

European Nuclear Safety Regulators Group ENSREG

2nd Topical Peer Review – 'Fire Protection'

Country Review Report

Slovenia

January 2025

CONTENTS

1.	Brief overview of the candidate installations		
2.	Regulatory framework	3	
3.	Findings and significant improvements of approaches on the installations from the national self-assessment		
	Nuclear power plants	4	
	Spent fuel storage	6	
	On-site radioactive waste storages	6	
4.	Peer-review conclusions	7	
4.1	Attributes of the NAR and the information provided	7	
4.2	Peer review findings	8	
	Definition of the types of findings	9	

1. Brief overview of the candidate installations

Installation category	Number of installations	Name of candidate installations
Nuclear power plant	1	Krško NPP
Research reactor		-
Fuel reprocessing facility		-
Fuel fabrication facility		-
Fuel enrichment facility		-
Dedicated spent fuel storage	1 (dry)	Spent Fuel Dry Storage of Krško NPP
Installations under decommissioning		-
On-site radioactive waste storage	1	Waste Storage Facilities of Krško NPP
Total	3	

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

2. Regulatory framework

The NAR mentions that "*The Act transposes into Slovenian law the Euratom Directives*". The main Act in nuclear and radiation safety is the 2017 Act (Revision 2019). It is complemented by decrees and rules.

The NAR indicates that "Slovenian nuclear legislation is aligned with the international safety standards and sources primarily the IAEA Safety Standards, EU directives, OECD/NEA documents, WENRA reference levels and others (HERCA, ENSREG)".

Regarding internal fire hazards, the requirements are written in "Rules on radiation and nuclear safety factors" (JV5). This rule addresses the following topics: "*Fire-protection objectives which shall observe the defence-in-depth principle, Fire-protection design bases, Building fire safety, Fire-risk analysis, Fire-protection systems, Fire-safety surveillance and maintenance, Fire-protection organisational arrangements.*"

In addition, all Slovenian organisations, including Krško NPP have to comply with the "National Fire Safety Code". The Fire Protection Act includes the organisation, planning, implementation, control and financing of fire protection activities and measures.

The NAR does not clearly state if the WENRA SRLs SV are binding. In response to the question of the TPR Team¹, Slovenia's answer was: "WENRA SRLs were implemented in our national regulatory requirements for nuclear and radiation facilities, including RR, and also about fire protection (WENRA Existing NPPs SRL Issue S). WENRA SRLs on fire protection are included in the JV5 - Rules on radiation

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..)?'

and nuclear safety factors. Rules JV5 are regulation and that is binding for all facilities, including NPPs and RRs. It shall be noted, that the fire protection requirements set in Rules JV5 contain additional requirements from IAEA standards and therefore even exceed the WENRA SRL requirements. WENRA SRL for RRs are currently in the process of self-assessment (within WENRA WGRR) and shall be later on included into the national legislation. However, the WENRA SRL for NPPs were set in the past as requirements also for RRs (with few exemptions and with possibility of application of graded approach for RRs). Within the periodic safety review (PSR) the latest WENRA reference levels are also checked and verified by reviewer; any identified gaps are then inserted into the PSR action plan to resolve the opened issues."

The NAR mentions that the licensee issues one report to demonstrate compliance with the U.S. regulatory requirements and another one to evaluate the Krško NPP compliance with WENRA Safety Reference Levels.

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

Nuclear power plants

KRŠKO NPP

The following strengths related to fire protection were reported in the NAR for Krško NPP:

- Control of fire load addresses the introduction of flammable material into the technological part of the plant and also into some "important-to-safety" areas at non- technological part, e.g. Spare parts store, Operations support center and Mobile equipment storage.
- A safety behaviour of employees has been established to recognize and report any not suitably left equipment that might have missed the process of control of transient load.
- Potential ignition/overheating sources are examined by the use of thermal imaging camera within predictive maintenance process.
- Outsourced professional firefighters gain experience in relatively frequent interventions outside the plant and are at the same time familiar with plant buildings, systems and processes.
- Fire permit process is not used solely for hot works but for many other situations that involve fire protection issues (e.g. inoperability, inaccessibility, explosion zones, fire barrier breach).
- A large fleet of mobile equipment such as fire trucks, pumping stations, diesel generators, air compressors, related accessory was provided to mitigate the consequences of severe accidents, some specifically dedicated to combat fire.
- A few inspections by the regulatory body on the topic of fire safety are carried out annually (1 to 3 inspections per year and one inspection with the participation of a inspectors for protection against natural and other disasters (fire inspector) every two years.
- Risk-based plant modifications were implemented.
- All smoke detectors are addressable which means that have discrete identification.
- Fire safety analyses were regularly reviewed and updated to account for the plant modifications that were carried out.
- Analyses of combination of all events with fires were also carried out, which show that the power plant is safe even for cases of combinations of events.
- PSA advanced in line with the findings on fire protection and analyses area.
- Krško NPP's FHA is in line with the latest WENRA RLSs and best industry practice.

