ENSREG SECOND TOPICAL PEER REVIEW

SWISS NATIONAL ACTION PLAN

Fire Protection

August 2026

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Confederazione Svizzera
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Swiss National Action Plan on Fire Protection

Fire Protection in Nuclear Installations

August 2026

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1 Introduction

In accordance with the ENSREG mandate /1/ and the WENRA technical specification /2/ for the second topical peer review (TPR), the peer review focused on fire safety in nuclear installations at nuclear power plants (NPP) and research reactors (RR) with a power output of more than 1 MWth, spent fuel storage facilities, enrichment plants, nuclear fuel fabrication facilities, reprocessing plants and radioactive waste repositories located on the same site and directly associated with the types of nuclear facilities listed above. Chapter 1 of the National Assessment Report (NAR) sets out the rationale for the scope of the nuclear facilities included in the TPR 2023 and describes the national regulations applicable to the topic of ‘fire safety’. The assessments focus on the fire safety measures implemented and the fire analyses carried out at Swiss nuclear power plants and interim storage facilities. In Chapter 2, ‘Fire Safety Analyses’, and Chapter 3, ‘Fire Safety Concept and its Implementation’, information and statements from the reports of the licence holders were incorporated and assessed by ENSI. The final chapter presents an overall assessment of the fire analyses carried out and the fire safety concepts implemented in Swiss nuclear facilities, together with the conclusions.

The aim of the second TPR was to examine the extent to which fire safety in the participating countries complies with international fire safety requirements. In addition, the TPR pursued the following objectives:

- To enable the participating countries to review their fire safety measures in order to identify strengths and weaknesses.
- To conduct a European peer review to exchange operational experience and gain insights into common problems or challenges at EU level, best practices, areas of good performance and areas with potential for improvement.
- To establish an open and transparent framework enabling the participating countries to develop appropriate follow-up measures to address areas with potential for improvement.

In the first phase of the review process, national self-assessments were carried out based on the WENRA technical specification /2/. The results of the self-assessments were documented in the National Assessment Reports (NARs), which were published at the end of 2023. The Swiss NAR /3/ documented three findings from the self-assessment.

The second phase began in January 2024, when the NARs were made available to stakeholders for comment and questions. Subsequently, in September/October 2024, ENSREG organised a week-long workshop to discuss the results of the self-assessments, the questions and comments on the NARs, and the responses to those questions, with the aim of identifying and discussing both general and country-specific findings on fire safety.

In the third and final phase of the TPR, a topical peer review report /4/ was produced. The results of the peer review on fire safety in nuclear installations were summarised, taking into account the general findings of the review process. The key findings are presented in the form of best practices, expected performance levels and challenges. Furthermore, these findings were allocated to the participating countries, and the resulting country-specific findings were documented in a separate report /5/. The expected performance levels set out in the TPR are regarded as good performance for those countries that achieve this level, and as an area with potential for improvement for the others.

In accordance with the ENSREG decision of 21 March 2021, countries that took part in the second TPR process were required to draw up National Action Plans (NAcPs) for nuclear installations in order to implement the findings of the peer review. In particular, the NAcPs should address the following points:

- Follow-up on the findings of the peer review – areas for national improvement
- Follow-up on further findings from the self-assessment
- Consideration of further findings – from the peer review on improving fire safety (optional)

To facilitate the follow-up process, the planned measures for further improving fire safety at nuclear installations should be summarised in a summary table. The NAcP is to be submitted by 31 August 2026 as part of the follow-up process.

The three topics mentioned above are addressed in Sections 2 to 4 of this Swiss NAcP report. In accordance with the ENSREG decision of 21 March 2011, the national comments in Sections 3 to 4 focus on the key findings of the peer review, which are presented in terms of best practice and expected performance levels. The challenges identified during the peer review are not addressed, as these apply across Europe. Annex A of this NAcP report contains a summary table of the national measures derived from the peer review process.

2 Follow-up on Findings from the Peer Review – National Areas for Improvement

This chapter focuses on the measures arising from the country-specific findings of the peer review, as published in Chapter 4 of the Country Review Report (CRR) /5/ Switzerland.

2.1 AFI (1) – Beznau and Gösgen nuclear power plants and the Zwibez spent fuel storage facility

A need to revise the fire protection concept to create an 'overarching fire protection concept' and detailed, building-specific fire protection concepts.

2.1.1 Identified action(s) and progress on implementation

Every Swiss nuclear facility has a facility-specific fire protection concept that defines the objectives and principles of fire protection. The fire protection concepts set out the structural, technical and organisational measures to be implemented at the facilities.

However, ENSI considers it necessary for the Beznau nuclear power plant and the ZWIBEZ interim storage facility to update and supplement their fire safety plans and the associated documentation in accordance with national fire safety regulations. Both the Beznau nuclear power plant and the ZWIBEZ interim storage facility are already implementing AFI 1 and are currently drawing up an overarching fire safety plan. In a second stage, detailed fire safety specifications will be drawn up for each building. ENSI will oversee this process over the next three years as part of its supervisory role.

2.1.2 Applicability to the installations covered

The overarching fire safety concept for the Gösgen nuclear power plant has been revised, reviewed by ENSI and approved on 11 July 2024. In addition to the overarching fire safety concept, detailed fire safety specifications have been drawn up for each building. Despite its complexity – involving around 35 different buildings and varying requirements – the overarching fire safety concept for the Gösgen NPP provides a good overall overview of the existing fire safety measures. As described in Chapter 2.1.1, every Swiss nuclear facility has a fire safety concept, including the Leibstadt NPP. The Leibstadt NPP has revised its fire safety concept and drawn up an overarching fire safety concept, which was reviewed by ENSI for completeness and traceability and approved on 30 August 2024. The overarching fire safety concept forms the basis for the fire safety descriptions for each building, which have also been drawn up.

