Hungarian Atomic Energy Authority

National Assessment Report of Hungary

for the Topical Peer-Review “Fire Protection” under Council Directive 2014/87/EURATOM

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EXECUTIVE SUMMARY

In line with Council Directive 2014/87/Euratom of 8 July 2014 amending Directive 2009/71/Euratom establishing a Community framework for the nuclear safety of nuclear installations and according to the scope of self-assessment defined by European Nuclear Safety Regulators Group the current Hungarian National Assessment Report aims to present the results of the self-evaluation in the context of the fire safety of nuclear installations operated in Hungary. The specific scope of the assessment as well as the structure and expected content of the various chapters within the National Assessment Report were defined by ENSREG in dedicated WENRA technical specification documents.

Based on the technical specifications four nuclear facilities were selected to be subjected to the self-assessment, one nuclear power plant (MVM Paks NPP), two research reactors (Budapest Research Reactor, Training Reactor of the Budapest University of Technology and Economics) and a spent fuel storage facility (Interim Spent Fuel Storage Facility).

The self-assessment was carried out on various levels, the first level being the self-assessment of the different operating license holders of nuclear facilities who were tasked to describe and evaluate their existing infrastructure and practice within the scope of the WENRA technical specifications. This self-evaluation was then reviewed and assessed by the nuclear regulator (Hungarian Atomic Energy Authority) and the co-authority in the field of industrial fire safety (National Directorate General for Disaster Management, Ministry Of The Interior). In order to reach adequate and justified regulatory conclusions the co-authorities carried out dedicated on-site inspections at every facility subjected to the TPR II self-assessment project. Final regulatory conclusions were drawn based on the written content within the National Assessment Report and its validation during the on-site inspections.

Several areas of improvement were identified in connection with the TPR II self-assessment, and corrective actions were developed accordingly. The major categories of findings can be summarized as follows:

- **Authority issues, e.g.:** The research reactors in Hungary are located on sites together with multiple research, training, education and even industrial facilities. This may lead to unclear responsibilities and authorities between the site operator, the Licensee and the reactor operator subdivision which may pose an obstacle for an effective and quick communication.
- **Technical modifications:** During or prior to the TPR self-assessment some necessary corrective actions were identified, such as the need for additional flame detectors in critical areas.
- **Administrative modifications:** During the on-site inspections and the review of the fire safety related procedures and regulations non-compliances and minor gaps were identified in the documentation and corrective actions were formulated accordingly.
- **Gaps in the legal and regulatory framework:** As part of the TPR II self-assessment the co-authorities carried out a limited gap analysis for the Hungarian legal and regulatory framework in comparison with the WENRA RLs. Gaps in the relevant regulations were identified in the Nuclear Safety Codes Volume 5 and 6, which contains the regulations for research reactors and interim spent fuel storage facilities.

The deadlines of corrective actions developed to resolve the identified issues were selected in a manner to provide a short but reasonable timeframe both for the licensees and the regulatory bodies.

ABBREVIATIONS

ASG	Armed Security Guards
BKR	Energiatudományi Kutatóközpont - Budapesti Kutatóreaktor - Centre for Energy Research – Budapest Research Reactor
BM	Belügyminisztérium / Ministry Of The Interior
BME	Budapesti Műszaki és Gazdaságtudományi Egyetem / Budapest University of Technology and Economics
BME OR	Budapesti Műszaki és Gazdaságtudományi Egyetem – Nukleáris Technikai Intézet – Oktatóreaktor / Budapest University of Technology and Economics – Institute of Nuclear Techniques – Training Reactor
BM OKF	Belügyminisztérium Országos Katasztrófavédelmi Főigazgatóság / National Directorate General For Disaster Management, Ministry Of The Interior
CER	Centre for Energy Research
CFD	Computational Fluid Dynamics
CDF	Core Damage Frequency
CDP	Core Damage Probability
DSA	Deterministic Safety Analysis
ENSREG	European Nuclear Safety Regulators Group
EPRI	Electric Power Research Institute in the USA
EURATOM	European Atomic Energy Community
FIVE	Fire-Induced Vulnerability Evaluation
FHA	Fire Hazard Analysis
FP	Fire Protection
FPR	Tűzvédelmi Szabályzat / Fire Protection Regulation
FPTG	Tűzvédelmi Műszaki Irányelv/Fire Protection Technical Guideline
FTRP	Tűzoltási- és Műszaki Mentési Terv / Firefighting and Technical Rescue Plan
HAEA	Országos Atomenergia Hivatal / Hungarian Atomic Energy Authority
HAZOP	Hazard and Operability analysis
IAEA	International Atomic Energy Agency
KKÁT	Kiégett Kazetták Átmeneti Tárolója - Spent Fuel Interim Storage Facility
NAR	National Assessment Report
NFSC	Nuclear Fire Safety Codes
NPP	Nuclear Power Plant
NSC	Nuclear Safety Codes
NSD	Nuclear Safety Directorate
OLC	Operational Limits and Conditions
OTSZ	Országos Tűzvédelmi Szabályzat /National Fire Protection Regulations
PAE	MVM Paksi Atomerőmű Zrt. – MVM Paks NPP Ltd.
PFH	Hivatásos Tűzoltóparancsnokság /Professional Firefighting Headquarters
POS	Plant Operational State
PSA	Probabilistic Safety Assessment

