passive heat rejection system; passive system of leakage filtration into the annulus;

double protective containment; melt trap upon beyond design basis accidents;

the maximum implementation of the defense-in-depth principle – creating a system of barriers to the spread of ionizing radiation and radioactive substances into the environment and a system of technical and organizational measures to protect barriers, as well as to preserve their effectiveness in direct protection of the population;

NPP compliance with radiation safety criteria contained both in national legislation and in international practice of NPP design.

To perform safety functions during NPP design, the use of safety systems based on the principles of redundancy, spatial and functional independence, and single failure, is provided.

In addition, assessing the safety and compliance of the project with its actual implementation was performed for power unit No. 1 of the Belarusian NPP during the licensing period of its

construction (including step-by-step commissioning), as well as part of documents revision prior to license issue for the operation of power unit No. 1. Safety assessment in relation to the construction (commissioning) and preparation for industrial operation of the power unit No. 2 of the Belarusian NPP is in progress out and is one of the main tasks at the time of publication of the report. The process of revision and conducting safety assessments is continuous, the safety assessment of changes in the basic configuration is implemented as part of the safety assessment of modifications realized during operation at the NPP, as well as within the framework of the periodic safety assessment provided for by the requirements (once in 10 years).

### **Article 18 (1) Implementation of the "defense-in-depth" concept**

The defense-in-depth concept implies creating a system of physical barriers to the spread of radioactive substances and irradiation, and a system of technical and organizational measures to maintain workability of physical barriers and to mitigate the consequences of their damage.

The defense-in-depth is ensured primarily through combination of consistent and independent defense levels. Only after the failure of all defense levels the population or the environment can be exposed to harmful effects. In case of the failure of one defense level or penetration through one barrier, there is the next level or barrier.

The technical design project of the Belarusian NPP provides five physical barriers preventing unacceptable release of radioactive substances and ionizing emission. This includes a fuel matrix, fuel-element cladding, primary coolant equipment, leak tight confinement of the reactor system and a biological shield.

The technical and organizational measures system includes the following defense-in-depth levels:

- level 1 - conditions for the NPP siting and preventing normal operation violations;
- level 2 - preventing design accidents by normal operation systems;
- level 3 - preventing BDBA by safety systems;
- level 4 - BDBA management;
- level 5 - emergency planning.

The NPP safety concept is based on the active safety systems having both normal power supply and emergency power supply from diesel generators.

To prevent severe accidents or reduce their consequences, the passive systems are available capable of operating without intervention of the NPP personnel and power supply.

To achieve the safety level required by the regulatory documents of the Republic of Belarus, the Russian Federation and the IAEA recommendations, the design project defines a set of safety systems and additional facilities for BDBA management.

The main tasks of BDBA management are: preventing the core damages; preventing the reactor vessel rupture; preventing the containment failure; decrease of nuclear emission into environment.

Accounting for personnel errors is a necessary element of both deterministic and probabilistic analysis of the safety of systems important for the safety of nuclear power plant.

The deterministic safety analysis demonstrated effectiveness of operation of the safety systems and the systems important for safety of the nuclear power unit within the frames of the design basics for provision of safe NPP operation in design conditions. The project of the NPP power unit enables fulfilment of the requirements for the radiation dose limits and emissions established by regulatory documents for the NPP design conditions.

The results of the BDBA modes analysis provided in SAR of the State Enterprise "Belarusian NPP" showed the possibility of managing the BDBA, which makes it possible to effectively limit their consequences. Based on the concept of safety assurance of the Belarusian NPP, the BDBA management (including severe accidents) is related to the 4th level of NPP protection which implies:

- preventing BDBA development and reducing their consequences;
- protecting tight enclosure (containment) from destruction during BDBA and maintenance of its operability;

the return of the nuclear power plant to a controlled state, at which the fission chain reaction stops;

ensuring constant cooling of the nuclear fuel and the retention of radioactive substances within the established limits. To achieve the goals of the 4th level of defense-in-depth, the following technical means are used among others:

emergency boron injection system, PHRS from SG, PHRS from containment, pulse-safety device of pressure compensator;

emergency ventilation system to maintain the medium vacuum and cleaning in the space between shells, a system for chemical binding of volatile forms of iodine, a core melt retention system; the system of emergency use of water from inspection cavities.

To manage accidents at the Belarusian NPP, instructions for accident mitigation, guidelines for BDBA management including severe accidents, have been developed;

The results of the implemented levels 1 and 2 PSA confirmed the probabilistic criteria for NPP safety established by regulatory documents: the probability of severe accidents for 1 year is  $8.57 \cdot 10^{-7}$  (1/year), the average value of the total probability of a large accidental emission for 1 year is  $8.61 \cdot 10^{-8}$  (1/year).

The application of the defense-in-depth principle at the power units of the Belarusian NPP is expressed in the SAR of power units, the results of the safety review of which indicate the compliance of the applied system of organizational and technical measures with regulatory documents requirements.

Following the submitted report on the assessment of the current state of safety of the Belarusian NPP for 2021 and the results of the control and supervisory measures implemented by Gosatomnadzor, the state of physical barriers meets the requirements of regulatory documents, design and operational documentation. Violations of the limits and conditions of safe operation have not been recorded.

Measures aimed at improving safety developed based on stress tests outcomes are given in Article 6 hereof.

### **Article 18 (2) Incorporation of proven technologies**

The NPP-2006 concept is based on the use of developed technology and equipment, the availability of prototypes, the experience of power units construction and operation. The major technological equipment used in the project has many years of positive operational experience at Russian NPPs and NPPs of other countries built according to Russian projects.

The advantage of NPP-2006 project is the unique combination of active and passive safety systems (double reactor doom, passive systems heat removal from reactor core in emergency, core catcher) ensuring the highest level of safety and meeting the requirements of today and decades to come.

These systems helps to protect NPP from natural and man-made impact, as well as from false personnel operation in case of emergency.

The operating power units of the Leningrad NPP-2 are the reference power units of the Belarusian NPP.

### **Article 18 (3) Design for reliable, stable and manageable operation**

AES-2006 design for the Belarusian NPP was selected based on the preliminary comprehensive analysis during preparation stage to ensure maximum reliability, safety, sustainable and manageable operation, taking into account the relevance of technologies used and with special attention to human factor.

The project provides technical measures to prevent and limit the consequences of false staff operation which violates safety functions. Taking into account the human factor in the design of a nuclear installation, its operation and maintenance, the licensee's measures (administrative and managerial, organizational, etc.) to take into account the influence of the human factor are given in Article 12 hereof.

Regulatory actions in relation to works related to the Belarusian NPP construction, the principles and legal basis for their implementation are described in Article 7 and Article 12 hereof.

Design and construction of the Belarusian NPP meets the principle 1 of the Vienna Declaration on Nuclear Safety of February 9, 2015: "New nuclear power plants are to be designed, sited, and constructed, consistent 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".

## ARTICLE 19. OPERATION

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

- i) 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;*
- ii) 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;*
- iii) operation, maintenance, inspection and testing of a nuclear installation are conducted in accordance with approved procedures;*
- iv) procedures are established for responding to anticipated operational occurrences and to accidents;*
- v) necessary engineering and technical support in all safety-related fields is available throughout the lifetime of a nuclear installation;*
- vi) incidents significant to safety are reported in a timely manner by the holder of the relevant license to the regulatory body;*
- vii) programs to collect and analyze operating experience are established, the results obtained and the conclusions drawn are acted upon and that existing mechanisms are used to share important experience with international bodies and with other operating organizations and regulatory bodies;*
- viii) 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.*

### **Article 19 (1) Initial authorization**

Based on Article 18 of the Law on the Use of Atomic Energy [6], the commissioning of a nuclear installation and (or) a storage facility shall be implemented in accordance with the program for commissioning a nuclear installation and (or) a storage facility developed by the operating organization on the basis of the projects of these facilities.