The following **weaknesses** related to fire protection were reported in the NAR for **Krško NPP**:

• Design of Krško NPP does not meet full compliance with the 10CFR50, Appendix R separation guidelines (20 feet separation between trains etc.) especially in some common (both train components are within the same rooms/areas). One of the goals for the recently implemented

Safety Upgrade Program (SUP) were to provide alternative systems to ensure the capability for all the safety functions even if the fire started in a such common areas and consequentially the equipment from both trains can be affected.

- The fire PSA needs to be updated with current international practice, and also to include all modifications of the Safety Upgrade Program.
- Circuit analysis was not performed in accordance with the NEI 00-01 guideline. SSA shall consider multiple spurious operation (MSO).
- Fire Protection systems are not seismically designed as required by RG 1.189. Nevertheless, the generic studies were performed under NUREG-1211 which indicated that enough margin exists in design of piping system, even though the system is not seismically designed.

The following lessons learned related to fire protection were reported in the NAR for Krško NPP:

- In the independent review mission in 2007, it was found that the fire barrier plates between cable trays of safety and non-safety systems have had cracks between plates. In response, all fire barrier plates between cable trays were corrected to have overlapping between plates.
- During OSART mission in 2003 the observation was indicated: "Warehouse of oils and gases in the non-technological part of the plant contain large quantities of combustible material; some barrels are corroded and deformed; some collection traps containing oil and water are not protected with Fire Detection System". In response Krško NPP performed these actions: Large quantity of combustible materials was substantially decreased; degraded barrels were replaced with new ones; warehouse roof wase expanded to prevent rain or snow to the warehouse.
- During OSART mission in 2017, the following Deficiencies were indicated: "Krško NPP does not have Fire Preplans for managing severe fires (airplane crash); there is no control of transient combustibles in temporary modification process; mobile diesel generators do not have installed Fire Detection System". In response, Krško NPP have developed new Fire Preplans for big fires; temporary modification process was upgraded with control of transient combustibles; mobile diesel generators were equipped with the Fire Detection System.
- As a result of an IAEA expert mission in 2020, the operator agreed to upgrade the Krško NPP's Fire PSA to meet the requirements of later PSA standards, as part of improvements covered by the 3rd PSR. Besides, outcomes from PSR3 indicates the need for fire PSA update to consider plant upgrade programme and development of standards and practice after the Krško NPP fire PSA implementation.
- Several Independent review mission (2007, 2011, 2014) led to improvements Fire (drills procedures improvements and to address a finding on discrepancy in proper protection of safety systems from fire.

The following improvements related to fire protection were reported in the NAR for Krško NPP:

- Modifications for most critical fire areas (the ones which most significantly reduced fire CDF) were performed between 1998-2021 and are as follows:
 - Main Control Room (Fire Area CB-1) modification;
 - Auxiliary Building el. 94 (Fire Area AB-9) modification;
 - Service Water Pumps Room (Fire Area SW) modification;
 - Switchgear room Train A (Fire Area CB-3A) modification.

Based on those modifications, fire PSA analyses and FPAP program were updated to reflect the new status of those areas in the fire analyses.

- The following Safety upgrade program 2013-2022 (SUP) modifications contributed the most to the enhancement of the Krško NPP fire safety:
 - Installation of Diesel generator 3 (completed in 2012);
 - Installation of Emergency Control Room (completed in 2018);

- Implementation of Spent Fuel Pool (SFP) Alternative Cooling System (completed in 2020);
- Installation of High Temperature Seals (HTS) on both Reactor Coolant Pumps (completed in 2021);
- Implementation of Alternative Auxiliary Feedwater System (AAF) (completed in 2022);
- Implementation of Alternative Residual Heat Removal System (ARHR) (completed in 2022);
- Implementation of Alternative Safety Injection System (ASI) (completed in 2022).
- Significant improvements have been implemented to upgrade the Fire Protection Systems and systems needed for Safe Shutdown in the case of fire. The Safe Shutdown Capability Analysis was performed. Discrepancies have been evaluated from the Probabilistic impact on the CDF and more important ones (criteria was CDF >10 E-6) have been implemented:
 - Safe Shutdown components (SSC) cable rerouting;
 - Additional 8-hour emergency lighting to facilitate safe shutdown of the plant;
 - SSC cable wrapping;
 - o installation of additional automatic fire extinguishing systems;
 - o additional fire detection systems;
 - fire barriers;
 - control circuits isolation;
 - o installation of additional controls for safe shutdown capability.
- A Fire Detection System was installed in all rooms with safety equipment and a redundant fire detection terminal was installed in the firefighters' control room.

