

# European Nuclear Safety Regulators Group ENSREG

# 2<sup>nd</sup> Topical Peer Review – 'Fire Protection'

**Country Review Report** 

Ukraine

January 2025

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# 1. Brief overview of the candidate installations

The following installations were finally selected and included in the national assessment report (NAR).

Installation category	Number of installations	Name of candidate installations
Nuclear power plant	2	Rivne NPP units 2 and 3 Pivdennoukrainsk (South Ukrainian) NPP unit 1
Research reactor	1	VVR-M
Fuel reprocessing facility		-
Fuel fabrication facility		-
Fuel enrichment facility		-
Dedicated spent fuel storage	1 (dry)	Interim Spent Fuel Storage Facility-2 (ISF-2, dry type)
Installations under decommissioning		-
On-site radioactive waste storage		-
Total	4	

# 2. Regulatory framework

The NAR mentions that there are specific requirements in a rule *"Fire Safety Rules in Operation of Nuclear Power Plants"*, which establishes fire safety requirements applied to NPP facilities that are under operation, construction, reconstruction, technical reequipment, as well as provisions regulating interaction of NPP administration and personnel, and involved organizations, enterprises or separate workers, who temporarily or permanently function at NPPs, with authorities of the State Fire Protection of Ukraine".

Besides, the NAR indicates that there are several Regulations and rules of nuclear and radiation safety. In particular, the regulation NP 306.2.141.2008 "General Safety Provisions for Nuclear Plants", which establish the objective, principles and criteria for NPP safety, and regarding fire safety, requirements for the implementation of defense-in-depth principle for NPP fire protection and general requirements for fire safety at NPPs (use of fire protection systems, use of non-flammable cables, division of NPP premises into firefighting areas, development of firefighting plans, creation of fire depots and fire services, exercises and trainings on fire safety issues). In 2021-2023, SNRIU revised this regulation to consider more than ten years of experience in their application, the need for implementation of the provisions of EU Directives, IAEA documents, WENRA documents. (See also section 4 below). Other regulations apply to research reactors and Interim dry spent fuel storage facilities.

The NAR mentions that "According to the requirements of Article 8 of the Law of Ukraine "On Nuclear Energy Use and Radiation Safety", nuclear and radiation safety regulations and rules are approved taking into account recommendations of international organizations on nuclear energy use. In order to implement these provisions, SNRIU shall take into account Ukraine's obligations in connection with Ukraine's aspirations to become a member of the EU (EURATOM Directives), IAEA documents, WENRA

reference levels, during the development / review / amendments of nuclear and radiation safety regulations and rules".

# 3. Findings and significant improvements of approaches on the installations from the national self-assessment

#### Nuclear power plants

#### **RIVNE NPP**

The following **strength** related to fire protection was reported in the NAR for **RIVNE NPP** units 2 and 3:

 Measures to improve the safety of RNPP Units 2 and 3 (see below), including measures to improve fire protection based on operating experience, recommendations of international organizations, results of inspections and surveys, and introduction of new safety requirements, are implemented by the operating organization taking into account their impact on safety within the timeframes agreed with the Ukrainian regulatory body SNRIU.

No weaknesses related to fire protection were reported in the NAR for RIVNE NPP units 2 and 3.

The following **lessons learned** related to fire protection were reported in the NAR for **RIVNE NPP** units 2 and 3:

- From 2001 to 2023, WANO has conducted nine peer reviews at the RNPP. Based on the main peer reviews, WANO made observations and provided assessments of fire protection and identified areas for improvement, identified as Level B that means issues adequately addressed, but with still some room for further improvements:
  - The condition of individual components and devices of passive fire protection, and in some cases their absence, does not prevent the spread of fires (2012);
  - There are shortcomings in fire separation, and fire protection systems are not installed in all premises where equipment important to safety is located. This increases the risk and potential severity of fire damage to equipment important to safety (2016);

An action plan was developed: a part of the developed corrective measures has been implemented and the remaining planned measures are expected to fully address the issues.

- The regulatory review and assessment of fire safety analyses performed in frame of updated Safety Analysis Reports, Periodic Safety Review Reports and living PSA in period of 2015-2019 resulted in the following findings:
  - the scope and methodology of the safety analysis comply with the regulations and standards on nuclear and radiation safety, as well as IAEA recommendations;
  - $\circ$  the computer models consider the current state of the power unit;
  - the safety analysis results meet the safety criteria defined by the regulations and standards on nuclear and radiation safety, as well as the design documentation;
  - The completeness and reliability of the information presented in corresponding Periodic Safety Review Reports were confirmed during regulatory inspections.