The commissioning program is developed no later than 6 months before the start of the power unit commissioning taking into account the experience of commissioning similar units, and applies to all works and services related to the power unit commissioning.

The commissioning program is developed with a view to elaborate sufficiently the issues require planning before the start of commissioning, safe and high-quality commissioning, compliance with the requirements of regulatory documents, determining the testing sequence at each stage of commissioning, checking the quality of work performed at previous stages, conducting a comparative analysis of the compliance of the actual condition of components and systems with design and engineering solutions, confirmation that systems and elements have been manufactured and are operating in accordance with the project, confirmation of the limits and conditions of safe operation, as well as the design characteristics of NPP systems and equipment.

According to the requirements of the General Provisions for the NPP Safety Assurance [5]:

commissioning of the NPP unit is implemented taking into account the regulatory documents requirements;

requirements for the sequence and scope of work performed during pre-commissioning, physical start-up, power start-up, pilot operation, including the procedure for checking NPP systems

and elements important for safety for compliance with design indicators, including acceptance criteria, are established and justified in the NPP project and provided to the NPP SAR (preliminary edition);

pre-commissioning, physical and power start-ups, pilot operation should confirm that the NPP on the whole, as well as systems and elements important for safety, have been manufactured and are operating in accordance with the NPP project, the revealed drawbacks have been eliminated;

the first delivery of nuclear fuel to the NPP site is allowed by the regulator after checking the NPP readiness for the nuclear fuel delivery provided that plans for personnel and the public protection in the event of an accident at the NPP are available and the readiness of their implementation and obtaining a license is ensured;

the first loading of the intended, tests in the subcritical state of the reactor system, performing physical experiments at a minimally controlled level, power start-up and pilot operation are allowed after checking readiness for the relevant stages of the NPP commissioning and obtaining special permits (licenses);

the operation of the NPP unit is allowed after obtaining a license for operation after the end of the NPP unit commissioning before the start of work of the State Acceptance Commission for commissioning the completed facility construction in accordance with the legislation.

The procedure for obtaining a license for the operation of nuclear installations is established in the Regulation on licensing activities in the field of the use of atomic energy and IRS [2], which was developed in order to improve the licensing of activities in the use of atomic energy, as well as taking measures to maintain an appropriate level of nuclear and radiation safety.

As part of implementing provisions of the Decree of the President of the Republic of Belarus [2], the requirements for the composition and content of documents justifying nuclear and radiation safety assurance were updated in 2021 [32].

The operating organization, together with the general contractor, ensure the preparation and timely submission to Gosatomnadzor of documents justifying nuclear and radiation safety assurance, as well as other documents inline with requirements of regulatory documents and special licensing requirements and license conditions.

The decision to issue a license for the operation of a nuclear installation, as well as Gosatomnadzor permits for the transition from one stage of operation to another, are based on results of a safety review, as well as the results of targeted inspections by Gosatomnadzor of the operator's readiness to transit from one stage of operation to another in accordance with the requirements of the Nuclear Safety Rules of the NPP reactor system [48].

The process of commissioning of the NPP unit start-up complex comprises two consecutive periods: the preparatory period of commissioning and the period of unit commissioning. The latter is implemented following step-by-step programs subject to safety review as part of documents justifying nuclear and radiation safety assurance [48] and includes the following main stages: Stage A - "Pre-commissioning", Stage B - "Physical start-up", Stage C - "Power start-up", Stage D - "Pilot operation".

Gosatomnadzor conducted targeted inspections of the readiness of the operating organization, as well as the NPP site in general, by the beginning of each stage of commissioning of the nuclear installation units for compliance with regulatory documents, as well as requirements contained in the design and operational documentation, including programs for power unit commissioning and step programs. At the same time, in the course of Gosatomnadzor inspections (both of the NPP site readiness for the next stage of power unit commissioning and during such stage), the compliance of the test results with the established requirements and criteria set in project documentation and documents justifying the provision of nuclear and radiation safety, is also subject to analysis.

Implementing safety review to obtain a license for the operation of a nuclear installation is performed in stages with submitting separate expert opinions for each stage of commissioning of a nuclear installation, and a final generalized expert opinion.

As part of expert opinions revision, comprehensive interaction of Gosatomnadzor, expert organizations, operating organization, general contractor and other organizations implementing work and providing services in the framework of the nuclear installation commissioning, was organized and conducted.

Information on the legislative and regulatory framework ensuring effective legal regulation of activities on nuclear installations operation is provided in the section with information on Article 7 "Legislative and regulatory framework".

### **Commissioning and operation of the power unit No. 1 of the Belarusian NPP.**

Power unit No. 1 of the Belarusian NPP is under commercial operation. From April to July 2022, scheduled outage was conducted at power unit No. 1 of the Belarusian NPP with complete unloading of the core (in order to inspect the reactor vessel) and partial replacement.

In accordance with the step-by-step process of permits issue within the framework of commissioning and obtaining a license to operate Unit No. 1 of the Belarusian NPP, the following permits were obtained:

April 2020 – for handling NF (fresh NF);

August 2020 – for the first loading of intended core and testing in a subcritical state;

October 2020 – to perform work to achieve the critical state of the reactor and perform the necessary physical experiments at a minimally controlled power level;

October 2020 - to perform work on power start-up and testing at power levels up to 50% of the nominal;

December 2020 – to perform work within pilot operation of the power unit No. 1 of the Belarusian NPP.

The license for the operation of power unit No. 1 of the Belarusian NPP was issued on June 2, 2021.

Following the requirements of the Regulation on licensing activities in the field of the use of atomic energy and IRS [2], the operating organization in March 2022 submitted the first (since the start of industrial operation of the Belarusian NPP power Unit No. 1) safety assessment report for the Belarusian NPP, the requirements for the composition and the content of which are set in the Instructions on requirements for the content of the report assessing the current state of safety of a nuclear installation, storage facility, or ongoing work and (or) services [83].

The report presented by the State Enterprise "Belarusian NPP" contains generalized information for 2021 regarding the state of the physical barriers systems (fuel element tightness, coolant circuit tightness, the state of the tight enclosures system), the state of safety systems, the output of the design resource of the main equipment of the NPP power unit; information regarding the organization of maintenance and repair, analysis of operational experience, efficiency of radiation protection of the population and the environment, physical protection, fire safety, results of nuclear and radiation safety inspections, etc.

Based on the implemented analysis, including by employees of the State Scientific and Technical Institution "Center for Nuclear and Radiation Safety", it was concluded that at this stage the safety of the power unit No. 1 of the Belarusian NPP is fully ensured, the requirements of regulatory documents, as well as international recommendations and norms in the field of atomic energy use are taken into account.

### **Commissioning of the power unit No. 2 of the Belarusian NPP.**

At the time of publication of this report, power unit No. 2 of the Belarusian NPP is at stage B "Physical start-up" of commissioning.

The stage objectives are to implement the physical start-up of the reactor of power unit No. 2 of the Belarusian NPP, including reactor loading with NF and obtaining experimental data on the neutron-physical and thermo-hydraulic parameters of the reactor and the primary circuit and enabling power unit No. 2 readiness for stage B "Power start-up".

Stage B starts with fuel assembly transportation from storage facility to the NPP for installation into the reactor according to the program and methods of first loading of intended core.

Stage B includes the following substages:

substage B-1 — "Loading of reactor with nuclear fuel and RS tests in subcritical state";

substage B-2 — "Achieving critical state of the reactor and implementing physical experiments at minimum controlled power level".