2.2 AFI (2) – Leibstadt NPP

There are two different systems in place to support fire load management. This does not allow information to be obtained efficiently.

2.2.1 Identified action(s) and implementation progress

At the Leibstadt NPP, fire loads are recorded using a database. Unlabelled storage areas are identified via the fault reporting process; the impact of the fire load is assessed taking into account the potential for activation, after which the measures for further action are defined. Fire loads are reviewed periodically. On a room-by-room or building-by-building basis, the fire loads are cross-checked against the technical database and checked for compliance with the maximum values. The two different systems supporting fire load management have been consolidated into a single software solution. A trial operation is currently underway using a test version. ENSI is monitoring the measures as part of its supervisory activities.

2.2.2 Applicability to the installations in question

From ENSI's perspective, the measure is being implemented correctly. ENSI will verify that it has been implemented correctly as part of its supervisory activities.

2.3 AFI (3) – Zwilag spent nuclear fuel storage facility

It is necessary to update and supplement the fire protection concepts and associated documentation in accordance with the national fire protection regulations.

2.3.1 Identified action(s) and implementation progress

The fire protection concepts for Swiss nuclear facilities define the objectives and principles of fire protection. The fire protection concepts set out the structural, technical and organisational measures to be implemented at the facilities.

With regard to the Zwilag Central Interim Storage Facility, ENSI considers it necessary to update and supplement the fire safety plans and the associated documentation in accordance with national fire safety regulations. There are as yet no plans to implement AFI 3 at the Zwilag Central Interim Storage Facility. ENSI will continue to press ahead with implementation as part of its supervisory activities. In ENSI's view, implementation of AFI 3 within the next three years would be appropriate.

2.3.2 Applicability to the installations concerned

In ENSI's view, no further measures are necessary, as the operators of the NPP and the Beznau interim storage facility (Zwibez) are revising the existing fire safety concept.

2.4 AFI (4) – Nuclear installation: All nuclear power plants

According to the FSA, there is a need to reassess the detection strategy in areas/rooms with harsh environmental conditions, in particular high radiation levels, and to consider the adoption of appropriate fire detection solutions where necessary.

2.4.1 Identified action(s) and implementation progress

In Swiss nuclear facilities, all buildings are monitored by fire alarm systems. The systems are designed and installed in accordance with the national regulations of the Association of Cantonal Fire Insurers (VKF) and the Association of Swiss Safety Installation Contractors (SES). Within the controlled area, every room is monitored by fire detectors, regardless of the fire load present. Rooms with high radiation levels are exempt from this.

Taking the Beznau NPP as an example: in the safety building, five video cameras are deployed in the area of the main reactor pumps to assess the situation in the event of a fire alarm. Two cameras each are directed at the two main pumps; a further camera is swivelling and is used for video surveillance of the control room. Fire detection in these rooms is carried out using other means, such as temperature measurements.

At the Gösgen NPP, trials were carried out with thermal imaging cameras; however, the chosen camera type did not prove effective. A further live test was conducted using a different camera type, which holds a VdS certificate. These cameras perform significantly better. ENSI welcomes KKG's safety-oriented approach and will continue to support KKG as part of its supervisory activities. Should the aim be to integrate the cameras into the fire alarm system as a 'detection device', the cameras must be tested in accordance with the SN EN 54 series of standards and approved by the VKF.

The fire alarm system at the KKL is equipped in accordance with the VKF fire safety guidelines. Certain areas are exempt from full monitoring due to internal conditions (e.g., radiation). The KKL has not yet planned any changes.

ENSI does not consider a general implementation of AFI 4 to represent a safety benefit, as there are currently no suitable fire detectors on the market that are designed for the harsh environmental conditions, in particular high levels of radiation.

2.4.2 Applicability to the installations in question

Fire protection systems are primarily based on the non-nuclear VKF guidelines, which do not take nuclear safety and radiation protection aspects into account. The approach to the requirement for fire detectors should be justified by a hazard assessment that takes nuclear safety and radiation protection into account.

ENSI concluded that the measures implemented in fire compartments with harsh environmental conditions, in particular high levels of radiation, are sufficient. The detection systems (fire alarm systems) used comply with the state of the art (EN 54), which is recognised throughout Europe. ENSI will pay particular attention to new detection systems that enable monitoring in fire compartments with harsh environmental conditions, particularly high levels of radiation. Consequently, no further measures are required at this stage. This circumstance is also taken into account in connection with the fire analysis (internal fire).

3 Follow-up on other findings resulting from the self-assessment

This chapter focuses on the measures arising from the areas for improvement identified for Switzerland during the TPR workshop /5/. The country-specific areas for improvement are based on the expected performance level defined in the TPR report /4/.

3.1 Beznau NPP (KKB) (NPP in operation)

3.1.1 Fire safety analysis

3.1.1.1 Weaknesses identified in the self-assessment

Identified action(s) and progress on implementation:

No areas for improvement were identified during the self-assessment process.

3.1.2 Fire prevention

3.1.2.1 Weaknesses identified in the self-assessment

Identified action(s) and progress on implementation:

No areas for improvement were identified during the self-assessment process.