The following **improvements** related to fire protection were reported in the NAR for **RIVNE NPP** (units 2 and 3):

For Unit 2, several improvements were implemented, in particular to reduce the high contribution of fires in electrotechnical device premises to the integral CDF in PSA results:

- Modernization of the Automatic Fire Alarm System for the Reactor Compartment, Turbine Hall, Deaerator Compartment, Electrical Equipment Rack and Special Building Premises (planned to be completed during outage in 2023).
- Provision of the Main NPP Electricity Generation Circuit with Automatic Control Units for Power Oil-Filled Equipment (planned to be completed during outage in 2024).
- Provision of NPP Premises Containing Electrical and Electronic Equipment with Stationary Non-automatic Gas Fire-Extinguishing Units (planned to be completed during outage in 2024).
- Installation of Fire Retardant Valves with a Standardized Fire Resistance Limit at Intersections between Supply and Exhaust Ventilation Air Ducts in the Standby Diesel Generator Building (implemented).
- Increase of the fire resistance limit of:
  - Columns near the Cable Routes in Turbine Halls to Regulatory Requirements (implemented);
  - Electrical Equipment Rack Load-Bearing Metal Structures to the Standardized Value (implemented);
  - Transit Air Ducts Passing Through the Premises of Safety Systems and Normal Operation Systems of the Electrical Equipment Racks of Units 1 and 2 to the Standardized Value (implemented);
  - Turbine Hall Roof Trusses to the Standardized Value (implemented).
- Implementation of a Fire Water Supply Network from Steel Pipes with Steel Valves (implemented at Units 1 and 2 under activities for long-term operation of these units in the period of 2008-2010).

For Unit 3:

- Development and Implementation of Smoke Protection System in RC Premises and Evacuation Corridors without Restrictions on Communication with the Environment (completed).
- Provision of the Main NPP Electricity Generation Circuit with Automatic Control Units for Power Oil-Filled Equipment (completed).
- Modernization of the Automatic Fire Alarm System of Reactor Compartment, Deaerator Compartment, Electrical Equipment Rack, Turbine Hall and Special Building Premises (completed).
- Provision of NPP Premises Containing Electrical and Electronic Equipment with Stationary Non-automatic Gas Fire-Extinguishing Units (completed).
- Installation of Fire-Retardant Valves on Air Ducts in Fire Partitions of Ventilation Centers, Storage Battery Premises, Cable Structures, and Premises Containing Electrical and Electronic Equipment, Separating Them from Premises" (completed).
- Bringing the Fire Resistance Limit of Removable Non-Combustible Structures of Cable Ducts and Raised Floors of NPP Premises Containing Electrical and Electronic Equipment to the Standardized Value" (completed).
- Provision of NPP Auxiliary Transformers with Automatic Fire-Extinguishing Units" (completed);
- Replacement of Combustible Insulation of the Turbine Hall Roof (completed).
- Ensuring the Operability of the Main Steam Isolation Valve for Resistance to Internal and External Events (completed).
- Modernization of the Automatic Fire Alarm System of NPP Safety System Premises (implemented under activities for long-term operation of this unit in the period of 2008-2012).

#### SOUTH UKRAINIAN NPP

The following strength related to fire protection was reported in the NAR for SOUTH UKRAINIAN NPP unit 1:

 Measures to improve the safety of PNPP Unit 1 (see below), including measures to improve fire protection based on operating experience, recommendations of international organizations, results of inspections and surveys, and introduction of new safety requirements, are implemented by the operating organization taking into account their impact on safety within the timeframes agreed with the SNRIU.

No **weaknesses** related to fire protection were reported in the NAR for **SOUTH UKRAINIAN NPP** unit 1.

The following **lessons learned** related to fire protection were reported in the NAR for **SOUTH UKRAINIAN NPP** unit 1:

- Several external reviews performed at Pivdennoukrainsk (South Ukrainian) NPP:
  - Mission to assess the design safety of the PNPP Unit 1, 2-9 February 2009;
  - WANO peer review from 12 to 23 April 2010;
  - WANO peer review from 13 to 29 November 2014;
  - WANO peer review from 19 to 23 September 2016;
  - WANO peer review from 28 September to 02 October 2020. According to the second WANO peer review (2020), two good practices were identified. One is implementation of SERGI TR system, which is dedicated for explosion prevention on the oil-filled power equipment of the main power output circuit, and the second is using a combination of the PLS-60 water cannon and NRT turbine type spray nozzle for fire protection;
  - Comprehensive inspection of the fire safety of the PNPP by representatives of the Energoatom from 13 to 18 June 2021.