Within the framework of licensing and permitting activities, a step-by-step licensing and permitting process is also applied to the power unit No. 2 of the Belarusian NPP.

Based on results of revision of the submitted package of documents justifying nuclear and radiation safety assurance, considering the results of safety review of the said documents in the amount required for issuing permit for NF loading and implementing work at stage B "Physical start-up", as well as based on results of the Gosatomnadzor-performed check of the readiness to transit to stage B "Physical start-up", appropriate changes were made by Gosatomnadzor to the license and a permit was issued to conduct work on NF loading to the reactor core of power unit No. 2 and perform tests as part of a physical start-up.

### **Article 19 (2) Operational limits and conditions**

Safe operation limits are technological process parameters values deviations from which could result in an accident. There are safe operation limits according to radiation parameters and those according to other technological parameters. The *conditions* of safe operation are the minimum conditions for the number, characteristics, state of operability and maintenance conditions of systems (elements) important for safety, in which compliance with the limits of safe operation and (or) safety criteria is ensured.

GSP NPP [5] and the Nuclear Safety Rules for NPP RS [48] establish the basic requirements and safety criteria, based on which the general requirements for the limits and conditions of safe operation are formed.

According to the GSP NPP requirements [5]:

the NPP project should justify the limits and conditions of safe operation, as well as provides technical means and organizational measures aimed at preventing violation of limits and conditions of safe operation.

the NPP SAR should express operational limits and conditions, limits and conditions of safe operation for all operational states of the NPP, including reactor operation at power, shutdown state and refueling.

The operating organization, with the participation of the NPP and RS projects developers, in line with the project ensures the development of technological regulations for the safe operation of the NPP power unit, which, according to GSP NPP requirements [5], is the main document determining the safe operation of the NPP unit and should contain rules and basic operating techniques, the general procedure for performing safety-related operations, as well as limits and conditions of safe operation. The operation of the NPP unit in violation of the requirements of the technological regulations for the operation of the NPP unit is prohibited.

The technological regulations for the safe operation of the NPP power unit and the changes made thereto must be agreed with organizations involved in its development.

The technological regulations for the safe operation of an NPP power unit according to the requirements of [32] is one of the documents justifying the provision of nuclear and radiation safety, is subject to safety review, and its compliance is a special licensing requirement and a condition for a special permit (license).

Based on norms and rules of nuclear and radiation safety "Requirements for the implementation of modifications at nuclear power plants and assessment of their safety" [39], the change in the Technological Regulations for the safe operation of an NPP power unit belongs to the first category of modifications, the implementation of which requires submission to Gosatomnadzor of the technical solution, modifications SAR, a training program for NPP personnel, and a list of operational documentation amended in connection with the planned modification. The above set of documents undergoes a safety assessment, including taking into account recommendations defined in the Manual on Nuclear and Radiation Safety "Recommendations for safety assessment of modifications at nuclear power plants" [56].

The results of safety assessment of the submitted set of documents on amendments to the Technological Regulations for Safe Operation of the NPP Power Unit are the basis for Gosatomnadzor decide on amending the operator's license that allow operating the NPP power unit taking into account the amendments made.



Such amendments to the Technological Regulations for the safe operation of power unit No. 1 of the Belarusian NPP were made taking into account the results of start-up operations being the subject of additional safety review. The said review was performed by experts of the Research Institute for Nuclear Problems of the Belarusian State University.

Compliance with the requirements of the Technological Regulations for the safe operation of power unit is one of the relevant issues of the Basic Program of Supervision at the Belarusian NPP at the operational stage approved by the Head of Gosatomnadzor.

Monitoring of compliance with the requirements of the Technological Regulations for the safe operation of power unit is implemented by Gosatomnadzor both through inspections and during systematic monitoring of fulfilling mandatory requirements by the operating organization including by analyzing the parameters received by the Gosatomnadzor information and analytical center, as well as reviewing daily operational reports and other documentation sent to Gosatomnadzor.

Operation of the unit at power involves periodic check of the operability of the channels of systems important for safety according to regulations for inspections and tests of systems important for safety. Monitoring such checks is also included in the Gosatomnadzor inspection program.

The responsibilities of the on-site control services of the operating organization also include monitoring compliance with the requirements of the Technological Regulations for the safe operation of power unit

The results of control and supervisory measures, the results of considering the report on assessing the current safety status of the Belarusian NPP indicate there were no violations of limits and conditions of safe operation over the reporting period as of the date of submission hereof.

Based on GSP NPP [5], the NPP power unit shall be stopped and put into safe state specified by the NPP project if limits and (or) conditions of safe operation established for RS are not met during its operation.

Violation of limits and conditions of safe operation of the Belarusian NPP must be investigated. Operating organization shall develop and implement measures to prevent recurrent violations of limits and conditions of safe operation for the same reasons.

Accounting and investigating violations in the NPP operation, and informing of the regulatory body about them shall be performed in accordance with the requirements of norms and rules for nuclear and radiation safety assurance "Requirements for investigation and account of violations in the operation of nuclear power plants" approved by the resolution of the Ministry for Emergency Situations No.52 of October 2, 2018 [54].

### **Article 19 (3) Procedures for operation, maintenance, inspection and testing**

Regulatory documents, including GSP NPP [5], define the requirements for the development and availability of documents regulating the issues of operation, maintenance and testing in terms of:

development and availability of technological regulations for the safe operation of an NPP power unit, containing rules and basic operating techniques, general procedure for performing safety-related operations, as well as limits and conditions of safe operation;

development by the operating organization prior to pre-commissioning of operating instructions for systems and equipment containing specific instructions to personnel on ways of work performance at normal operation, operation with deviations and pre-emergency situations;

development of implementation by the operating organization of regulations for maintenance, repair, testing and inspections. The development of these regulations for the Belarusian NPP was performed with the participation of the RS and NPP project developers in accordance with the NPP project and SAR;

performance of nuclear hazardous works based on nuclear hazardous works programs developed and approved in due order. Performing nuclear hazardous works not provided for by the Technological Regulations for the Safe Operation of the NPP Power Unit and the operating instructions may be implemented by the operating organization only according to a specially developed work program containing measures to ensure the safety of these tests based on the safety analysis performed and agreed with the RS and NPP project developers. Tests are allowed following the license requirements and after conducting safety review

timely amendments to the operational documentation in connection with planned modifications;

developments for systems important for safety, instructions for inspections, schedules for maintenance, scheduled outage and overhaul of systems and elements, schedules for testing and inspections of safety systems operability in accordance with the requirements of the Nuclear Safety Rules of the NPP reactor system [48]

Upon request of the regulatory body, the operating organization shall inspect in extraordinary manner the operability of safety systems, special technical means for BDBA management, as well as to control in extraordinary manner the state of base metal and welding joints of NPP safety-relevant elements and systems.

The operating organization together with the general contractor, based on the results of commissioning prior to putting power unit No. 1 of the Belarusian NPP into commercial operation, adjusted operating instructions in terms of bringing them into compliance with the actual state of the power unit after the pre-commissioning and the requirements of documents justifying nuclear and radiation safety assurance. Work on adjustment of operational documentation at power unit No. 2 of the Belarusian NPP is implemented in line with the established procedure as part of the ongoing work on the power unit commissioning.

Following the regulatory documents requirements, the operating organization has developed a complete list of documents regulating the course of operation, maintenance, testing and inspections.

Instructions, programs and schedules for maintenance, repair, testing and inspections of systems important for safety, standard programs (regulations) for pre-operational and operational control of the condition of the base metal and welded joints of equipment and pipelines of systems important for safety in accordance with the requirements are included in the documents for obtaining a license to operate a nuclear installation, [32] and passed a safety review within the framework of obtaining a license to operate Unit No. 1 of the Belarusian NPP, as well as within the framework of a phased safety review for power unit No. 2 of the Belarusian NPP.