PSR	Periodic Safety Review
PTI	Plant Trip Initiator
RD	Reaktor üzem / Reactor Department (CER)
RHK	Radioaktív Hulladékokat Kezelő Kft. / Public Limited Company for Radioactive Waste Management
SRL/RL	Safety Reference Level/Reference Level
SSC	Structures, Systems and Components
TPR	Topical Peer Review
TS	Technical Specification
WANO	World Association of Nuclear Operators
WENRA	Western European Nuclear Regulatory Association
WGWD	Working Group on Waste and Decommissioning

INTRODUCTION

Based on Council Directive 2014/87/Euratom of 8 July 2014 amending Directive 2009/71/Euratom establishing a Community framework for the nuclear safety of nuclear installations member states are obliged to conduct a topical peer review in nuclear facilities starting from 2017 every 6 years. In accordance with the regulation:

- member states must conduct a national assessment of their nuclear facilities in the given topic,
- the non-nuclear member states and the Commission participate as observers in the review process,
- corrective measures must be formulated in the evaluation for the deviations discovered during the assessment,
- reports and main results should be published.

The European Nuclear Safety Regulators Group (hereinafter referred to as ENSREG) decided that the theme for the 2017 review was ageing management. Its objectives were:

- To review national legislation to identify problems and good practices.
- To conduct a Europe-wide peer review to share operational experience and identify key common issues.
- To provide an open and public framework for participants to take appropriate actions.

The above objectives were formulated for nuclear power plants, but were later extended to research reactors. The Topical Peer Review (hereinafter referred to as TPR) I project was successfully implemented and in November 2020, at its plenary meeting, ENSREG decided that the TPR II project should focus on fire safety. [1] sets out the expectations for National Assessment Reports (hereinafter referred to as NAR), while document [2] lays down a framework for the Europe-wide review project. The National Assessment Reports aim to present:

- the strengths and weaknesses of national practices in the field of fire safety;
- related operational experiences in order to identify common challenges, good practices and areas for further improvement at EU level;
- the implementation of corrective actions and improvements based on the self-assessment carried out during the TPR in a transparent and open manner.

Regarding their content the National Assessment Reports aim to:

- summarize the fire protection of facilities within the scope of TPR II, including:
    - how the sampling procedure was carried out based on the principle of a graded approach
    - the implementation of fire safety programmes
    - experience with fire safety and related activities
- identify key strengths and good practices in the national practice,
- identify possible areas for developments and improvements and formulate corrective actions to address them,
- provide information of sufficient depth and quality to allow a meaningful review.

1 GENERAL INFORMATION

1.1 Nuclear installations identification

The nuclear facilities within the scope of the NAR were selected based on the conditions defined by the TPR II Technical Specification. Nuclear facilities currently in operation in Hungary are the following:

Facility	Acronym	Site
MVM Paks Nuclear Power Plant	PAE	Paks
Budapest University of Technology and Economics – Institute of Nuclear Techniques – Training Reactor	BME OR	Budapest
Centre for Energy Research – Budapest Research Reactor	BKR	Budapest
Public Limited Company for Radioactive Waste Management - Spent Fuel Interim Storage Facility	KKÁT	Paks

Two of the listed facilities are located on neighbouring site within the administrative zone of the city of Paks: the KKÁT and the PAE. During the preliminary design stages of the KKÁT its site was considered to be part of the PAE site and as a result its water supply for fire protection is provided by the PAE.

1.1.1 Qualifying nuclear installations

- Nuclear Power Plants: Unit 1 to 4 of PAE
- Research Reactors: BME OR, BKR
- Interim Spent Fuel Storage Facilities: KKÁT

1.1.2 National selection of installations for TPR II and justification

The following criteria have been taken into account in the selection of the facilities covered by the NAR under [1]:
The NAR focuses on facilities that pose a significant radiological risk to the surrounding population or the environment in the case of a fire event. A source of radiological risk may arise if, as a result of the spread of fire, the safety systems are damaged because of failure or inadequate functioning of the safety systems, or if the fire occurs in an area or damages a system resulting in radioactive release.
The scope of the NAR includes the following nuclear installations listed in 1.1.1:

- nuclear power plants,
- research reactors with a thermal power ≥ 1 MWth and research reactors with a thermal power < 1 MWth but presenting a significant additional risk.
- dedicated spent fuel storage facilities

The thermal power ≥ 1 MWth is not a sufficient factor in itself for establishing the risk profile. For research reactors with a thermal power less than 1 MWth, additional characteristics must also be taken into account. Examples include: the duration of exposure, its location (proximity to inhabited areas and/or proximity to other facilities that may occur as external hazard), reactor-specific characteristics that are likely to affect safety (e.g. spent fuel storage sites, hot chamber areas, high pressure systems, heating systems and storage of combustible materials) and reactor use (experimental instruments, testing, radioisotope production, reactor physics experiments).

According to the Technical Specification the scope of the assessment should also include:

- Radioactive waste storages located at the site of nuclear facilities
- Nuclear facilities under decommissioning
- Nuclear fuel-cycle facilities
- New nuclear power plants that obtained a construction license before 30^{th} of June 2022

Since there are no such facilities in Hungary the related mandatory chapters were left empty and were given a „not applicable" indicator in the document.