3.1.3 Passive fire protection

3.1.3.1 Weaknesses identified in the self-assessment

1. The challenge in fire protection lies in reconciling the current state of the art with the existing design of nuclear facilities, some of which in Switzerland are already over 50 years old. The design criteria that represented the state of the art 50 years ago are no longer up to date, but in some cases cannot be adapted.
2. Over the years of operation, the needs of the employees and the operator have changed, amongst other things, which has led to the installation of equipment in some areas of the KKB that the Swiss Federal Nuclear Safety Inspectorate (ENSI) considers to be a potential fire hazard. For example, there are additional fire loads in escape and rescue routes (automatic machines, charging stations for electrical equipment, battery-powered lifting equipment and cleaning equipment) that also pose a risk of ignition.

Identified action(s) and progress on implementation:

Re 1. As part of its supervisory activities, ENSI will verify, in the event of plant modifications, extensions and conversions, that the changes comply with the current state of the art. This is an ongoing process and, in the case of older plants, can only be implemented step by step.

Re 2. As part of its supervisory activities, ENSI will verify, in the event of plant modifications, extensions and conversions, that the changes comply with the current state of the art. This is an ongoing process and, in the case of older plants, can only be implemented step by step.

3.1.4 Active fire protection

3.1.4.1 Weaknesses identified in the self-assessment

Identified action(s) and progress of implementation:

No areas for improvement were identified during the self-assessment process.

3.2 Gösgen NPP (KKG) (NPP in operation)

3.2.1 Fire safety analysis

3.2.1.1 Weaknesses identified in the self-assessment

1. The fire-PSA still shows some areas where improvements are needed; in particular, there is a lack of studies on secondary fires caused by fires resulting in damage to electrical safety equipment, and the possible effects of such fire damage on the control of the power supply.

Identified action(s) and progress on implementation:

Re 1. As part of the PSA 2027, KKG is in the process of drawing up the new fire PSA in accordance with the NUREG/CR-6850 guideline, whilst also taking into account more recent guidelines for certain aspects (e.g. NUREG-2169 for fire occurrence frequencies and NUREG/CR-7150 for fire-induced short circuits). ENSI will review the fire PSA newly drawn up as part of the PSÜ 2027 and pay particular attention to those aspects where a need for improvement has been identified.

3.2.2 Fire prevention

3.2.2.1 Weaknesses identified in the self-assessment

Identified action(s) and progress on implementation:

No areas for improvement were identified during the self-assessment process.

3.2.3 Passive fire protection

1. The challenges lie in ensuring that fire protection requirements and their implementation remain state of the art, given that the facility was built around 45 years ago.
2. In the annular space of the reactor building in particular, consistent fire protection redundancy and separation are only possible to a limited extent.
3. The on-site signage for the fire-resistant partitions and fire protection expansion joints has not yet been completed.
4. In a few safety-relevant areas, structural fire compartmentation is in place, but missing fire dampers mean there are gaps in the fire compartmentation. These gaps are currently being closed by retrofitting the missing fire dampers.

3.2.3.1 Weaknesses identified in the self-assessment

Identified action(s) and progress on implementation:

Re 1. As part of its supervisory activities, ENSI will verify, in the event of plant modifications, extensions and conversions, that the changes comply with the current state of the art. This is an ongoing process and, in the case of older plants, can only be implemented step by step.

Re 2. ENSI is aware of this situation and, as part of its supervisory role, will ensure that any modifications, extensions or conversions to installations comply with the current state of the art. This is an ongoing process and, in the case of older installations, can only be implemented step by step.

Re 3. This is an ongoing process and, where signage is missing, is carried out by the fire safety officer. ENSI estimates that 90 per cent of all signage has been installed.

Re 4. As part of its supervisory activities, ENSI will verify, in the event of plant modifications, extensions and conversions, that the changes comply with the current state of the art. The missing fire dampers are already planned as part of the relevant plant modifications.

3.2.4 Active fire protection

3.2.4.1 Weaknesses identified in the self-assessment

Identified action(s) and progress on implementation:

No areas for improvement were identified during the self-assessment process.

3.3 Leibstadt NPP (KKL) (NPP in operation)

3.3.1 Fire safety analysis

3.3.1.1 Weaknesses identified in the self-assessment

Identified action(s) and progress on implementation:

No areas for improvement were identified during the self-assessment process.

3.3.2 Fire prevention

3.3.2.1 Weaknesses identified in the self-assessment

Identified action(s) and progress on implementation:

No areas for improvement were identified during the self-assessment process.

3.3.3 Passive fire protection

3.3.3.1 Weaknesses identified in the self-assessment

1. Combustible filters in the exhaust air systems are housed in non-combustible casings at KKL. In the event of a fire, the combustible filter systems can be bypassed.
2. Some of the fire compartments in the laundry no longer meet current best practice standards. The KKL is already planning to carry out modifications to the plant in this area.

3. The structural fire protection in the facility was designed and installed around 45 years ago.

Identified action(s) and progress towards implementation:

Re 1. As part of its supervisory activities, ENSI will check, in the event of plant modifications, extensions and conversions, that the changes comply with the current state of the art. This is an ongoing process and, in the case of older plants, can only be implemented step by step.

Re 2. The plant modification is currently being planned and will be implemented in the near future. ENSI will continue to monitor this matter as part of its supervisory activities.

Re 3. As part of its supervisory activities, ENSI will verify, in the event of plant modifications, extensions and conversions, that the changes comply with the current state of the art. This is an ongoing process and, in the case of older plants, can only be implemented step by step.