To perform maintenance and repair of equipment of the Belarusian NPP, the following concept has been adopted:

- maintenance and routine repair shall be implemented by the repair personnel of the Belarusian NPP, for which the necessary personnel and a set of workshops are provided at the Belarusian NPP;

- average repair and overhaul of safety-related systems shall be implemented on a service basis by supplier factories or specialized repair organizations;

- acceptance of equipment of systems important for safety after repair shall be performed by the operator's repair personnel;

- the repair personnel involved must be trained and certified, specialize in certain systems, be assigned thereto and be responsible for the quality of repair of equipment of these systems.

Routine scheduled and unscheduled inspections (tests) (except hydraulic tests) of safety-related systems during power unit operation are performed in line with the "Regulations for Inspections and Tests of Systems Important for Safety". The frequency of inspections (testing) of equipment of safety-related systems of the power unit is determined by the annually compiled Schedule of Routine Inspections of Systems Important for Safety. The conditions, procedure, criteria for the success of inspections (tests) of systems (elements) important for safety are determined by "Regulations for Inspections and Tests of Systems Important for Safety". Where the criteria for the success of inspections (tests) are not defined by the "Regulations for Inspections and Tests of Systems Important for Safety. Unit No.1", the criteria shall be determined by programs developed for appropriate inspections (tests) following the current requirements of regulatory documents and based on operational documentation requirements.

Production control is implemented in line with the developed and approved regulation on the system of production control of the safety state of the State Enterprise "Belarusian NPP".

A schedule of workplace checks by administrative and technical personnel is drawn up and approved at the NPP. Workplaces rounds and inspections are performed out by heads of the NPP and structural units, including at night shifts. The check results are analyzed by the NPP management.

The test results of systems important for safety are provided to Gosatomnadzor on a monthly

basis.

Control over compliance with the requirements of regulatory documents within the framework of operation, including maintenance, repair and testing is provided by Gosatomnadzor as targeted and raid inspections in the mode of constant control (supervision), taking into account the developed and approved Basic program of supervision at the operational stage.

The operating organization ensures permanent control of all activities relevant for the safety of the Belarusian NPP.

Following the requirements of the Regulation on licensing activities in the field of the use of atomic energy and IRS [2], the operating organization provides an annual report on the assessment of the current state of safety, which includes the results of the evaluation of the operator's activities regarding maintenance, testing, and the results of departmental control.

With regard to power unit No. 2 of the Belarusian NPP: the results of commissioning are provided to Gosatomnadzor taking into account the established special licensing requirements and conditions. Gosatomnadzor, in the mode of constant monitoring (supervision), ensures the review of the results of pre-commissioning, assessment of the actual state of systems and equipment, the results of metal control and the timeliness of the implementation of technical and organizational measures to bring operational documentation and documents justifying nuclear and radiation safety assurance during commissioning, in compliance with the requirements of regulatory documents and the actual condition of power unit No. 2 of the Belarusian nuclear power plant.

#### **Article 19 (4) Procedures for responding to operational occurrences and accidents**

Requirements for the procedures to respond to the anticipated commissioning and operational occurrences and accidents are regulated by the legislation in the field of nuclear and radiation safety. The operating organization shall be responsible for their full implementation.

Emergency plans have been developed, approved and tested for the Belarusian NPP during emergency exercise: on-site emergency plan approved by the Director General of the Belarusian NPP in May 2018 (the current version – Version No. 2. Amendment No. 3 was approved on December 13, 2021) and off-site emergency plan approved by the Decree of the Government of the Republic of Belarus No.211 of March 22, 2018. Information about emergency plans is provided in Article 16.

The operating organization, following the established regulatory requirements developed the following documents defining measures to prevent pre-emergency situations and accidents, and actions to manage them:

- Technological Regulations for the Safe Operation of Power Units No. 1, No. 2;
- Instructions for the Elimination of Violations of the Normal Operation of Power Units No. 1, No. 2;
- Instructions for Managing Design Accidents of the Belarusian NPP in the Event-Oriented Format of Power Units No. 1, No. 2;
- Instructions for Managing Design Accidents of the Belarusian NPP in the Symptom-Oriented Format of Power Units No. 1, No. 2;
- Guidance for Beyond Design Basis Accident Management (RUZA). Part 1 Event-oriented. Power Unit No. 1, No. 2;
- Guidance for Beyond Design Basis Accident Management (RUZA). Part 2 Symptom-oriented. Power Unit No. 1, No. 2;
- Severe Accident Management Guidance (SAMG). Belarusian NPP. Power Unit No. 1, No. 2. Part 1 General provisions. Part 2 Accident management rules. Part 3 SAMG Instructions;
- Emergency response regulations for possible flooding, destruction, spills of chemically hazardous substances, premises or equipment icing affecting the trouble-free operation of Belarusian NPP facilities;
- Guidance on restoring the RS safe state (engineering support in case of accidents and emergencies at nuclear power plants);
- Regulations on the Accident Management Group;
- Instructions for the operational personnel actions at MCR / BCP APC alarm tripping. Power

Unit No.1. Power Unit No.2;

Instructions for the operational personnel actions at FODMS (control panel) alarm tripping.  
Power Unit No.1. Power Unit No.2.

In order to plan, ensure readiness and implement measures to protect the NPP personnel and the territory from natural and man-made emergencies, in accordance with the laws of the Republic of Belarus and the resolutions of the Government of the Republic of Belarus, the system of prevention and mitigation of emergency situations of the Belarusian NPP has been created and is operating.

The main information and control element in the NPP emergency prevention and response system is the Crisis Center. One of the main tasks of the Crisis Center is to monitor the readiness of NPP safety systems for activation, to interact with the operational-duty services of the Ministry for Emergency Situations, Belenergo and Gosatomnadzor, to create conditions for the work of the NPP emergency assistance group. Prior to the nuclear fuel delivery, the operating organization put into operation the Crisis Center and as the main and duplicate means of communication with the Ministry for Emergency Situations, republican bodies of state administration implementing state administration in the field of the use of atomic energy and regulating safety activities in the use of atomic energy, emergency management bodies at the territorial level and local executive authorities and self-government of settlements, included in the NPP SA.

Before the start of each stage (substage) of the NPP unit commissioning, the operating organization shall ensure the preparation of all activities and safety means under SAR, NPP unit commissioning program, NPP unit commissioning stage (substage) implementation programs, as well as programs on start-up works and tests of safety-relevant systems (elements). The readiness of technical and organizational actions to ensure nuclear and radiation safety by the beginning of each of the commissioning stages is assessed by the operating organization in line with procedure established by the SAR and the program of the power unit commissioning, as well as following the requirements of the Nuclear Safety Rules of the NPP reactor system [48]. The said readiness is also checked by Gosatomnadzor prior to issuing a permit on the possible transit from one stage of commissioning to another.

In the course of commissioning and operation of NPP power units, the operating organization ensures and maintains the level of emergency preparedness to respond to accidents and emergencies.

To train personnel actions in the case of emergency, the operating organization develops methods and programs of preparing and holding emergency response exercise, organizes and regularly holds emergency response exercise in accordance with the established schedule.

In the course of professional training of the NPP personnel, technical means shall be used to work out practical skills of NPP operation, including various simulators admitted to train the NPP staff. Special attention must be paid to work out actions in case of possible violations, including accidents, in the NPP operation, considering the operating experience. The Training Center with full-scale simulator started operating before NF delivery to the Belarusian NPP site.

Emergency exercise and trainings are constantly conducted at the NPP according to approved schedules.