1.1.3 Key parameters per installation

- PAE
    - Licensee: MVM Paks Nuclear Power Plant Ltd.
    - Type: VVER 440/213 pressurized water reactors – 4 units
    - Thermal power: 1485 MW
    - Electric power: 500 MW/unit
    - Year of commissioning: Unit 1 – 1982; Unit 2 – 1984; Unit 3 – 1986; Unit 4 – 1987
    - Year of operational license expiring date: Unit 1 – 2032; Unit 2 -2034; Unit 3 – 2036; Unit 4 – 2037
    - Only temporary radioactive waste storage on site, no dedicated waste storage facility on site
- BME OR
    - Licensee: Budapest University of Technology and Economics
    - Type: Pool type light water reactor with water and graphite reflectors
    - Thermal power: maximum 100 kW, typically 0-10 kW
    - Year of commissioning: 1971
    - Year of operational license expiring date: 30.06.2027
- BKR
    - Licensee: Centre for Energy Research
    - Type: Vessel type light water reactor with beryllium reflectors
    - Thermal power: 10 MW
    - Year of commissioning: 1959
    - Year of operational license expiring date: 15.12.2023
- KKÁT
    - Licensee: Public Limited Company for Radioactive Waste Management (RHK)
    - Type: Modular dry storage with vertical storage vaults
    - Year of commissioning: 1997
    - Year of planned decommissioning: 2074 - 2080

1.1.4 Approach to development of the NAR for the national selection

The compilation of the report was the responsibility of the Hungarian Atomic Energy Authority (hereinafter referred to as HAEA), taking into account the information received both from the co-authority and the licensees. On the part of the participants, the work consisted of carrying out the self-assessment and to a large extent documenting it and writing the relevant chapters of the report. The self-assessment was based on the framework of the WENRA reference levels.

Based on the Technical Specification document, the HAEA has prepared a Work Plan, precisely setting:

- the expected content of each chapter of the National Assessment Report,
- the organization responsible for the preparation of each chapter,
- the list of requirements for which fulfilment has to be justified in the different chapters,
- the time frame available and an estimate of the workhours required for each phase of work.

As a first step in the implementation of the task, those involved in the preparation of the Hungarian TPR II report and those responsible to represent the selected facility were designated. After the approval of the Work Plan, the project coordinator was in charge of contacting the heads of the institutions participating in the TPR II project, as instructed by the HAEA management, and inviting them to the TPR working group (contact persons and experts) to take part in the work.

Coordinating the work of the working group was also the task of the HAEA coordinator, who communicated with the experts through the contact persons appointed by the heads of the institutions. During the finalization of the members of the working group, the first task was to review and finalize the Work Plan, on the basis of which the self-assessment could be started. In the first phase of the report preparation, the report (and in particular its main body text) was prepared in Hungarian. It was the responsibility of the working group members to fill the National Assessment Report in Hungarian with content of such quantity and quality that it could meet the expected requirements without further modification.

After the self-assessment of the Licensees was finalized the co-authorities reviewed the answers provided by them and carried out an in-depth review. Since the format and certain confidentiality issues did not make it possible to list and include all relevant information and document in the NAR, the co-authorities carried out an on-site inspection for every facility within the scope of the NAR. During these site visits the co-authorities aimed to inspect the relevant documentation, procedures and verify the adequacy of the fire protection systems by visual confirmation. The extract of these on-site inspections are presented as Annex I to Annex IV of the NAR. In order to optimize the efficiency and speed of the professional discussions, the HAEA organized three technical workshop days during which project participants were able to discuss on the spot and in person any possible differences of opinion and finalize the text of the report.

The expected content of each section of the NAR was set by the Technical Specifications of the TPR II project, which also identified and listed the WENRA RLs relevant for the different chapters and subchapters. The WENRA RLs however are not directly mandatory for the Licensees operating in the various member states but indirectly through the national legal and regulatory framework. In order to describe what is currently expected from the Licensees the HAEA and the BM OKF as co-authorities took the opportunity to list and carry out a gap analysis on the existing Hungarian rules and regulations in comparison with the WENRA RLs and verify the Licensees compliance with the WENRA RLs through the corresponding national regulations.

Based on the self-assessments of the Licensees, the regulatory review of the self-assessments and the results of the on-site inspections of the co-authorities final conclusions were drawn with the aim to identify good practices that could be utilized in other EU member states and issues that require corrective actions in order to minimize the risk of fires as much as reasonably achievable. The conclusions, identified good practices, issues and formulated corrective actions are presented in Chapter 4, and in a tabular form in Annex V and Annex VI.

1.2 National regulatory framework

As elements of fire protection the regulation of preventive and emergency fire protection activities has always been carried out in accordance with the technical and social requirements of the given time period and within the current administrative framework. The first essential element of the period covered by the current assessment was the comprehensive regulation of fire prevention and fire-fighting activities, which emerged in the early 1980s as a result of the revision of previous requirements, in response to the industrial and agricultural development of the time and the processes of urbanization. Thus, the regulation covered the basic tasks, development principles and organizational and operational rules [A1]-[A2]-[A3].