Spent fuel storage

Spent Fuel Dry Storage of Krško NPP (SFDS)

The following **strength** related to fire protection was reported in the NAR for **Spent Fuel Dry Storage of Krško (SFDS)**:

• Both the deterministic and probabilistic part of fire safety analyses were carried out for the SFDS.

No **weaknesses**, **lessons learned** and **improvements** related to fire protection were reported in the NAR for Spent Fuel Dry Storage of Krško.

On-site radioactive waste storages

Waste Storage Facilities of Krško NPP

The following **strengths** related to fire protection were reported in the NAR for **Waste Storage Facilities of Krško NPP**:

- The plant is divided into several buildings that are separated from each other by three hour rated fire walls.
- Fire will be quickly detected by Fire Detection System available in all fire areas (except in DB-1 fire area).
- Amount of combustible material is minimized by performing procedural controls.
- HVAC systems for radwaste storage facilities are equipped with fire dampers and isolation dampers, which will automatically isolate the buildings in case of a detected fire and will as such prevent any possible radioactive releases to the environment.
- The packages of waste, stored in RWSF are prepared and managed in accordance with waste acceptance criteria for storage, based on requirements from the national regulations.

• The related quantities of source terms are so low, that they could not cause the raise of radioactivity on the site to the level needed for the activation of an emergency event in accordance with Emergency Planning Procedure.

The following **weaknesses** related to fire protection were reported in the NAR for **Waste Storage** Facilities of Krško NPP:

 There are no separate FHA for waste storage facilities (WSF) buildings, particularly for radioactive waste storage facility (RWSF) (YD-22). It should be highlighted that the fire risk in RWSF is quite high (level 4), as it is noted in TD-6 (Fire Protection Program)). Krško NPP will consider RWSF as a separate fire area in the next revision of fire safety analysis – FHA. Fire detection system is missing in fire area DB-1 (old steam generators warehouse with a negligible combustible load).

The following **lessons learned** related to fire protection were reported in the NAR for **Waste Storage Facilities of Krško NPP**:

- In accordance with observations and findings of various events, reviews and missions, the following improvements were performed in recent 10 years, related to waste storage facilities:
 - Fire plans for Waste Manipulating Building (WMB) were prepared;
 - Fire Hazard Analysis was revised to include waste storage facilities (Decontamination Building (DB), RWSF and WMB).
- In 2009, the authorized inspection of active fire protection systems was carried out, related to the implemented modification on the RWSF HVAC system. Active fire protection, fire dampers and smoke dampers were tested, and some deviations were found. These inspection findings were eliminated and after re-inspection and testing it was found that the system meets the acceptance criteria from a fire safety point of view, for which the relevant certificates were issued.
- SNSA identified that in general NPP's FHA the RWSF (Yard-22) building is not divided into fire zones or fire cells. NEK considers RWSF as a separate fire area (RWS) in the newly prepared revision of fire safety analysis – FHA, currently under review.

No **improvements** related to fire protection were reported in the NAR for **Waste Storage Facilities of Krško NPP**.

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 to consider additional facilities (research reactor from Jožef Stefan Institute in Ljubljana) was not taken into account in the NAR. The recommendation of the Board (consideration of on-site waste storage) was addressed in the NAR.

The information provided in the NAR allowed a meaningful peer review in particular, for the identification of peer review findings.

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

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							
Nuclear installation: Krško NPP							
AFI (1)	Absence of multiple spurious operation (MSO) in FHA.						

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

During the country review workshop, the findings identified during the peer review phase have been discussed. Based on these discussions, the TPR team concluded on the following finding:

Areas of Good performance						
Nuclear installation: Spent Fuel Dry Storage at Krško NPP site						
	Finding	Fire resulting from large commercial aircraft crash are considered in the design basis in the deterministic studies for storage casks for spent fuel.				
AGP (1)	Justification	Aircraft crash is considered as DEC for the storage facility, assuming a fire affecting the casks with the entire consumption of fuel from the aircraft and concluding that no significant radiological release is produced. The consideration of a commercial aircraft implies a larger amount of fuel and a longer fire time duration with respect to what is assumed in the analyses performed in other countries.				

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.