3.3.4 Active fire protection

3.3.4.1 Weaknesses identified in the self-assessment

Identified action(s) and progress on implementation:

No areas for improvement were identified during the self-assessment process.

3.4 Mühleberg NPP (KKM) (NPP undergoing decommissioning)

3.4.1 Fire safety analysis

3.4.1.1 Weaknesses identified in the self-assessment

Identified action(s) and progress on implementation:

No areas for improvement were identified during the self-assessment process.

3.4.2 Fire prevention

3.4.2.1 Weaknesses identified in the self-assessment

Identified action(s) and progress on implementation:

No areas for improvement were identified during the self-assessment process.

3.4.3 Passive fire protection

3.4.3.1 Weaknesses identified in the self-assessment

Identified action(s) and progress on implementation:

No areas for improvement were identified during the self-assessment process.

3.4.4 Active fire protection

3.4.4.1 Weaknesses identified in the self-assessment

1. The high cost and time-consuming nature of making changes is assessed as a weakness in structural fire protection. During decommissioning, technical fire protection measures often involve significant expense or are implemented with a time delay.

Identified action(s) and progress on implementation:

Re 1. The decommissioning of the plant is leading to ongoing adjustments to structural and technical fire protection. Adjustments to technical fire protection systems are subject to a multi-stage approval process. ENSI is closely monitoring these adjustments as part of its supervisory activities.

3.5 ZWIBEZ interim storage facility at the Beznau NPP (KKB)

3.5.1 Fire safety analysis

3.5.1.1 Weaknesses identified in the self-assessment

Identified action(s) and progress on implementation:

No areas for improvement were identified during the self-assessment process.

3.5.2 Fire prevention

3.5.2.1 Weaknesses identified in the self-assessment

Identified action(s) and progress on implementation:

No areas for improvement were identified during the self-assessment process.

3.5.3 Passive fire protection

3.5.3.1 Weaknesses identified in the self-assessment

Identified action(s) and progress on implementation:

No areas for improvement were identified during the self-assessment process.

3.5.4 Active fire protection

3.5.4.1 Weaknesses identified in the self-assessment

Identified action(s) and progress on implementation:

No areas for improvement were identified during the self-assessment process.

3.6 Interim storage facility at Gösgen NPP (KKG)

3.6.1 Fire safety analysis

3.6.1.1 Weaknesses identified in the self-assessment

Identified action(s) and progress on implementation:

No areas for improvement were identified during the self-assessment process.

3.6.2 Fire prevention

3.6.2.1 Weaknesses identified in the self-assessment

Identified action(s) and progress on implementation:

No areas for improvement were identified during the self-assessment process.

3.6.3 Passive fire protection

3.6.3.1 Weaknesses identified in the self-assessment

Identified action(s) and progress on implementation:

No areas for improvement were identified during the self-assessment process.

3.6.4 Active fire protection

3.6.4.1 Weaknesses identified in the self-assessment

Identified action(s) and progress on implementation:

No areas for improvement were identified during the self-assessment process.

3.7 Zwilag central interim storage facility

3.7.1 Fire safety analysis

3.7.1.1 Weaknesses identified in the self-assessment

Identified action(s) and progress on implementation:

No areas for improvement were identified during the self-assessment process.

3.7.2 Fire prevention

3.7.2.1 Weaknesses identified in the self-assessment

Identified action(s) and progress on implementation:

No areas for improvement were identified during the self-assessment process.

3.7.3 Passive fire protection

3.7.3.1 Weaknesses identified in the self-assessment

Identified action(s) and progress on implementation:

No areas for improvement were identified during the self-assessment process.

3.7.4 Active fire protection

3.7.4.1 Weaknesses identified in the self-assessment

Identified action(s) and progress on implementation:

No areas for improvement were identified during the self-assessment process.

4 Consideration of other Findings from the Peer Review to enhance Fire Protection *[OPTIONAL]*

ENSI has reviewed Chapter 4 and the associated Annexes B, C and D and sees no need to amend Chapter 4.

4.1 Applicability of good practices identified in the peer review.

4.2 Applicability of national areas of good performance in other countries.

4.3 Applicability of national areas for improvement in other countries.

5 Overall conclusions

Annex A – Summary table of planned/implemented actions

Annex B – Summary of good practices

Annex C – Compilation of national areas of good performance

Annex D – Compilation of national areas for improvement

Annex A – Summary Table of Planned/Implemented Actions

Section of NAcP	**Reference number of the finding**	**Installation type/name** (where applicable)	**Thematic**	**Finding**	**Action** (specify whether planned, in progress or completed)	**Deadline**	**Regulatory authority's comment on progress**
2.1	AFI 1	Beznau NPP; Gösgen NPP; Spent fuel storage at Zwibez	Areas for improvement mentioned in the NAR as weaknesses and acknowledged as such by the TPR team	A need to revise the fire protection concept into an 'overarching fire protection concept' and detailed building-specific fire protection concepts.	Beznau NPP: in progress; Gösgen NPP: completed/in progress Zwibez Beznau: in progress; Leibstadt NPP: completed/in progress	End of 2029	The overarching fire safety concept (BSK) for the Beznau and Zwibez nuclear power plants is being drawn up. The overarching fire safety concept (BSK) for the Gösgen NPP was reviewed by ENSI and approved on 11 July 2024. The overarching BSK for the Leibstadt NPP was approved by ENSI on 30 August 2024
2.2	AFI 2	Leibstadt NPP	Areas for improvement mentioned in the NAR as weaknesses and acknowledged as such by the TPR team	There are two different systems to support fire load management. This does not allow information to be obtained efficiently.	In progress	End of 2029	The two different systems supporting fire load management have been consolidated into a single software solution. A trial operation is currently underway using a test version.