#### **Article 19 (5) Engineering and technical support**

Engineering and technical support during commissioning and operation of the NPP shall be provided by the Russian organization implementing AES-2006 project in the Republic of Belarus through:

tests, start-up works, commissioning, and support during the warranty period of the NPP operation;

provision of maintenance services for the delivered equipment, including consultations, delivery of spare parts, provision of equipment storage and conservation technology, support in organization of repair maintenance and repairs;

NPP QAP development and coordination with the Owner of the Belarusian NPP construction;  
providing engineering and consultation services to the Belarusian organization during the development of programs and measures for physical protection of the NPP;  
training of Belarusian specialists.

The regulatory body receives the necessary support from both the TSO of the Republic of Belarus and from the relevant TSO of the regulatory body- the technology supplier country of the Russian Federation (on a contractual basis) FSUE VO "Security" (Russian Federation) and a number of other organizations.

#### **Article 19 (6) Reporting of incidents significant to safety**

The requirements for the procedure for notification and preparation of reporting documentation on events at the NPP are set out in the norms and rules for nuclear and radiation safety assurance "Requirements for investigation and account of violations in the operation of nuclear power plants" [54], and in special licensing requirements and conditions of the operator's license.

Additionally, the operating organization, based on the requirements of [54], have developed on-site local proceedings regulating the order of investigating events at various levels.

Information about events at power unit No. 1 of the Belarusian NPP during start-up activities was provided to Gosatomnadzor in due order. The events that took place by their signs and consequences refer to "Incidents". Events with "Accidents" signs and consequences, as well as events with radiation consequences, exposure of personnel and the public have not been recorded. According to the International Nuclear and Radiological Event Scale (INES), events are classified as events not essential for safety - level "0". Prior to start of industrial operation of power unit No. 1 of the Belarusian NPP, documents confirming the implementation of activities aimed at preventing similar events in the future were submitted to Gosatomnadzor. An analysis of measures effectiveness and the absence of similar events at industrial operation may indicate their effectiveness.

During the period of industrial operation of power unit No. 1 of the Belarusian NPP, an event was recorded related to disconnection of power unit No. 1 of the Belarusian NPP from power grid by action of protection against unlimited overcurrent excitation of the exciter. Following regulatory requirements and local documents, the operating organization investigated the event, drew up a report, and developed and implemented corrective actions. Based on results of the reporting documentation revision, Gosatomnadzor, in accordance with the licensing requirements and conditions, issued a permit to start the power unit after shutdown.

#### **Article 19 (7) Operational experience feedback**

When operating a nuclear facility, the operating organization shall ensure collection, processing, analysis, systematization and storage of information about failures of elements of safety-relevant systems and false staff actions, as well as its prompt transfer to all organizations involved.

The requirements for the functioning of the national system of operational experience accounting are established in the norms and rules for ensuring nuclear and radiation safety "Requirements for the functioning of the system of accounting and analysis of operational experience of nuclear power plants" [39].

Annually, in accordance with [39], Gosatomnadzor is provided with a report on the analysis of operational experience, containing a generalized analysis of internal and external operational experience.

In order to organize work during commissioning and decommissioning of power units No. 1 and No. 2 of the Belarusian NPP in terms of transmitting information about events at the Belarusian NPP to the IAEA International Reporting System for Operating Experience, Gosatomnadzor, together with the State Enterprise "Belarusian NPP", has developed the relevant procedure for interaction.

Gosatomnadzor has developed a Procedure for interaction between Gosatomnadzor and the State Scientific Technical Institution "Centre for Nuclear and Radiation Safety", which sets a procedure for scientific and technical support of regulatory actions in nuclear and radiation safety within the framework of the system of accounting and analysis of operational experience of nuclear power plants. The procedure is aimed at effective use of the results of the analysis of internal and external operational experience in regulatory activities.

The operating organization shall act to improve NPP safety in accordance with the plans made with regard of the results of safety analysis and operation experience to achieve new target safety

points.

Due to the lack of its own experience of NPP power unit operation, the Republic of Belarus made steps to obtain an opportunity to study operational experience of other countries, as well as mechanisms of its accounting and use by regulatory authorities and operating organizations. Exchange of relevant regulating and operational experience is performed:

on a multilateral basis - at the sites of international nuclear safety regulators associations (RCF – Belarus accession in 2012 as a recipient of assistance, WENRA - Belarus accession in 2015 as an observer, the Forum of the State Nuclear Safety Authorities of the Countries Operating WWER Type Reactors – Belarus accession in 2015 as an observer), the IAEA Global Nuclear Safety and Security Network (GNNSN), the World Association of Nuclear Operators (WANO – entry of the State Enterprise "Belarusian NPP" in 2015), the IAEA International Reporting System for Operating Experience (Belarus accession in 2019).

on bilateral basis — in terms of cooperation agreements concluded with Austria, Armenia, France, Germany, Poland, Russia, and Ukraine.

## **Article 19 (8) SNF and RW management at the site**

### **SNF management**

SNF management activities in the Republic of Belarus are regulated by [1, 5, 6, 48, 84].

After unloading from the reactor, SNF is sent to the SNF design storage system. This system represents a spent fuel storage pool with necessary equipment and systems ensuring reliable and safe performance of the following functions:

placement of SNF unloaded from the reactor during refueling, as well as placement of nuclear fuel of the entire core at any time;

storage of spent control rods of the control and protection system;

SNF storage to remove residual heat and reduce activity to the values required for SF transportation;

removing residual heat from spent nuclear fuel;

providing biological protection of personnel from spent fuel stored in the storage pool.

The SNF storage system provides storage and exposure of SNF in the reactor building of each power unit for 10 years, taking into account planned refueling and unloading of the entire reactor core at any time of NPP power units operation.

As of July 2022, there are 48 spent fuel assemblies located in the spent fuel storage pool of power unit No. 1, unloaded during the scheduled outage-2022 period after the first fuel company of power unit No. 1.

There are no spent fuel assemblies in the spent fuel storage pool of power unit No. 2.

After being stored in the SNF storage system to the parameters allowing transportation, the SNF is placed in a transport cask (TUK-137T.P) and is removed from the reactor building to a cumulative facility or a plant transfer unit for further delivery by special railway train from the NPP territory.

According to the agreement between the Government of the Republic of Belarus and the Government of the Russian Federation of March 15, 2011 on cooperation in the construction of a nuclear power plant on the territory of the Republic of Belarus, SNF is subject to return to the Russian Federation for processing.

In order to form and implement a technologically optimal, economically feasible, environmentally and socially safe state policy in the field of SNF management, Resolution of the Council of Ministers of the Republic of Belarus No. 558 of August 22, 2019 "Strategy of SNF Management of the Belarusian NPP" (hereinafter referred to as the Strategy) was developed and approved.

The Strategy was developed taking into account the world experience obtained in the course of scientific, technical and practical activities, taking into account the prospects for the development of the technological process in the field of SNF management, as well as socio-economic, environmental and territorial aspects considered inside feasibility study of options for SNF management of the

Belarusian NPP.

The strategy determined that the priority option for handling spent nuclear fuel of the Belarusian NPP is the processing of spent nuclear fuel in the Russian Federation with the return to the Republic of Belarus of waste included in a glass-like matrix containing radionuclides of the cesium-strontium fraction, with the exception of long-lived radionuclides.

The processing of spent nuclear fuel of the Belarusian NPP is expedient from a technical, environmental and economic point of view due to the possible disposal of SNF processing products containing mainly the cesium-strontium fraction in pit near-surface facilities when implementing the "delayed disposal" option. When implementing this option, the object is operated in the RWDF mode until heat release and activity values are reduced to the established limits, and then, after final conservation, is transformed to a near-surface RW disposal facility. This will eliminate the need to create a disposal facility for SNF or HLRW in deep geological formations, currently having no counterparts in the world.