An essential new element was the involvement of government agencies, state-owned enterprises and other economic entities in the performance of fire protection tasks, in addition to fire brigades. The regulation also laid the foundation for the hierarchical structure of the current official organization, although it had even more elements at that time, so it separated the operation at the national, regional (county), district and local levels. The activities of the state fire brigades were supported by corporate and voluntary fire brigades.

In the 1970s, in addition to emergency fire protection, the public fire brigades were responsible for regulatory activities, as they are today. At that time, however, there was no independent national fire protection regulation prescribed in high-level legislation, but instead detailed rules were laid down in individual sectoral regulations. In this time period, the authorities of first and second level in certain cases were able to approve and grant derogations and exemptions from fire protection requirements, and for unregulated cases the national fire brigade was responsible, similarly to the regulatory environment in force today. The regulatory environment already separated the various professional issues in detail in accordance with the spirit of current times, in particular:

- the construction rules (design, location and fire distance, fire category and fire protection, fire retardant separation, escape route, combustion product drainage, electrical and lightning protection equipment), and
- rules of use (commissioning, storage, agricultural and industrial use).

Despite the detailed professional elaboration, the specific fire protection issues related to the peaceful uses of nuclear energy, typically industrial activities, have not yet been regulated during this period.

A milestone in the regulation of preventive fire protection were the National Fire Protection Regulation [A4] issued in 1980, the use of which was ordered by the Minister of the Interior. The new form of regulation facilitated an appropriate response to the accelerating pace of technological development. However, following the change of regime, the hierarchy of the authorities has changed significantly, and the powers of the authorities have become divided. In principle, the notary of the municipality was the body of first level for fire protection licensing, who also consulted the competent professional municipal fire brigade. The National Fire Protection Regulation and the system of delegation of public authority remained in place for more than the next two decades, after numerous improvements and amendments [A5]-[A9], until 2012.

In the regulatory environment another important milestone was the establishment of a single state level professional disaster management organization in 2012 [A10]-[A11]. Together with the National Fire Protection Regulation [A12] and the related Fire Protection Technical Guidelines [A13], published in 2014, a fire protection regulatory environment capable to continuously meet the challenges arising from economic development and the increased emergence of investments even at the European level has been established. The protection of human life and the minimization of damage to property are among the primary protection objectives of [A12]. The elements of [A13] include certain technical solutions and calculation methods necessary to meet the fire protection requirements, corresponding to the level of safety to be achieved.

The specific fire protection requirements for the peaceful use of nuclear energy have been integrated in the legislation in three stages. The first element of the process was the publication of the Nuclear Safety Codes [A14], which covered the structure of architectural fire protection documentation and harmonization of nuclear and fire protection requirements at system level in both the construction and the operational rules among the various nuclear-related regulatory elements. The Codes were later amended several times according to [A15] - [A16] and [A19].

The regulation, which was still a separate regulation without specific fire protection requirements, was completed in 2007, then only for nuclear facilities with the Nuclear Fire Protection Codes [A21], and in 2015 with the publication of the Radioactive Waste Storage Fire Protection Codes [A17]. Together, [A16] and [A17] ensured the simultaneous and coordinated enforcement of nuclear safety and preventive fire protection requirements. Since 2017, the Regulation [A18] on general and specific rules for the procedures of fire protection authorities have further empowered fire protection authorities to manage specific solutions resulting from special requirements at system level, in the form of derogation licensing procedures upon request.

Thus, the general and specific regulatory system of fire protection requirements was completed with the emergence of [A17]-[A18] within the regulatory framework of the official and specialized authority activities of the state professional disaster management body. With the amendment of [A17] in 2022 [A20], in addition to the incorporation of professional experience into legislation, the representation of technical regulatory elements with a European approach (e.g. fire cell) has also been achieved.

The current legal regulatory environment therefore regulates the operational requirements of existing facilities in full, with general fire protection rules complemented by special nuclear requirements. Overall, the current legal environment is modern, sets a comprehensive framework, and at the same time allows for the application of engineering methods, supporting future planning and design processes in an appropriate way, in addition to meeting operational requirements.

1.2.1 National regulatory requirements and standards

Fire protection of nuclear facilities is an integral part of nuclear safety, thus protection against fire and fast combustion processes (deflagration, detonation) plays an important role in the design and operation of the facilities. The provisions considered consist of the following:

- standards used in the design and operation of nuclear installations covered by the NAR
- the safety assessment of these facilities, including the methods, data and analytical tools used

1.2.1.1 General fire safety requirements for nuclear facilities

- Act XXXI of 1996 on the protection against fire, technical rescue and the Fire Department,
- Decree 30/1996. (XII. 06.) of the Ministry of the Interior on the preparation of fire protection regulations,
- Decree 45/2011. (XII. 7.) of the Ministry of the Interior, on occupations and jobs subject to fire protection examination, on the sectors of employment and jobs where specialized fire protection qualification is required, as well as on the organization of education associated with specialized fire protection qualification and the detailed rules of specialized fire protection qualification,
- Decree 47/2011. (XII. 15.) of the Ministry of the Interior, on the rules for the activity of fire protection experts,
- Decree 50/2011. (XII. 20.) of the Ministry of the Interior, on the detailed rules for the commencement and continuation of fire protection service activities subject to notification,
- Government Decree 375/2011. (XII. 31.) on the rules for the conduct of fire protection design activities,
- Government Decree 239/2011. (XI. 18.) on the rules governing municipal and facility fire brigades, as well as the contribution to the maintenance of professional fire brigades, municipal fire brigades and voluntary fire brigade associations,
- Government Decree 259/2011. (XII. 7.) on the organizations performing the duties of fire protection authorities, on fire protection fines and on compulsory life and accident insurance coverage for fire protection personnel,
- Decree 16/2012. (IV. 3.) of the Ministry of the Interior on the administrative service fee to be paid for each fire prevention authority, procedures and services for specialty procedures,