2.3	AFI 3	Central Spent Fuel Storage Facility – Zwilag	Areas for improvement mentioned in the NAR as weaknesses and acknowledged as such by the TPR team	It is necessary to update and supplement the fire protection concepts and associated documentation in accordance with national fire protection regulations.	Planned	End of 2029	ENSI will continue to drive forward implementation as part of its supervisory activities. ENSI considers it appropriate for AFI3 to be implemented within the next three years.
2.4	AFI 4	Beznau NPP; Gösgen NPP; Leibstadt NPP	Areas for improvement	According to the FSA, there is a need to reassess the detection strategy in areas/rooms with harsh environmental conditions, in particular high radiation levels, and to consider the adoption of appropriate fire detection solutions where necessary	Completed	August 2026	The measures implemented in areas/rooms with harsh environmental conditions, in particular high levels of radiation, are adequate. Consequently, no further measures are required at this stage

Annex B – Summary of Good Practices
(Adapted from the summary report, Annex IV. See this report for further details)

Ref. No	Good Practice
GP-1	‘Implementing lessons learnt from fire incidents in non-nuclear settings.’
GP-2	‘An extensive series of tests carried out to assess the effects of fire on components (electrical equipment, fire doors, cables, seals, etc.) included in the fire safety analyses, in order to confirm their assumed resistance to fire-induced phenomena.’
GP-3	‘A dynamic system for managing storage areas for transient fire loads and other non-combustible materials.’
GP-4	‘Thermographic cameras installed on worksites, or in the event of a detector failure, with different detection zones and alarms.’

Annex C – Compilation of National Areas of Good Performance
(by installation type, adapted from the summary report, Annex VI)

Ref. No	Findings	Identified in the TPR for the installation
All/Multiple installations		
FR-AGP-7	Comprehensive national review following a fire incident at Lubrizol (chemical industry), which led to enquiries from the ASN and, consequently, to specific measures being implemented at all nuclear power plants.	All installations (FR)
NL-AGP-1	Full-scope fire PSA in all operating conditions for PSA levels 1 to 3.	Borssele NPP, HFR RR (NL)
UK-AGP-1	In addition to the assessment by the 'Hot Work Selected Person' and the review by the 'Hot Work Controller', an independent review of the Hot Work Controllers is carried out to ensure better control of the work areas.	All installations (UK)
UK-AGP-2	The sector-wide review of risks to combustible cladding, initiated by the Nuclear Regulatory Authority to identify and implement lessons learnt from the Grenfell fire.	All sites (UK)
UK-AGP-4	Implementation of an automated fire protection system for the movement of tractors across the entire site.	Sellafield (UK)
Nuclear power plants		
BE-AGP-1	A robust process is in place to manage authorisations for opening fire doors: the wedge blocking the fire door can be collected from the main control room once authorisation has been granted.	Tihange 3 nuclear power plant (BE)
BE-AGP-2	The existence of first-response teams (comprising plant operators) and second-response teams (comprising professional firefighters), equipped with suitable equipment, and – in the case of the external firefighters at the Tihange NPP – stationed opposite the site, ensures an appropriate response to any fire incident.	Tihange 3 nuclear power plant (BE)
BE-AGP-3	Use of a mobile scanner with an intuitive IT tool and a barcode on items to easily identify equipment or materials that may be stored.	Tihange 3 nuclear power plant (BE)
BE-AGP-4	Implementation of a software tool to easily assess the adequacy of fire safety measures.	Tihange 3 nuclear power plant (BE)
CH-AGP-2	Robustness of the fire detection system against individual failures.	Nuclear power plants (CH)
CZ-AGP-1	A large professional fire brigade (FRSU), comprising between 12 and 18 personnel depending on the nuclear power plant, is permanently stationed at the site and provides fire prevention, firefighting and rescue services.	Nuclear power plants (CZ)
CZ-AGP-2	A comprehensive modernisation of the fire protection system has been carried out using new generations of multi-criteria detectors.	Nuclear power plants (CZ)

