European Nuclear Safety Regulators Group
ENSREG

2nd Topical Peer Review – 'Fire Protection'

Country Review Report

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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	1	Kozloduy Unit 5
Research reactor		
Fuel reprocessing facility		
Fuel fabrication facility		
Fuel enrichment facility		
Dedicated spent fuel storage	1 wet 1 dry	Wet SFSF Kozloduy site Dry SFSF Kozloduy site
Installations under decommissioning	1	Kozloduy 4 NPP
On-site radioactive waste storage	1	Storage Facility for Conditioned RAW (SFCRAW) at Kozloduy site
Total	**5**	

2. Regulatory framework

The NAR describes the national legislation applicable to fire safety and lists the different regulations that apply to the nuclear installations, principally to NPPs, as well as to spent fuel, decommissioning, and radioactive waste facilities). The NAR indicates that "*the main requirements for fire protection in nuclear power plants resulting from the application of the concept of defence-in-depth (DiD) are included in the Regulation on ensuring the safety of nuclear power plants*".

Measures for fire safety include the implementation of the DiD in the design in order to prevent the occurrence of fire, early detection and extinguishing any fire that occurs, ensuring the resistance of the structure in case of fire, limiting the spread of fire and smoke and the consequences of a fire, creating conditions for evacuation of the personnel and for the safety of the emergency teams. For NPPs, the requirements of the regulation, including related to deterministic fire hazard analysis and probabilistic safety analyses, are supplemented by a regulatory guide on protection against internal fires.

A specific regulation, when a building permit is required, specifies the requirements for the design and implementation of constructions in compliance with the provisions of the Spatial Planning Act for ensuring fire safety. This regulation specifies the requirements as well for all passive and active fire safety measures.

Another regulation defines the rules and norms for fire safety during the operation of the different facilities.

The NAR indicates that the WENRA SRLs for Existing Reactors (2021), for Waste and Spent Fuel Storage (2014) and for Decommissioning (2015) are included in the regulatory framework. In response to the

question of the TPR Team[1] about whether or not the SRLs are binding, Bulgaria's reply was "*In para 1.2.2. is stated that the Fire safety is ensured in compliance with the Bulgarian regulatory requirements for matters relating to fire safety and the current International Atomic Energy Agency (IAEA) standards in force, considering WENRA reference levels and years of accumulated operating experience.*

The Bulgarian regulations are harmonized with the WENRA Reference levels (RLs) for existing reactors and thus the RLs are binding. There are no operating research reactors in the country."

The NAR indicates that "*the main international standards, guidance and other documents that are included in the regulatory framework and are applied in relation to ensuring fire safety in nuclear facilities are..*" those from IAEA and WENRA.

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

Nuclear Power Plant

KOZLODUY UNIT 5

The following **strengths** related to fire protection were reported in the NAR for **KOZLODUY UNIT 5:**

- An in-depth deterministic analysis of units 5 and 6 of the Kozloduy NPP was carried out, which also includes the RAW storage facilities associated with these units.
- An analysis of a large fire in turbine hall – units 5 and 6 and its impact on MSL compartment, was carried out.
- An analysis of the oil fire in the Containment - RC of units 5 and 6 was carried out.
- An update of the level 1 probabilistic safety analysis of units 5 and 6 of the Kozloduy NPP was carried out, taking into account the fire risk, reflecting all changes in the design until mid-2020. This shows a reduction in the overall frequency of fuel damage from internal fires by about 76%.
- The Fire Safety Program includes maintenance, testing, monitoring, and inspections, including hazard management processes such as:
    - control and administrative procedures for fire hazard control;
    - inclusion of firefighting equipment in the scope of the aging management process - physical and technological;
    - hazard mitigation and response equipment monitoring programs;
    - fire risk management;
    - Fire hazards are taken into account when planning and conducting inspections.

The following **weaknesses** related to fire protection were reported in the NAR for **KOZLODUY UNIT 5:**

- Existing detectors (AlgoRex CS1140 Modular Fire Detection System) are of an old technology. The replacement is planned to take place in the period until 2027.
- There is a lack of an automatic fire extinguishing system for the diesel fuel tanks in Circulation water pumping station (CWPS 3 and 4). The corrective measure is planned for implementation by the end of 2025.