Also, the provisions of the Strategy define the key goals, objectives and organizational aspects for creating and implementing a national SNF management system.

In order to implement tasks and goals set for the creation and implementation of the national SNF management system, a Belarusian-Russian working group on SNF and RW management was established, consisting of authorized representatives of ministries and departments of the Republic of Belarus and the Russian Federation responsible for coordinating and performing work on the implementation of the strategy for SNF management of the Belarusian NPP, as well as organizations, providing scientific and technical support to the regulator and the operating organization.

Activities provided for in the Strategy are implemented based on mutually agreed plans.

As of July 2022, of the priority tasks to realize the Strategy, the following activities have been and are being implemented:

1. On November 8, 2021, an agreement was signed between the Government of the Republic of Belarus and the Government of the Russian Federation on cooperation in transportation of nuclear materials, which entered into force on May 31, 2022;

2. A draft agreement has been prepared between the Government of the Republic of Belarus and the Government of the Russian Federation on the management of SNF of the Belarusian NPP. The main elements of the agreement have been agreed upon by the parties and are currently undergoing administrative approval procedures;

3. Priority measures to create an RWDF are being implemented;

After signing and ratification of the agreement between the Government of the Republic of Belarus and the Government of the Russian Federation on cooperation management of SNF of the Belarusian NPP, work will be initiated on preparing contracts that will specify the scope of cooperation and other conditions for SNF import to the Russian Federation, the processing of SNF of the Belarusian NPP, and RW return to the Republic of Belarus.

### **RW management**

The main legal act establishing requirements for radiation safety assurance during radioactive waste management is the Law of the Republic of Belarus "On Radiation Safety" [1].

There is a number of normative documents in force in the Republic of Belarus regulating safety issues of RW management.

The Resolution of the Council of Ministers of the Republic of Belarus [85] approved the Strategy for the Management of RW of the Belarusian NPP (hereinafter referred to as the NPP RW Strategy). The NPP RW Strategy defines the ways of development of the Belarusian NPP RW management system, describes how the various types of RW of the Belarusian NPP will be handled at all stages of the waste life cycle, sets the deadlines for constructing a disposal facility, determines resources necessary to achieve the goals.

Following the Belarusian NPP project, VLLRW, LLRW and ILRW will be stored in conditioned form in the NPP storage facilities for 10 years, and then sent for final isolation in the RWDF. HLRW will be stored in NPP storage facilities for the entire service life of the NPP and will be removed to the RWDF for final disposal at NPP decommissioning.

Based on NPP RW Strategy, a near-surface RWDF is planned to be constructed for VLLRW, LLRW and ILRW disposal. The issue of the need to construct a HLRW disposal facility in deep geological formations is also being elaborated.

Commissioning of the 1st stage of the RWDF is scheduled not later than 2030 which shall ensure placement of RW of VLLRW, LLRW and ILRW categories accumulated after 10 years of the NPP operation.

The NPP RW management system is designed to collect, purify, process, condition, transport and store the RW generated during the NPP operation.

In the course of NPP operation, gaseous RW, liquid RW and solid RW will be generated.

Solid RW belong mainly to VLLRW, LLRW and ILRW categories. The amount of the high-level operational RW will constitute approximately 1% of the total amount of the waste.

Main tasks solved in NPP RW management:

when handling gaseous waste - cleanup to a condition that meets sanitary standards;

when handling liquid RW – cleanup from radionuclides, concentration of radionuclides in a minimum volume followed by conditioning in order to transfer liquid concentrated radioactive waste into forms convenient for storage;

when handling solid RW – minimization of volumes and their safe, reliable storage over the project period.

Solid VLLRW, LLRW and ILRW are packed in metal barrels with a capacity of 200 liters. HLRW generated during replacing inter-reactor detectors and cutting the surveillance specimen are collected in special metal capsules, loaded into shielded casks and transported to the solid RW storage area for storage over entire NPP operation period. Liquid radioactive waste after solidification are placed in concrete shielded casks.

The expected average volume of annually generated solid RW, taking into account their processing per NPP unit:

8 m<sup>3</sup> (40 barrels) - VLLRW (17.6%);

32 m<sup>3</sup> (160 barrels) - LLRW (70.4%);

5 m<sup>3</sup> (50 barrels) - ILRW (11%);

0.5 m<sup>3</sup> - HLRW (1%).

The expected amount of generated processed (solidified) liquid RW in reinforced concrete shielded casks per one power unit per year shall be approximately 33 m<sup>3</sup> (22 NSCs)

Storage of barrels with solid RW and NSC with solidified liquid RW is provided at nuclear power plant in specially equipped ground-type capital storages, one for each power unit.

The projected volumes of solid RW being subject for disposal generated over 60 years of operation of two nuclear power plant units are: 960 m<sup>3</sup> – VLLRW; 3840 m<sup>3</sup> – LLRW; 600 m<sup>3</sup> – ILRW; 60 m<sup>3</sup> – HLRW.

The expected generation of solidified liquid RW in the NCS over the NPP lifetime will be about 3960 m<sup>3</sup> (2640 NCS).

Therefore, in the course of the nuclear power plant lifetime (60 years), the formation of 9360 m<sup>3</sup> of solid RW of various categories and 60 m<sup>3</sup> of HLRW is predicted.

The RW management system provides for reliable protection of workers (personnel) and the public from RW exposure beyond the limits established by NLA, and preventing emissions (discharges) in handling RW into the environment in amounts exceeding the maximum admissible values.

Following the norms and rules for nuclear and radiation safety assurance "Safety rules in radioactive waste management of nuclear power plants", approved by the Resolution of the Ministry for Emergency Situations No. 43 of October 12, 2017, the operating organization shall ensure the NPP operation with minimal RW formation both in terms of their activity and quantity. The Belarusian NPP State Enterprise has developed a Program for minimizing RW, which provides for organizational measures to minimize RW, rationing of RW formation and monitoring of compliance with RW formation standards, the procedure for planning RW formation in structural divisions [63].



## CONCLUSION

For a long time since the decision was made to build own nuclear power plant, the Republic of Belarus has been developing a modern nuclear safety system based on the IAEA safety standards and advanced world experience. By the beginning of commercial operation of power unit No. 1 of the Belarusian NPP, this system has been formed and is operating: the country has an independent competent regulatory body and its technical support system, nuclear law, personnel training system, emergency preparedness and response system and other elements in the country, which is confirmed by outcomes of international assessment missions and peer reviews. The Republic of Belarus is a full party to the global nuclear safety regime.

During the next three-year cycle of the Convention, the main efforts will be focused on ensuring the nuclear and radiation safety of Belarusian NPP power units in their commercial operation, including:

- supervising the operation of nuclear power plant and conducting appropriate safety assessments, including at changing the NPP configuration;

- monitoring the licensees' compliance with licensing requirements and conditions;

- accounting for operational experience;

- implementing recommendations and suggestions of international assessment missions and peer reviews in compliance with the set deadlines;

- enabling work of the national emergency preparedness and response systems, accounting and control of the nuclear materials, radiation and ecological monitoring etc., and their improvement with considering new IAEA safety standards.

The Republic of Belarus remains consistently committed to the evolutionary principle of safety assurance, the essence of which is the constant search for ways to improve it, regardless of how high the level achieved is. The most important condition for its implementing is the international exchange of experience, which is established, among other things, within the framework of the Convention and contributes to the common aspirations to maintain a high level of nuclear safety both in each individual country and on a regional and international scale.