Ref. No	Findings	Identified in the TPR for the installation
ES-AGP-1	Implementation of effective flood protection for critical equipment against the harmful effects of a fire-suppression water system.	Almaraz and Cofrentes nuclear power plants (ES)
ES-AGP-2	Detailed regulations for the management of hot structures are provided for (e.g. scope of work, supervision, necessary fire-fighting equipment).	Cofrentes nuclear power plant (EN)
ES-AGP-3	New fire-fighting procedures and training programmes have been introduced as a result of lessons learnt from the conventional industrial sector.	Vandellos 2 NPP (EN)
FI-AGP-1	Use of a battery to operate fire dampers and smoke extraction dampers for at least 10 minutes as a compensatory measure.	Olkiluoto 3 (FI)
FI-AGP-2	Gas detectors are installed in rooms housing diesel generators to detect the escape of flammable gases from fuel tanks.	Loviisa 1, 2 NPP (FI)
FR-AGP-1	Implementation of door-opening alarms for those posing a safety risk (PSA-based).	Tricastin 900 MWe nuclear power plant (FR)
FR-AGP-2	Use of thermal imaging cameras at certain construction sites, which trigger an alarm in the main control room to provide warning in the event of a fire.	Nuclear power plants (FR)
FR-AGP-3	The measures to be taken by operators in the control room are predefined in written instructions (FAIOp).	Nuclear power plants (FR)
FR-AGP-4	Advanced modelling of the effects of fire (soot, pressure effects, etc.) to verify the fire resistance of compartmentalisation elements and the performance of structures, systems and components (SSCs).	Nuclear power plants (FR)
HU-AGP-1	There is a permanently well-equipped fire brigade on site.	Paks NPP (HU)
RO-AGP-1	Since 2022, a professional fire brigade (15 firefighters, 3 fire engines) has been permanently stationed at the Cernavoda nuclear power plant site.	Cernavoda nuclear power plant Unit 1 (RO)
SE-AGP-1	The design approach for the fire protection and alarm system is robust in terms of the separation of redundant circuits.	Nuclear power plants (SE)
SE-AGP-2	The measures to be taken by operators in the control room are predefined in written instructions for each individual fire compartment, depending on the area affected. For complex rooms, intervention layouts (rooms, detectors, etc.) and fire compartment layouts are supplemented by specially developed intervention plans.	Ringhals 3 NPP (SE)
SK-AGP-1	A professional, multi-functional fire brigade (at least 18 members) is permanently stationed on the nuclear power plant site. In addition, an external fire brigade is available, which is scheduled to be deployed in the event of a fire. The effectiveness of the joint response is tested through annual drills.	Mohovce 3, 4 NPP (SK)
TR-AGP-1	The presence of a well-equipped on-site fire brigade helps to ensure that fires can be tackled promptly and effectively.	AKKUYU NPP (EN)

Ref. No	Findings	Identified in the TPR for the installation
UA-AGP-1	A comprehensive and targeted modernisation programme for fire protection equipment and systems has been carried out at the nuclear power plants.	Nuclear power plants (UA)
UK-AGP-3	Fire doors and hatches forming part of the nuclear fire compartment are fitted with position monitoring that triggers an alarm in the MCR if the door remains open.	Hinkley Point C, Sizewell B and second-generation AGRs (UK)
Research reactors		
FR-AGP-5	Use of a semi-quantitative fire risk assessment methodology for each of the 600 rooms in the reactor building.	RHF RR (FR)
FR-AGP-6	Modernisation of the plant with significant improvements (to both passive and active components), including those carried out as part of the PSR.	RHF RR (FR)
HU-AGP-2	A significant proportion of the staff and reactor operators are certified fire safety engineers.	Budapest Research Reactor (HU)
NL-AGP-2	A systematic approach to combining hazards is applied.	HFR RR (NL)
PL-AGP-1	Implementation of new and modern provisions, in particular to comply with current fire safety regulations.	MARIA, Spruce (PL)
TR-AGP-2	Formalised agreements between the reactor facility and the municipal fire service contribute to an effective response in the event of a fire.	ITU Research Reactor (TR)
Decommissioning		
IT-AGP-2	The permanent presence of the research reactor on site is ensured by a well-equipped on-site fire brigade.	ESSOR RR – Decommissioning (IT)
Storage of spent fuel		
CH-AGP-1	Fires caused by a military aircraft crash were already taken into account during the planning phase of the spent fuel storage facility and the buildings for radioactive waste.	Zwilag SFS (CH)
SI-AGP-1	Fires resulting from a major crash involving a commercial aircraft are taken into account in the deterministic studies for spent fuel storage casks as part of the design basis.	Dry SFDS Krško nuclear power plant site (SI)
Waste		
IT-AGP-1	Fires caused by a military aircraft crash into waste storage buildings are taken into account during the design phase, and compliance with the consequences in line with specified radiological objectives is verified.	OPEC2 and D2 EUREX – Waste (IT)

Annex D – Compilation of National Areas for Improvement
(by type of installation, adapted from the summary report, Annex VII). See also the Country-specific CRR for further details, including justifications)

Ref. No	Finding	Identified in the TPR for the installation
All/Multiple installations		
DK-AFI-2	Fire prevention measures rely to a greater extent on compliance with operational procedures than on the structural and layout features of the building itself.	Risø site (DK)
LT-AFI-3	There is a need to standardise inspection and functionality testing procedures for fire dampers. Fire dampers must be visually inspected on site to check their operational condition, and such a method must be properly addressed in the relevant Ignalina NPP operating and maintenance procedures.	All installations (LT)
UK-AFI-3	Holistic Fire Safety Strategies (FSSs) covering fire safety objectives – nuclear safety, life safety and property protection – are not currently available for all nuclear facilities.	Sellafield (UK)
NPPs		
BE-AFI-1	The verification and inspection process for the seals in fire-resistant concrete dals has been implemented but has not yet been integrated into all maintenance procedures.	Tihange 3 NPP (BE)
BE-AFI-2	The FSA should take into account seismically induced fire.	Tihange 3 NPP (BE)
BG-AFI-1	The need to replace fire detectors as part of ageing management.	Kozloduy Unit 5 NPP (BG)
CH-AFI-2	There are two different systems in place to support fire load management. This does not allow information to be obtained efficiently.	Leibstadt NPP (CH)
CH-AFI-4	According to the FSA, there is a need to reassess the detection strategy in areas/rooms with harsh environmental conditions, in particular high radiation levels, and to consider the adoption of appropriate fire detection solutions where necessary.	All NPPs (CH)
CZ-AFI-1	The water-based fire-extinguishing system protecting the cable compartments is obsolete.	Dukovany NPP (CZ)
ES-AFI-1	Licensees should make better use of fire operational experience databases, such as ‘FIRE’.	NPPs (ES)
FI-AFI-1	A need to complete the replacement of old CO_2 gas extinguishing systems, whose design basis does not comply with today’s industrial standards.	Olkiluoto 1 and 2 NPPs (FI)
FI-AFI-2	The FSA should consider the risk of fire caused by seismic activity.	Lovisa 1, 2 & Olkiluoto 1, 2 NPP (FI)
HU-AFI-3	Lack of a detector in an area where combustible materials are temporarily stored.	Paks NPP (HU)