The following **improvements** related to fire protection were reported in the NAR for **SOUTH UKRAINIAN NPP** unit:

- Modernization of the Automatic Fire Alarm System of NPP Safety System Premises and of Deaerator Compartment 5dc°, Turbine Hall and Special Building Premises (completed).
- Implementation of Smoke Removal System in DC Evacuation Corridors (completed).
- Provision of the Main NPP Electricity Generation Circuit with Automatic Control Units for Power Oil-Filled Equipment (completed).
- Implementation of Redundancy for Water Fire-Extinguishing Units of Safety Systems (completed).
- Introduction of Automatic Fire Extinguishing System in Premises of Standby Diesel Generators (completed).
- Replacement of Combustible Insulation of the Turbine Hall Roof (completed).
- Installation of Fire-Retardant Valves with a Standardized Fire Resistance Limit at Intersections between Supply and Exhaust Ventilation Air Ducts and Fire Barriers of Battery Premises and Premises Containing Electrical and Electronic Equipment (completed).
- Increase of the fire resistance limit of:
  - o DC Load-Bearing Metal Structures to the Standardized Value (completed);
  - Enclosing Structures of Premises with Switchgears, Direct Current Boards and DC Relay Panels to the Standardized Value (completed);
  - Transit Air Ducts and Process Piping Passing Through the Premises of Safety Systems and Normal Operation Systems to the Standardized Value (partially implemented);
  - Removable Non-Combustible Structures of Cable Ducts and Raised Floors of NPP Premises Containing Electrical and Electronic Equipment to the Standardized Value (completed).

- Development and Implementation of Measures to Reduce Hydrogen Concentration in the Containment for Beyond Design-Basis Accidents at PNPP Unit 1 (completed).
- Provision of NPP Premises Containing Electrical and Electronic Equipment with Stationary Gas Fire-Extinguishing Units (partially implemented).

#### **Research reactors**

#### VVR-M

The following **strengths** related to fire protection were reported in the NAR for **VVR-M research reactor**:

- Measures to improve the safety of the VVR-M nuclear research reactor including measures to improve fire protection, developed on the basis of operating experience, recommendations of international organizations, the results of inspections and testing, the entry into force of new safety requirements are carried out by the operating organization taking into account their impact on safety within the timeframe agreed with the SNRIU.
- The fire resistance limits of the doors in the reactor building comply with the fire resistance standards of the fence structures whose openings they block. The doors of the control panel, emergency control room, and corridors at the exits to the inter-floor stairs have devices for self-closing and sealing in porches.
- The multi-train (3 trains) principle is applied to mitigate fire consequences on the safety systems, taking into account the single failure principle. Each of the three trains for monitoring and protection of capacity and period is physically separated and has appropriate fire barriers cable insulation does not spread fire, partitions are installed on their pathway.

No weaknesses related to fire protection were reported in the NAR for VVR-M research reactor.

The following **lesson learned** related to fire protection was reported in the NAR for **VVR-M research reactor**:

 Over the years of operation, the VVR-M systems, equipment and components have been upgraded or replaced with new ones. Modernization and replacement designs were developed in accordance with the requirements, rules, standards and regulations in force in the nuclear energy industry of Ukraine taking into account the IAEA recommendations. Fences and bearing structures (walls, partitions, plates, doors, manholes) in the premises and buildings separating the safety system channels from each other are made of non-combustible materials with a fire resistance limit not less than the permissible one established in the standards and regulations (at least 1.5 hours).

The following **improvements** related to fire protection were reported in the NAR for **VVR-M research reactor**:

- An automatic fire detection and warning system for immediate detection of signs of fire was installed at the nuclear research reactor in 2011. Each premise in the reactor building where personnel stays is equipped with loudspeakers to notify about a fire. Each premise and cable networks are equipped with fire detectors.
- Fences and bearing structures (walls, partitions, plates, doors, manholes) in the premises and buildings separating the safety system channels from each other are made of non-combustible materials with a fire resistance limit not less than the permissible one established in the standards and regulations (at least 1.5 hours).
- The emergency control room has been implemented at the reactor in a different premise than the main control room.
- The plastic floor in the reactor hall was replaced with a fire-resistant flood floor.
- Fire-retardant treatment of wooden structures of the attic was completed.
- Power and control cables were replaced with new ones whose insulation is flame retardant.