- Govt. Decree 275/2013. (VII. 16.) on planning and building of construction products into buildings, and on performance certification during these activities,
- Decree 54/2014. (XII. 5.) of the Ministry of Interior on the National Fire Protection Regulation,
- From 2015: https://www.katasztrofavedelem.hu/213/tuzvedelmi-muszaki-iranyelvek,
- Decree 9/2015. (III. 25.) of the Ministry of the Interior on the professional qualification requirements and professional training of personnel employed by professional disaster management bodies, municipal and facility fire brigades, voluntary fire-fighting associations and related branches,
- Government Decree 489/2017. (XII. 29.) on the general and specific rules of fire protection authority procedures;
- Government Decree 490/2017. (XII. 29.) on the procedural rules for the investigation of fires,
- Government Decree 491 on the detailed rules of the administrative procedure for licensing the installation, commissioning and termination of fixed alarm and fire extinguishing equipment,
- EN standard 54 Fire Detection and Fire Alarm Systems

1.2.1.2 Specific fire safety requirements for nuclear facilities

The fire protection requirements for the design and operation of nuclear facilities are set in the chapters of the HAEA Decree 1/2022. (IV. 29.) and its annexes, the Nuclear Safety Codes (hereinafter referred to as NSC), and Decree 5/2015. (II. 27.) of the Ministry of the Interior on the specific fire protection requirements related to the use of nuclear energy and the manner of their enforcement in the course of the activities by the authorities and its annexes, the Nuclear Fire Safety Codes (hereinafter referred to as NFSC):

Nuclear facility	**HAEA Decree 1/2022. (IV. 29.)**	**Decree 5/2015. (II. 27.) of the Ministry of the Interior**
Nuclear power plants • MVM Paks NPP Ltd. Unit 1-4 (PAE)	Annex 3, Chapter 3.3.7 Annex 4, Chapter 4.13	Annex 1 Chapter I
Research reactors • Budapest research reactor (BKR) • BME training reactor (BME OR)	Annex 5, Chapter 5.2.15	Annex 1 Chapter II
Dedicated spent fuel storage facilities • Spent Fuel Interim Storage Facility (KKÁT)	Annex 6, (6.2.1.10500.-6.2.1.11000., 6.3.15.0100.-6.3.15.0200.)	Annex 1 Chapter III

1.2.2 Implementation/Application of international standards and guidance

The deterministic assessment of nuclear fire safety as a requirement of the nuclear authority (HAEA) is defined in the NSC. The detailed requirements for implementation are laid down by the fire protection authority (BM OKF) in the NFSC. To date, no dedicated official guidance for the assessment of nuclear fire safety has been developed by the HAEA as the nuclear safety authority. The application of the recommendations of NUREG/CR-6850 [A23], IAEA SSG-77 [A24] and IAEA SSG-3 [A25] is considered as good practice in the field of nuclear fire risk assessment. PSA related issues are addressed by specific requirements in the NSC and in the dedicated Probabilistic Safety Assessment (hereinafter referred to as PSA) regulatory guides issued by the HAEA (A3.11, N3a.11).

1.3 Improvements in fire safety as a result of experience feedback

1.3.1 Nuclear Power Plants (PAE)

Unit 1 of the Paks nuclear power plant has been producing electricity for the grid since 1982 and Unit 4 since 1987. During the construction period, there were no fire protection requirements for nuclear power plants. During the design period, the passive and active fire protection of the nuclear power plant was developed by a Hungarian energy design office, taking into account its design standard, which was developed based on the experience of a fire incident and fire spread in a Hungarian thermal power plant in the 1970s, as well as the Western European requirements, regarding for example, cabling, fire sectioning, built-in fire extinguishing systems. During the subsequent period, on the one hand, gradually the legislative requirements, and on the other hand, operational experiences contributed to the fire safety development programs. Thus, for example, in the cable room under the control rooms on each PAE unit got fireproof coating against the flame spreading, the cable rooms were divided into several fire sections to limit the spread of fire, and built-in fire extinguishers were installed to protect the diesel generators and the main circulation pumps. In the meantime, the formation, development and adaptation of international requirements systems into Hungarian practice, such as the IAEA Safety Series No. 50-SG-D2 Fire Protection in NPP publication and the IAEA Safety Series No. 50-P-11 Assessment of the Fire Safety Arrangements at NPPs also took place. The development of national requirements and legislation had a strong impact on the development of NPP fire protection. The development of the deterministic fire risk analysis methodology, or more precisely, its incorporation into national regulations, had a strong impact on the development of fire safety. The details will be shown in the following chapters. These improvements on the one hand refer to the amendments made to the national legislations in the field of fire safety and on the other hand the administrative and engineering modifications arising from these amendments.