The following **lessons learned** related to fire protection were reported in the NAR for **KOZLODUY UNIT 5:**

- At the Kozloduy NPP EAD, a system has been introduced for evaluation of events related to fire initiators and the identification of events related to the determination of potential sources of

[1] 'The NAR in §1.2 presents the regulatory framework. If not yet clearly mentioned in the NAR, could you indicate whether the WENRA SRLs for NPPs, and RRs (if relevant for your country), which are used as reference for this topical peer review on 'fire protection' (as per the Technical specification) are binding or not in your country? If they are not binding, what is the status of the SRLs (non-binding, guidance, advisory..)?'

fire. In the specified database for fire events, information from each initiating event is archived according to characteristic assessment data (place of fire, duration, operating conditions). From the conducted WANO review missions 2013, 2017 and 2021, areas for improvement were identified as a result of which the following more important measures were derived and implemented.

- The deadline for the implementation of the planned corrective measures is determined by the configuration management system at Kozloduy NPP and the defined approaches in the implementation of technical measures in the scope of increasing fire protection. For example, in connection with a registered defect of a pipeline from an automatic fire extinguishing system of the safety systems and a conducted analysis, decisions were made to replace the pipelines with corrosion-resistant austenitic steel. The developed design is in the process of implementation. In this regard, a long-term schedule for operational control (thickness measurement) of the pipelines has been developed.
- When planning measures to improve fire safety, the recommendations formulated in the scope of insurance inspections at the “Kozloduy NPP” EAD and the conducted partner missions and inspections of the IAEA and WANO in the field of fire safety are reflected.
- From the insurance inspection carried out in 2012-2023, weaknesses were identified and as a result the following measures to improve fire safety were implemented:
    - Installed detectors for the presence of hydrogen in the rooms of the storage batteries and related annunciators for unit 5 and 6;
    - Installed detectors for the presence of hydrogen on the ceiling in the batteries’ room, sensors for the flow of exhaust ventilation and related annunciators;
    - Replacement of the diesel fire pumps.
- Plant managers participate in every exercise and actively support the emergency preparedness training program. Firefighters and emergency response teams at the plant receive prior training at the national center in Montana. This facility includes rooms simulating conditions that might exist during a plant accident: radiation environment, high noise level, presence of steam or poisonous gases, or total darkness.
- An inspection was carried out and the "Burgas" type fire doors were replaced in all fire areas and cells of units 5 and 6, CWPS-3,4 and SRSB -3.
- A commission inspection of cable ducts was conducted in all fire protection areas and cells of units 5 and 6, CWPS-3,4 and SRSB -3, to establish their condition (sealed/unsealed) and measures were taken to seal them.

The following **improvements** related to fire protection were reported in the NAR for **KOZLODUY UNIT 5:**

- A possible common cause failure analysis was performed. As a result of this study, the volume of work on the measures related to the modernization of the fire extinguishing systems was determined for:
    - Improving the fire resistance of fire doors;
    - Limiting the spread of fire through ventilation ducts;
    - The modification of gas fire extinguishing system;
    - The qualification of fire alarm devices according to the required seismic level.
- According to detailed designs, modernizations (replacement) of the existing fire alarm and fire extinguishing systems (FAS and FES) were carried out in the TB of units 5 and 6, circulation pumping stations 3 and 4, the additional diesel generators and the new backup emergency power supply - unit 6, Water Treatment Plant (WTP) and United Auxiliary Building (UAB), SRSB-3 with new SIEMENS systems based on the SINTESO platform, model FC 20XX.

Dedicated spent fuel storage

The following **strengths** related to fire protection were reported in the NAR as generic for **spent fuel storage (wet (PSFSF) and dry (DSFSF):**

- The PSFSF and DSFSF buildings do not contain combustible materials:
    - The use of combustible materials outside the storage area in the receiving area is minimized by not storing materials and equipment that could pose a fire hazard;
    - In the administrative area, where there are materials and equipment that could be a fire hazard, the fire load is minimized as far as possible. In addition, the administrative area is separated from the reception area and the storage area by a technical fire barrier with 1-hour fire resistance.
- The types of electrical cables used do not maintain combustion and do not form poisonous smoke. All secondary electrical systems are shut down when the building is not in service. Backup generators and their fuel tanks are located at a distance from the PSFSF and DSFSF main building.