- The spent fuel management system was modernized and additional spent fuel storage facility was constructed as part of this modernization.
- The emergency autonomous power supply system was modernized, at the same time, new components such as battery, emergency generators were replaced and an additional power supply source was implemented, namely a diesel power plant.
- Four ventilators of the special ventilation system were replaced with new ones (one from each four pairs).
- A new fresh nuclear fuel storage facility was commissioned.
- An emergency air purification system was constructed and implemented for air released into the environment through a ventilation centre pipe from the space above the water surface in the reactor tank.

### Spent fuel storage

#### ISF-2

The following **strengths** related to fire protection were reported in the NAR for **spent fuel storage ISF-**2:

- ISF-2 fire safety of is ensured by the fire prevention and fire protection subsystems, including administrative and technical measures.
- Use of non-combustible building structures and materials with standardized fire hazard indicators.
- Use of smoke protection equipment.
- Maximum possible replacement of combustible liquids in equipment with non- combustible ones.
- The designed on-site passages provide a rational distance between the facilities and the possibility of access for firefighting vehicles.
- All transit air ducts in fire-hazardous premises after crossing the ceiling or fire barrier throughout the entire length to the ventilation equipment premise, as well as air ducts of the smoke protection systems are made of non-combustible materials of EI 90 fire resistance class with installation of fire protection valves with EI 90 fire resistance class.
- The ISF-2 site is systematically cleaned of any vegetation that may have a certain fire load.
- Concrete storage module ability to ensure spent fuel cooling after a fire following the design permissible temperature limit.

No weaknesses, lessons learned, or improvements related to fire protection were reported in the NAR for spent fuel storage ISF-2.

#### 4. Peer-review conclusions

#### 4.1 Attributes of the NAR and the information provided

The candidate installations are the ones which were the subject of the Board's review prior to the national self-assessment. The recommendation of the Board (consideration of on-site waste storage) was not clearly addressed in the NAR.

In general, the information provided in the NAR was sufficient for the peer review.

The document was reader-friendly and facilitated the finding of relevant information.

In general, the outcomes of the self-assessment were clearly mentioned.

Additional information and updates provided in the national presentations in the country review workshop, including replies to written questions, were taken into account in the definition of the findings below in section 4.2.

# 4.2 Peer review findings

The self-assessment did not reveal any weaknesses in the fire protection of the nuclear installations.

During the country review workshop, the findings identified during the peer review phase have been discussed. Based on these discussions as well as additional information presented by Country after the country review workshop, the TPR team concluded on the following findings:

Areas For Improvement					
Nuclear installation: All NPPs					
	Finding	A need to enhance fire hazard analysis by further development of deterministic analyses to specifically assesses the potential consequences of fire events on the performance of the safety functions.			
AFI (1)	Justification	The main purpose of the present deterministic fire hazard analyses is to support the development of the necessary parts of the Section "Probabilistic Safety Analysis" of the Safety Analysis Report (SAR) for identifying fire safety deficits, providing recommendations and proposing corrective measures for their elimination. There is a need for further development of the deterministic analysis in order to verify that safety functions are ensured and that redundant equipment performing the same safety function are not simultaneously impaired.			

The TPR Board recommends that Ukraine addresses this area for improvement in the TPR national action plan.

Areas of Good performance						
Nuclear installation: All NPPs						
	Finding	An extensive and targeted modernisation programme of fire protection equipment and systems has been undertaken at the NPPs.				
AGP (1)	Justification	The modernisation programme includes the installation of door opening alarms with indication in the MCR (on doors associated with fire compartment boundaries and safety systems compartments with electrical and electronic equipment), the extensive replacement of cables across the plants for improved fire safety performance, as well as the implementation of new automatic fire extinguishing systems.				

The TPR Team notes the adoption of the new revision of "General provision on nuclear power plants safety": this new revision which is in line with WENRA SRLs has been approved by SNRIU in March 2024, and is mandatory from 15 May 2024, but there is still a need to revise and improve the existing legislative framework with special focus on fire hazard analysis requirements (scope, methodologies, assumptions, deterministic analyses, etc).

## **Definition of the types of findings**

According to the TPR II Terms of Reference, the country group workshop discussions should lead to conclude on the findings categorised as an 'area of good performance' or 'area for improvement'. These are defined therein as follows:

A National area of good performance which should be understood as an arrangement, practice, policy or programme related to fire protection that is recognized by the TPR Review Team as a significant accomplishment for the country and has been undertaken and implemented effectively in the country and is worthwhile to commend.

A National area for improvement which should be understood as an aspect of fire protection identified by the TPR Peer Review Team where improvement is expected, considering the arrangement, practice, policy or programme generally observed in other participating countries. It may also be self-identified by the country itself (i.e. self-assessment) where improvement is appropriate.