Figure 1.3.1 – 1: PAE aerial view

The following pieces of national legislation (as amended) shall apply:

- **Decree 54/2014. (XII. 5.) of the Ministry of Interior** on the National Fire Protection Regulation
- **Decree 5/2015. (II. 27.) of the Ministry of the Interior** on the specific fire protection requirements related to the use of nuclear energy and the manner of their enforcement in the course of the activities by the authorities and its annexes, the Nuclear Fire Safety Codes
- **HAEA Decree 1/2022. (IV. 29.)** on the nuclear safety requirements of nuclear facilities and on related regulatory activities, and its annexes, the Nuclear Safety Codes (NSC)
- **HAEA Decree 5/2022. (IV. 29.)** on the independent technical expert acting in the field of application of atomic energy

Detailed information can be found in Section 2.1.4.

1.3.2 Research Reactors

BKR

The BKR is the leading research infrastructure in Hungary and it is one of the largest in Central-Europe. Scientists at BKR have decades of experience in using neutron beams for neutron scattering investigations, as well as neutron-based element analysis and imaging. BKR is a VVR-type (water-cooled, water-moderated reactor) of Soviet design and construction. The construction work started in 1956. The nuclear reactor went critical for the first time on March 25, 1959. Initially the reactor power was 2 MW, but it was upgraded to 5 MW in 1967. A full-scale reactor refurbishment (1986-1992), designed and constructed exclusively by Hungarian companies, was supported by the International Atomic Energy Agency (IAEA) and the European Commission. The reactor is being operated by the Centre for Energy Research of the Hungarian Academy of Sciences. The Budapest Neutron Centre (BNC) consortium was formed in 1993, with the participation of the neutron-research-related laboratories on the KFKI science campus.

Figure 1.3.2-1: The KFKI Science Campus

When reviewing or upgrading the facility, the Licensee shall take into account the changes in legislation in the relevant period. Over the past ten years, Decree 54/2014. (XII. 5.) of the Ministry of the Interior on the National Fire Protection Regulation, as the basis of the national fire safety regulations, has been amended several times, most recently by Decree 8/2022. (IV. 14.) of the Ministry of the Interior. In the meantime, the Decree 5/2015. (II.27.) of the Minister of the Interior and its annexes on the NFSC have been issued concerning the licensee as well.

During the operating period, the above-mentioned regulatory system has also developed, and on the other hand, the operational experience of the Licensee has also helped to lay the foundations for improving fire safety. During the last period, the condition of the fire barriers has been inspected and from 2014 onwards, the operator maintains them and their inspections are documented in accordance with the requirements of the NFSC. Also during this time, the specialists developed the new fire alarm system based on the licensing scheme. The introduction of annual trainings and audits, which are managed through online platforms, also leads to the development of the fire safety culture. A further major step forward in the field of fire safety is the installation of an automatic fire detection and extinguishing system in the reactor block of the Research Reactor.

Developments and experiences:

2012-13 - Deployment of a new, intelligent fire alarm system at a site level (new centre, new network, new equipment)

- Relevant experience:

    - The main issue is the complexity of the site (a single site shared by multiple different facilities and organizations), and the lack of the person in charge for the system, which is discussed in later chapters.
- Conclusions/Feedback:
    - The retrofitting of protection was feasible and the continuous replacement of sensors is ensured.
    - Expansion of the system is also possible, missing sensors can be installed according to the NFSC requirement.
    - It is necessary to create a clear framework for those responsible for the different buildings integrated into the system, who and what they do in case of different problems.

2021 - New fire alarm and extinguishing system has been approved (installation expected in Q4 2023 due to lack of spare parts). The local (reactor unit) CO_2 extinguishing system is automatic and its display system is compatible with the existing fire alarm system.
The purpose of the conversion is to replace the obsolete manually operated reactor hall extinguishing system and the halon extinguishing equipment as required.
In its decision, No. 629/23/2003 of the National Directorate General for Disaster Management, Ministry of Interior allowed the Budapest Research Reactor to keep "halon" (halon 1211) fire extinguishers on standby after April 30, 2004.

2021 - Extension of the fire alarm system under the framework of the NSS's (National Security Surveillance) 'Data processing license application'.
Pursuant to section 2/A of Government Decree 491/2017. (XII. 29.) On the detailed rules of the administrative procedure for the licensing of the installation, commissioning and removal of built-in fire alarm and fire extinguishing systems:
'*It was not necessary to obtain a permit for the modification or extension of the existing fire alarm equipment, as the number of automatic detectors and manual call points was changed by a total of +1 in the calendar year in question, and the boundary of the signal zone did not change.'*
In the case of the confidential archives, only one sensor had to be connected to the existing fire alarm system, which did not cause any change in the boundary of the signal zone, and the relevant authorities were informed of the change.

- Relevant experience:
    - Taking into account the facilitation of the aforementioned legislation, it is much more easy and smooth to integrate a new detector or system element into a given system.

2022 – The required fire safety walk-downs/check-ups have been carried out at the end of 2022, during which multiple conclusions were drawn and corrective actions to be carried out were formulated such as the written request to clean up each area in the facility.