Ref. No	Finding	Identified in the TPR for the installation
HU-AFI-4	Fire detection systems for buildings other than the reactor and turbine buildings and the water extraction plant are not seismically qualified and are not independent between adjacent compartments. A risk-based justification has not been provided.	Paks NPP (HU)
HU-AFI-5	There is a need to reassess the detection strategy in areas/rooms with harsh environmental conditions, in particular high radiation levels, in accordance with the FSA, and to consider the adoption of appropriate fire detection solutions where necessary.	Paks NPP (HU)
NL-AFI-1	Several automatic fire-extinguishing systems do not fully comply with current design requirements and regulations.	Borssele NPP (NL)
NL-AFI-2	The fire detection alarms are not simulated in the control room simulator.	Borssele NPP (NL)
NL-AFI-4	Automatic fire suppression is not guaranteed in the event of a SSE.	Borssele NPP (NL)
RO-AFI-1	Fire hydrants and piping have not yet been installed in the reactor building of Unit 1.	Cernavoda NPP Unit 1 (RO)
RO-AFI-3	The combination of fire and earthquake events is not systematically considered and documented in all nuclear installations, where applicable.	Cernavoda NPP Unit 1 (RO)
SI-AFI-1	Absence of multiple spurious operation (MSO) in the FHA.	Krško NPP (SI)
SK-AFI-1	The response time of the response teams may be delayed due to restricted access to certain rooms.	Mochovce 3,4 NPP (SK)
UA-AFI-1	There is a need to improve fire hazard analysis by further developing deterministic analyses to specifically assess the potential consequences of fire events on the performance of safety functions.	NPPs (UA)
Research reactors		
AT-AFI-1	Absence of fire-extinguishing blankets that could prevent fires from developing and causing damage to the infrastructure.	TRIGA Mark II Vienna RR (AT)
HU-AFI-2	No record of flammable materials brought into the facility (e.g. packaging materials, paints).	Budapest Training Reactor (HU)
HU-AFI-1	The site conditions give rise to conflicting responsibilities between the site owner and the reactor operator organisation, which complicates the approval processes for certain modifications or corrective actions.	RRs (HU)
HU-AFI-6	Insufficient physical separation between redundant safety-related components (i.e. diesel generators, ventilators).	Budapest Research Reactor (HU)
IT-AFI-1	Based on the FHA results, the fire protection system for the RSV TAPIRO needs to be improved, particularly with regard to fire compartmentation and the ventilation system.	TAPIRO Fast Neutron Research Reactor (IT)

Ref. No	Finding	Identified in the TPR for the installation
NL-AFI-5	Inadequate management and qualification of isolation valves in the reactor building.	Hoger Onderwijs Reactor – HOR (NL)
NL-AFI-6	In the reactor building, fire detectors are located only in the ventilation ducts.	Hoger Onderwijs Reactor – HOR (NL)
PL-AFI-1	Lack of automatic fire-extinguishing systems.	MARIA, Świerk (PL)
PL-AFI-2	Lack of compartmentalisation or compensatory measures between redundant SSCs (UPS, diesel generators).	MARIA, Świerk (PL)
RO-AFI-2	The fire hazard analysis carried out in 2013 has not yet been revised and updated. It should be updated as part of the Periodic Safety Review of the research reactor, which is currently being developed. According to the TPR Team, the FHA should be revised at least every 10 years as part of the PSR.	TRIGA Research Reactor in Pitesti (RO)
TR-AFI-1	There is a need to review and upgrade the fire safety-related systems in order to bring them into line with the design requirements set out in the new regulation on fire safety at nuclear facilities.	İTÜ Research Reactor (TR)
TR-AFI-2	Due to the new regulation on fire safety, the licensee will have to carry out a fire safety analysis and hazard assessment. This should include justification of the acceptability of the fire protection measures, including the seismic robustness of fire protection equipment.	İTÜ Research Reactor (TR)
Fuel cycle facilities		
ES-AFI-2	The need to take radiological risks into account in the FHA.	Juzbado FCF (ES)
FR-AFI-1	In the event of a fire being extinguished with water, the extinguishing water must be retained and collected within the building concerned or its immediate vicinity. For two of the eight buildings containing uranium-bearing materials, some of the extinguishing water is likely to seep into the ground. Consequently, these two buildings must undergo improvements to retain and recover fire-extinguishing effluents. These improvements are being taken into account as part of the installation's ongoing periodic safety review.	Framatome Romans fuel fabrication facility (FR)
FR-AFI-2	Improve the implementation of spray water extinguishers in accordance with the requirements of the Labour Code. Incompatibilities with the process or specific water-reactive substances should be assessed to ensure that the safety of nuclear installations is not compromised.	La Hague (FR)
NL-AFI-3	No obvious connection between the various fire analyses carried out, which were based on different requirements, guidelines and scenarios depending on the fire analyses.	FCF Urenco (NL)