## REFERENCES

1. Law of the Republic of Belarus No. 198-3 of June 18, 2019 "On Radiation Safety";
2. Decree of the President of the Republic of Belarus No. 137 of April 05, 2021 "On regulation of activities in the field of use of atomic energy and ionizing radiation sources";
3. Decree of the President of the Republic of Belarus No. 427 of November 2, 2021 "On Improving the Radioactive Waste Management System";
4. Decree of the President of the Republic of Belarus No. 499 of November 02, 2013 "On the Construction of the Belarusian Nuclear Power Plant;.
5. Norms and Rules for ensuring nuclear and radiation safety "General Provisions for Ensuring the Safety of Nuclear Power Plants", approved by Resolution of the Ministry for Emergency Situations of the Republic of Belarus No.15 of April 13, 2020;
6. Law of the Republic of Belarus No.426-3 of July 30, 2008 "On the Use of Atomic Energy";
7. Convention on Early Notification of a Nuclear Accident (since 1987);
8. Convention on Assistance in the case of Nuclear Accident or Radiation Emergency (since 1987);
9. Convention on the Physical Protection of Nuclear Material (since 1993);
10. Convention on Nuclear Safety (since 1999);
11. Convention on Civil Liability for Nuclear Damage (Vienna Convention) (since 1998);
12. Protocol to amend the Vienna Convention on Civil Liability for Nuclear Damage (since 2003);
13. Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (since 2003);
14. Agreement of 14 April 1995 between the Republic of Belarus and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons (since 1995);
15. Agreement between the Government of the Republic of Belarus and the Cabinet of Ministers of Ukraine on Nuclear Accident Prompt Notification and Cooperation in the Field of Nuclear Safety (2001);
16. Decree of the President of the Republic of Belarus "On Several Measures Aimed at the Nuclear Power Plant Construction" No.565 of November 12, 2007;
17. Decree of the President of the Republic of Belarus No. 62 of February 16, 2015 "On Ensuring Safety During the Construction of the Belarusian Nuclear Power Plant";
18. Decree of the President of the Republic of Belarus No. 361 of October 05, 2017 "On the Establishment of an Institution";
19. Decree of the President of the Republic of Belarus No. 279 of May 28, 2010 "On determination of the state body responsible for the implementation of obligations under certain international agreements";
20. Agreement between the Government of the Republic of Belarus and the Government of the Republic of Austria on the exchange of information in the field of nuclear safety and protection from ionizing radiation (2000);
21. Agreement between the Government of the Republic of Belarus and the Government of the People's Republic of China on cooperation in the peaceful use of atomic energy (2008);
22. Agreement between the Government of the Republic of Belarus and the Government of the Russian Federation on cooperation in the field of peaceful uses of atomic energy (2009).14
23. Agreement between the Government of the Republic of Belarus and the Government of the Russian Federation on cooperation in the construction of a nuclear power plant on the territory of the Republic of Belarus (2011);
24. Agreement between the Government of the Republic of Belarus and the Government of the Russian Federation on cooperation in the field of nuclear safety (2013);

25. Agreement between the Government of the Republic of Belarus and the Government of the Republic of Armenia on information exchange and cooperation in the field of nuclear safety and radiation protection (2013);
26. Agreement between the Ministry for Emergency Situations of the Republic of Belarus and the Nuclear Regulatory Agency of Ukraine on cooperation in the field of nuclear and radiation safety (2013);
27. Agreement between the Government of the Republic of Belarus and the Government of the Russian Federation on prompt notification of a nuclear accident and exchange of information in the field of nuclear and radiation safety (2013);
28. Resolution of the Council of Ministers of the Republic of Belarus No. 721 of December 12, 2020 "On Amendments to Resolutions of the Council of Ministers of the Republic of Belarus No. 79 of January 27, 2004 and No. 991 of December 02, 2016";
29. Resolution of the Council of Ministers of the Republic of Belarus No. 497 of August 21, 2020 "On the implementation of the Law of the Republic of Belarus No. 198-3 of June 18, 2019 "On Radiation Safety";
30. Resolution of the Council of Ministers of the Republic of Belarus No. 558 of October 06, 2021 "On the implementation of the Decree of the President of the Republic of Belarus No. 137 of April 5, 2021"
31. Resolution of the Council of Ministers of the Republic of Belarus No. 991 of December 2, 2016 "On provision of scientific and technical support to the Ministry for Emergency Situations in the field of nuclear and radiation safety";
32. Resolution of the Ministry of Emergency Situations of the Republic of Belarus No. 64 of September 21, 2021 "On the requirements for the composition and content of the documents justifying nuclear and radiation safety";
33. Resolution of the Ministry for Emergency Situations of the Republic of Belarus No.35 of April 25, 2019 "On the Lists of Works (Services) and Equipment for Nuclear Energy Facilities";
34. Resolution of the Ministry for Emergency Situations of the Republic of Belarus No. 65 of September 24, 2021 "On the establishment of application forms and conformity assessment";
35. Resolution of the Ministry for Emergency Situations of the Republic of Belarus No.33 of March 28, 2022 "On approval of regulations of administrative procedures";
36. Resolution of the Council of Ministers of the Republic of Belarus No. 133 of February 25, 2015 "On Approval of the Regulations on the Organization and Implementation of Control (Supervision) over Safety during the Construction and Commissioning of the Belarusian Nuclear Power Plant";
37. Regulation on State supervision in the field of nuclear and radiation safety approved by the Resolution of the Council of Ministers of the Republic of Belarus No. 497 of August 21, 2020 "On the implementation of the Law of the Republic of Belarus No. 198-3 of June 18, 2019 "On Radiation Safety" as amended on October 06, 2021;
38. Resolution of the Ministry for Emergency Situations of the Republic of Belarus No. 58 of September 06, 2021 "On the procedure for conducting a periodic safety assessment of a nuclear installation, storage facility";
39. Resolution of the Ministry for Emergency Situations of the Republic of Belarus No. 34 of July 27, 2017 "On approving the regulations and standards for nuclear and radiation safety (the procedure for implementation of modifications at nuclear power plants and modifications safety assessment; the requirements for the operation of recording and analyzing systems for nuclear power plant operational experience);
40. Decree of the President of the Republic of Belarus No.756 of December 29, 2006 "On several issues of the Ministry for Emergency Situations";
41. The Criminal Code of the Republic of Belarus of July 9, 1999;
42. Code of Administrative Offences of the Republic of Belarus No. 26 of April 21, 2003;
43. Resolution of the Council of Ministers of the Republic of Belarus No. 57 of January 29, 2021 "On the State Program "Education and Youth Policy" for 2021-2025";

44. Resolution of the Council of Ministers of the Republic of Belarus No. 258 of April 24, 2019 "On Approval of the Regulation on Public Hearings on Safety Regulation of the Belarusian Nuclear Power Plant";

45. Norms and rules for ensuring nuclear and radiation safety "General requirements for the operating organization management systems in order to ensure nuclear and radiation safety", approved by Resolution of the Ministry for Emergency Situations of the Republic of Belarus No. 73 of October 18, 2021;

46. Nuclear and Radiation Safety Guidelines "Ensuring a safety culture at all stages of the life cycle of the Belarusian NPP", approved by Gosatomnadzor Order No. 7 of February 04, 2022;

47. Decree of the President of the Republic of Belarus No. 124 of March 29, 2011 "On measures aimed at implementation of international instruments on civil liability for nuclear damage";

48. Resolution of the Ministry for Emergency Situations of the Republic of Belarus No. 42 of June 16, 2021 "On approving the regulations and standards for nuclear and radiation safety ("Rules for Nuclear Safety of Reactor Installations of Nuclear Power Plants");

49. Decree of the President of the Republic of Belarus No. 32 of January 26, 2021 "On the Funds of the Belarusian Nuclear Power Plant";