- Relevant experience:
    - The disparate activities of the territorially responsible persons (different departments) are to the detriment of the safety culture.
    - It had to be clarified in the regulations that the operational manager of the Reactor Department (plant manager, operating engineer) has the right of control and supervision also in the individual measuring halls and measuring points.
    - The regulations of the Reactor Department impose obligations on everyone (operator, user) to maintain a high level of safety.

- Feedback:

- o From the beginning of 2023, at the time of the PSR, an up-to-date fire safety analysis has been launched, which takes into account changes in national legislation, changes in technological systems and is based on the international recommendations 'WENRA Safety Reference Level for Existing Research Reactors - Protection against internal fires'. Based on the corrective actions identified in the analysis, the operator's fire safety activities should be improved.
- o It is necessary to share the report of the annual fire safety inspections with the heads of department.
- o Fire safety compliance is required in addition to annual refresher training.
- o Particular attention should be paid to the conduct and documentation of annual training sessions for different departments.

BME OR

The Training Reactor of the Budapest University of Technology and Economics (hereinafter: BME) is a light water moderated and cooled reactor of 100 kW nominal thermal power. The core consists of EK-10 type fuel assemblies, containing 10% enriched UO2 in metal magnesium matrix. The fuel region is surrounded by graphite reflector assemblies. The maximum thermal neutron flux in the reactor core is $2.7 \cdot 10^{12} n/cm^2s$. The main purpose of the facility is the training of young engineers and physicists. Furthermore, research projects are also carried out on the reactor and using the connected experimental devices. The reactor can also be used for the production of short-lived radioisotopes. Neutron and gamma irradiations can be performed using the vertical irradiation channels, horizontal beam tubes, the large irradiation tunnel and the pneumatic rabbit systems. Radiochemical laboratories and a hot cell support the training and research activities. The facility was designed by Hungarian engineers and physicists in the 1960's. For the design process, the experience gained during the operation of several critical assemblies, and the then 2 MW Budapest Research Reactor (originally designed by Soviet engineers), was effectively applied. The core first went critical in the summer of 1969 as a critical assembly at the BKR site, commissioning at its current location was in May 1971. The reactor is located at the Central Campus of BME.

Figure 1.3.2-2: Outside view on the BME OR

In 2016, the BME Training Reactor underwent a complete building renovation. During this process, the reactor building and all the rooms and laboratories in it received a new ventilation, air-conditioning and high-current system, and new, modern wall and floor coverings were installed.

During the design and installation of systems, both the designer and the contractor paid special attention to the fire protection rules. The high-current system was designed by a huge margin during the design that ensures its robustness and conservative nature. This means that, despite the fact that the only kW power consumer in the building is the furnace used for cremation of soil and grass samples - all the main cables belonging to the 230V network are capable of carrying many 10 kW of electric power. This approach also ensures that the occurrence frequency of cable fires is minimized.

Before the renovation began, the Licensee developed a task to remove any and all unnecessary temporary materials and equipment from the facility. Apart from the reactor block, the fresh fuel storage room, and the technological rooms, the Licensee removed most materials and unnecessary equipment from the building. Unnecessary material or equipment that might increase the risk of fire was not returned to the building after the renovation was finished, hence ensuring a safe working environment with minimized fire risk and adequate amount of spare spaces.

The reactor in the building has a maximum output of 100 kWth, but since it is mostly used for educational purposes, its typical output is the range of 0-10 kWth. The core of the reactor is located 5 m below the water surface, therefore the direct fire risk of the core can be considered negligible.

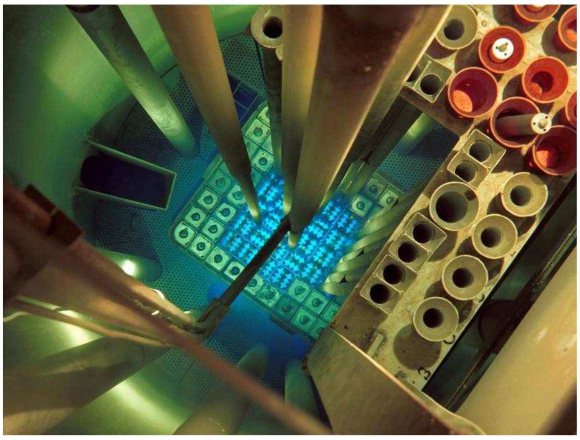
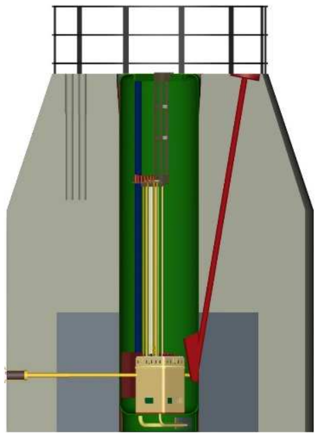

Figure 1.3.2 – 3: Reactor core as seen from above and the vertical section of the reactor core

There are several laboratories in the reactor building. There are ionizing radiation sources in these areas as well as in the vaults in the reactor hall. The typical activity of gamma-ray sources is in the range of 10 kBq, therefore they can be considered to not pose a significant radiation risk even in the case of a fire event. The radiation source storage located in the basement contains steel-encased neutron sources, as well as some more active gamma-ray sources. During the operation of the reactor, neutron activation analysis is rarely used, which involves the generation of radioactive material. If more significant (activity exceeding 100 kBq) is generated, then the radioactive material is stored in the open reactor vessel approx. below a 1 m water column.