WET SFSF KOZLODUY SITE (PSFSF)

The following **weakness** related to fire protection was reported in the NAR for **WET SFSF KOZLODUY SITE (PSFSF):**

- From an inspection of the insurance risk of "Kozloduy NPP" EAD in 2023, a Report of nuclear insurance pools for "Civil liability for nuclear damage" insurance" was received, in which a recommendation was made to revise the Fire Hazard Analysis (FHA) of the PSFSF. Kozloduy NPP has decided to carry out a Fire Hazard Analysis (FHA) of the PSFSF by the end of 2025.

The following **lessons learned** related to fire protection were reported in the NAR for **WET SFSF KOZLODUY SITE (PSFSF):**

- Implementation of corrective actions to address weaknesses identified in inspections and missions.

The following **improvements** related to fire protection were reported in the NAR for **WET SFSF KOZLODUY SITE (PSFSF):**

- The detected violations or deviations from the requirements for fire safety are filled in the plant information system "Organization of Operational Activities" (IS OOA).
- In order to limit the spread of the products of the fire, new qualified fire dampers were delivered and installed, the ventilation ducts were isolated with an additional fire protection coating.
- Modernization strategy of the architecture of fire alarm systems components.

DRY SFSF KOZLODUY SITE (DSFSF)

The following **strength** related to fire protection was reported in the NAR for **DRY SFSF KOZLODUY SITE (DSFSF):**

- The main supporting structure of the DSFSF (columns and walls) is reinforced concrete with a fire resistance limit of more than 2.5 hours and more than 6 hours, respectively. The steel roof structures are covered with a fire protection coating that provides fire resistance of over 45 min. The roof panels are selected panels with required equivalent fire resistance.

No **weaknesses** related to fire protection were reported in the NAR for **DRY SFSF KOZLODUY SITE (DSFSF).**

No **lessons learned** related to fire protection were reported in the NAR for **DRY SFSF KOZLODUY SITE (DSFSF).**

No **improvements** related to fire protection were reported in the NAR for **DRY SFSF KOZLODUY SITE (DSFSF).**

Installations under decommissioning

KOZLODUY 4 NPP

The following **strength** related to fire protection was reported in the NAR for **KOZLODUY 4 NPP:**

- For units 1-4, in terms of fire safety, a positive factor is the achieved high degree of fire resistance during the phase of their operation as nuclear units. The specific risks arising for a certain stage of the decommissioning activities are analysed as a basis for their authorisation.

No **weaknesses** related to fire protection were reported in the NAR for **KOZLODUY 4 NPP.**

No **lessons learned** related to fire protection were reported in the NAR for **KOZLODUY 4 NPP.**

No **improvements** related to fire protection were reported in the NAR for **KOZLODUY 4 NPP.**

On-site radioactive waste storage

Storage Facility for Conditioned RAW (SFCRAW) at Kozloduy site

The following **strengths** related to fire protection were reported in the NAR for **Storage Facility for Conditioned RAW (SFCRAW) at Kozloduy site:**

- Sharing of common resources such as external fire rings, RSFSPP-NPP located at the site, joint training and exercises.
- The possibility that all firefighting means and systems of SE RAW will be maintained on the basis of contractual relations by the specialists from "Kozloduy NPP" EAD.

No **weaknesses** related to fire protection were reported in the NAR for **Storage Facility for Conditioned RAW (SFCRAW) at Kozloduy site.**

No **lessons learned** related to fire protection were reported in the NAR for **Storage Facility for Conditioned RAW (SFCRAW) at Kozloduy site.**

No **improvements** related to fire protection were reported in the NAR for **Storage Facility for Conditioned RAW (SFCRAW) at Kozloduy site.**

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, plus the one (storage facility) to address the recommendation by the Board (indication if the on-site waste storage facilities are considered in the NAR as a part of the installation or as a separate one and report on it accordingly).

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

There are no comments on the structure of the NAR.

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

Adequate information was provided in reply to the written questions.

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

4.2 Peer review findings

The self-assessment revealed some weaknesses in the fire protection of the nuclear installations. The finding in the table below was acknowledged as an area for improvement by the TPR Team.

Areas For Improvement mentioned in the NAR as weaknesses and acknowledged as such by the TPR Team	
AFI (1)	**Nuclear installation:** Kozloduy Unit 5 NPP The need for replacement of fire detectors due to ageing management.

The TPR team recommends that Bulgaria addresses this area for improvement in the National Action plan.

During the country review workshop, any findings identified during the peer review phase have been discussed in detail. Based on these discussions, no finding was identified for Bulgaria by the TPR team.

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.