50. Decree of the President of the Republic of Belarus No. 15 of January 14, 2019 "On liability for nuclear damage";

51. Resolution of the Council of Ministers of the Republic of Belarus No. 854 of 14.10.2015 "On Permits Issue for Work Performance in the Implementation of Activities in the Field of Atomic Energy Use";

52. Resolution of the Ministry for Emergency Situations of the Republic of Belarus No. 18 of April 16, 2020 "On Approval of the Instructions on the Procedure for Training and Testing (Evaluation) of Knowledge on Nuclear and Radiation Safety";

53. Resolution of the Ministry of Energy of the Republic of Belarus No. 18 of April 05, 2021 "On approval of the list of positions of employees (personnel) of the Belarusian NPP State Enterprise subject to permits to conduct work in implementing activities for the use of atomic energy";

54. Norms and rules for nuclear and radiation safety assurance "Requirements for assigning an emergency class, the procedure for announcing emergency situation, and the prompt information transfer in the event of a nuclear and (or) radiation emergency at a nuclear power plant", "The procedure for investigating and accounting for violations in the operation of nuclear power plants" approved by the Resolution of the Ministry for Emergency Situations of the Republic of Belarus No. 52 of October 02, 2018;

55. TCP (Technical Code of Common Practice) 101-2007 Location of Nuclear Power Plants. Procedure for Developing a General Quality Assurance Program for a Nuclear Power Plant;

56. Nuclear and Radiation Safety Guidelines "Recommendations for safety assessment of modifications at nuclear power plants", approved by Order of the Department of Nuclear and Radiation Safety No. 92 of December 30, 2021;

57. Resolution of the Ministry for Emergency Situations of the Republic of Belarus No. 61 of December 06, 2018 "On approving the regulations and standards for nuclear and radiation safety" ("Requirements for the program for managing the aging of nuclear power plants");

58. Sanitary Norms and Rules "Requirements for Radiation safety" approved by the Resolution of the Ministry of Health of the Republic of Belarus No. 213 of December 28, 2012;

59. Hygienic Standard "Criteria for Assessing Radiation Exposure" approved by the Resolution of the Ministry of Health of the Republic of Belarus of No. 213 of December 28, 2012;

60. Sanitary Norms and Rules "Hygienic requirements for the design and operation of nuclear power plants" approved by the Resolution of the Ministry of Health of the Republic of Belarus No.39 of March 31, 2010;

61. Sanitary Norms and Rules "Requirements to radiation safety assurance of personnel and population when exercising an activity on use of nuclear energy and ionizing radiation sources" approved by the Resolution of the Ministry of Health of the Republic of Belarus No. 137 of December 31, 2013;

62. Norms and Rules for Nuclear and Radiation Safety Assurance "Safety in ionizing radiation sources management. General provisions" approved by the resolution of the Ministry for Emergency Situations of the Republic of Belarus No. 47 of September 28, 2010.

63. Norms and Rules for Nuclear And Radiation Safety Assurance "Safety Rules for handling radioactive waste from nuclear power plants" approved by Resolution of the Ministry for Emergency Situations of the Republic of Belarus No. 43 of October 12, 2017;

64. The Technical Code of Practice "Safety assurance of dry storage of spent nuclear fuel" approved by the Resolution of the Ministry for Emergency Situations of the Republic of Belarus No. 26 of September 9, 2014 (TCP 545-2014).

65. Sanitary Norms and Rules "Requirements to radiation safety assurance of personnel and population in radioactive waste management" approved by the Resolution of the Ministry of Health of the Republic of Belarus No. 142 of December 31, 2015;

66. Norms and rules for nuclear and radiation safety assurance "Nuclear power plants safety in the sanitary protection zone and the supervised area. Requirements for the organization and provision of radiation monitoring", approved by Resolution of the Ministry for Emergency Situations of the Republic of Belarus No. 29 of June 30, 2016;

67. Norms and Rules for Nuclear and Radiation Safety Assurance "Safety in ionizing radiation sources management. General Provisions" approved by the Resolution of the Ministry for Emergency Situations of the Republic of Belarus No. 42 of October 19, 2020;

68. Regulation on the procedure for accounting exposure received by the population and personnel, approved by Resolution of the Ministry of Health of the Republic of Belarus No. 110 of November 27, 2020;

69. Instructions on the procedure for accounting and control of ionizing radiation sources, approved by Resolution of the Ministry for Emergency Situations of the Republic of Belarus No. 16 of April 13, 2020.

70. Resolution of the Council of Ministers of the Republic of Belarus "On approval of the regulations on the conditions and procedure for emergency plans development" No. 1242 of August 27, 2010;

71. Resolution of the Ministry for Emergency Situations of the Republic of Belarus No.38 of August 27, 2017 "On approving Norms and Rules for ensuring nuclear and radiation safety ("Requirements for categorization of emergency planning in the event of a nuclear or radiological emergency");

72. Resolution of the Ministry for Emergency Situations of the Republic of Belarus No. 24 of June 02, 2017 "On approving Norms and Rules for ensuring nuclear and radiation safety" ("Requirements for the composition and content of the action plan for the protection of NPP workers in the event of a radiation accident (Internal Emergency Plan)");

73. Resolution of the Ministry for Emergency Situations of the Republic of Belarus No. 43 of August 08, 2018 "On approving Norms and Rules for ensuring nuclear and radiation safety "Requirements for the composition and content of the action plan for the protection of personnel in the event of an accident at a nuclear research facility";

74. Resolution of the Ministry for Emergency Situations of the Republic of Belarus No.11 of April 12, 2017 "On approving the regulations and standards for nuclear and radiation safety" ("Requirements for operating organization for the planning and implementation of radiation monitoring in nuclear or radiological emergency situations at nuclear power plants);

75. Resolution of the Council of Ministers of the Republic of Belarus No. 495 of April 10, 2001 "On approval of the regulations on the State system of prevention and liquidation of emergency situations";

76. Law of the Republic of Belarus "On civil and territory protection against natural and man-made emergencies" No.141-3 of May 05, 1998;

77. Resolution of the Government of the Republic of Belarus No. 1280 of August 23, 2001 "On the procedure for collecting information in the field of civil and territory protection against natural and man-made emergencies and the exchange of this information";

78. Resolution of the Ministry for Emergency Situations of the Republic of Belarus No. 41 of August 02, 2005 "On approval of the Instructions for information provision in the field of civil and territory protection against natural and man-made emergencies";

79. Resolution of the Ministry for Emergency Situations of the Republic of Belarus "On the information and control system of the State System Of Prevention and Liquidation of Emergency Situations" No. 33 of July 31, 2020;

80. TCP (Technical Code of Common Practice) 099-2007 Location of Nuclear Power Plants. Guidance on the Development and Contents of Justifications for the Environmental Safety of Nuclear Power Plants;

81. TCP (Technical Code of Common Practice) 101-2007 Location of Nuclear Power Plants. Procedure for Developing a General Quality Assurance Program for a Nuclear Power Plant;

82. TCP (Technical Code of Common Practice) 102-2007 Location of Nuclear Power Plants. The Procedure for developing a quality assurance program when selecting a site for a Nuclear Power Plant".

83. Resolution of the Ministry for Emergency Situations of the Republic of Belarus No. 59 of September 06, 2021 "On the requirements for the content of the report on the assessment of the current state of security";

84. Safety Rules for nuclear fuel storage and transportation at the complexes of storage systems and SNF management, approved by the Resolution of the Ministry for Emergency Situations of the Republic of Belarus No. 72 of December 30, 2006;

85. Resolution of the Council of Ministers of the Republic of Belarus "On approval of the Strategy for radioactive waste management of the Belarusian Nuclear Power Plant" No. 460 of June 02, 2015.