Ref. No	Finding	Identified in the TPR for the installation
UK-AFI-1	Lack of systematic consideration of combined or consequential hazards assessment as part of the current safety case.	Springfields Fuels Ltd (UK)
Spent fuel storage		
CH-AFI-1	A need to revise the fire protection concept into an ‘overarching fire protection concept’ and detailed building-specific fire protection concepts.	Beznau and Gösgen nuclear power plants and Zwibez spent fuel storage (CH)
CH-AFI-3	It is necessary to update and supplement the fire protection concepts and associated documentation in accordance with national fire protection regulations.	Zwilag SFS (CH)
IT-AFI-2	There is a need to strengthen the fire detection provisions in the context of the planned transfer of fuel to the new dry storage facility.	ITREC plant – SFS (IT)
IT-AFI-4	There is a need to reassess the fire protection measures to decide whether to install new provisions (e.g. fire dampers, smoke detectors, ventilation ducts, …).	ESSOR Plant – SFS (IT)
LT-AFI-1	There is a need to install additional equipment that would allow remote monitoring of the situation in SNFSF-1 from the INPP main control room.	SNFSF-1 (LT)
SK-AFI-2	There is a need to complete the replacement of external underground fire hydrants with external above-ground fire hydrants.	Interim spent fuel (SK)
SK-AFI-3	Further work is required to inspect the components and replace the cable connections of the fire detection and protection system (FDPS).	Interim spent fuel (SK)
SK-AFI-4	There is a need to reassess the use of voice alarms in the civil structure.	Interim spent fuel (SK)
SK-AFI-5	There is a need to reassess the possibility of controlling key fire-fighting equipment (HVAC systems, ventilation of protected escape routes, fire doors, power cut-off) via the FDPS.	Interim spent fuel (SK)
SK-AFI-6	There is a need to draw up procedures for the repair, operational readiness and identification of fire protection system components.	Interim spent fuel (SK)
Decommissioning		
DK-AFI-1	As there are no dampers fitted to the ventilation system, a fire in the building could spread through the ductwork.	Hot Cell facility – Risø site – Decommissioning (DK)
IT-AFI-3	There is a need to update the fire protection provisions in accordance with Technical Guide No. 31, as part of the ongoing licensing process for decommissioning.	ESSOR RR, EUREX FCF – Decommissioning (IT)

Ref. No	Finding	Identified in the TPR for the installation
UK-AFI-2	No explicit fire loading limits: a proportionate approach is required to implement the day-to-day management of fire loading, alongside the assessment of fire loadings in the nuclear safety case.	Dounreay Prototype Fast Reactor – Decommissioning (UK)
Waste storage		
DK-AFI-3	The lack of compartmentalisation (rooms not always separated by doors and the absence of floor-to-ceiling walls) requires supplementary analysis to verify and, where necessary, implement compensatory measures to ensure that fire does not spread between different activities.	Risø – Waste (DK)
DK-AFI-4	There is a need to implement a system to document the inventory of fire loads (e.g. a computer system).	Risø – Waste (DK)
LT-AFI-2	There is a need to implement solutions to improve the reliability of fire detectors operating in harsh conditions (for example, high radiation, humidity) in solid waste treatment and storage facilities (B3/4 project) and solid waste storage buildings 157 and 157/1.	Waste (LT)

6 Abbreviations

AGV:	Aargau Building Insurance
BFW:	Company fire brigade
BMA:	Fire alarm system
FACP:	Fire alarm control panel
BWR:	Boiling Water Reactor
CDF:	Core Damage Frequency
CAD:	Computer-Aided Design
CFAST:	Consolidated Fire and Smoke Transport
DIN:	German Institute for Standardisation
DECT:	Digital Enhanced Cordless Telecommunications
DETEC:	Federal Department of the Environment, Transport, Energy and Communications
ENSI:	Swiss Federal Nuclear Safety Inspectorate
EPRI:	Electric Power Research Institute
ESK:	German Disposal Commission
FDF:	Fuel Damage Frequency
FDS:	Fire Dynamics Simulator
FDT:	Fire Dynamics Tool
GVB:	Building Insurance Bern
HAW:	High-level radioactive waste
IAEA:	International Atomic Energy Agency
I&C:	Instrumentation & Control
ISRAM:	Information System for Radioactive Materials
IvG:	Intervention group
KKB:	Beznau Nuclear Power Plant
KKG:	Gösgen Nuclear Power Plant
KKL:	Leibstadt Nuclear Power Plant
KKM:	Mühleberg Nuclear Power Plant
KTA:	Nuclear Safety Standards Commission (Germany)
LAW:	Low-level radioactive waste
LERF:	Large Early Release Frequency
MAW:	Medium Active Waste
MCA:	Multi-compartment analyses

MSO:	Multiple Spurious Operations
Nagra:	National Cooperative for the Disposal of Radioactive Waste
NAR:	National Assessment Report
NEA:	Nuclear Energy Act
NEI:	Nuclear Energy Institute
NEO:	Nuclear Energy Ordinance
NUREG:	Nuclear Regulatory Commission (gov.)
OECD/NEA:	Organisation for Economic Co-operation and Development/Nuclear Energy Agency
PSA:	Probabilistic Safety Assessment
PSI:	Paul Scherrer Institute (Switzerland)
PSR:	Periodic Safety Review
PTS:	Pressurised Thermal Shock
PWR:	Pressurised Water Reactor
QAA:	Quality Assurance Officer
RSD:	Remote Shutdown Area
SES:	Association of Swiss Security System Installers
SMS:	Short Message Service
SRL:	Safety Reference Level
SSC:	Structures, Systems and Components
TPR:	Topical Peer Review
VKF:	Association of Cantonal Fire Insurances
U.S.-NRC:	United States Nuclear Regulatory Commission

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