There are chemicals in the radiochemistry laboratory (room 108), but only the most essential, minimum quantities of flammable chemicals are stored in this area, as it is strictly forbidden to store unnecessary amounts of chemicals in the laboratories in accordance with the Fire Protection Regulations.
There are also office spaces on the first floor of the reactor building, which contain a minimal amount of paper-based documents, but only those that are most necessary for everyday work.

According to the fire protection plans, the building consists of a single fire section. The plans describe the amount and type of fire extinguishers required based on the fire hazard class and the type of combustible materials, as well as the risk class. In the reactor building - in accordance with the purpose and classification of the given room - extinguishing devices with foam, powder and CO_2 gas are installed in quantities corresponding to the fire protection plans.

The reactor building's fire alarm systems transmit their signals to the Property and Institutional Security Department operated by the BME Chancery, and also generate a local alarm. Based on these, the front desk personnel providing the 24-hour porter service of the training reactor and the BME university dispatcher immediately call the operator on standby and call the national emergency number and initiate a fire alarm. Specialists of the Metropolitan Disaster Management take part in the annual emergency response exercises, in order to ensure that they are aware of the specifics and layout of the facility.

1.3.3 Fuel Cycle Facilities

Not applicable.

1.3.4 Dedicated Spent Fuel Storage Facilities (KKÁT)

The Spent Fuel Interim Storage Facility (hereinafter referred to as KKÁT), designed by the GEC Alsthom and licensed by the Hungarian Atomic Energy Committee on the 17th of February, 1997, is a Modular Vault Dry Storage (MVDS) type facility which provides storage of spent fuel assemblies stored in the spent fuel pools of units of Paks Nuclear Power Plant for a period of at least three years.

Figure 1.3.4-1: View of KKÁT

After expiration of the storage period of at least three years, the fuel assemblies are placed into a C30 type transport cask filled with water. When decontamination of the outer surface of the cask is completed, the cask is transported by railway into the storage facility. In the KKÁT, the transport cask containing the spent fuel assemblies is taken over in the reception bay where the cask is lifted out of the transport carriage and preparations are made for unloading the fuel assemblies.

Figure 1.3.4-2: Transport cask being on railway carriage in the KKÁT

The assemblies are lifted directly into the drying tube located above the transport cask. Before having lifted into the transporting machine, the assemblies are dried one by one in the drying tube. The assemblies are placed by the transporting machine into the vertical fuel assembly storage tubes located in the chamber. The fuel assemblies are stored in the storage tubes within an inert gas environment. The storage tubes are located in a concrete chamber which ensures sufficient shielding. The spent fuel assemblies are stored in dry condition. The decay heat removal is provided by a cooling system based on draught effect of the ambient air. The cooling air goes through among the storage tubes. The fuel assemblies do not directly contact with the air draft.

Figure 1.3.4-3: The cooling air is removed through the chimney

The storage facility ensures an interim storage opportunity of at least 50 years for the VVER-440 spent fuel assemblies. At the end of the interim storage period, the assemblies are relocated into an appropriate transport container in which they will be transported from the facility.

By means of design parameters of the storage facility, is the exclusion of reception of spent fuel assemblies stored in the spent fuel pool for a period of less than 3 years, as well as of ones which are known to be defective in terms of hermeticity and consequently closed in a hermetic casing is ensured.

Factors considered from fire protection aspect during design of the storage facility:
Considered factors leading to occurrence of external fires:

- Emergency, accidental fire event originated from surrounding industrial facilities.
- During air traffic, fire event originated from aircraft crash onto the KKÁT.
- During public road transport of hazardous materials, fire event originated from a public road accidents.
- Fire event occurring in surrounding forests, forest fire.
- Fire event occurred in a vehicle parking in a surrounding parking place.

During examination of the abovementioned fire events, it was stated, taking into account the fire distance, the safety distance and the operating range, that the abovementioned events have no realistically possible negative impact on nuclear safety of the KKÁT facility. Considering the levels of defence in depth (for additional information see item 1.4.3.):

- The KKÁT facility has been designed so that its structure consisting of steel and concrete ensures avoidance of the occurrence and spreading of more significant fires. Except for cables located in switchboards and on cable trays, there are limited quantities of combustible material in the KKÁT and the quantity of combustion feeding materials located in the building is negligible. The steel structures are equipped with passive fire protection system, fireproof coating. (Prevention of occurrence of fire cases: control of combustible material).
- During design of the electrical equipment of the KKÁT, the national legislation and standards have been considered. (Prevention of occurrence of fire cases: control of ignition source).
- In order to operate the technological systems of the KKÁT, it is not necessary to perform hot works. (Prevention of occurrence of fire cases: control of hot works).
- After the reconstruction performed in 2018, the existing fire alarm system in the KKÁT facility has been replaced and modernized with a Siemens fabricated analogue addressable fire alarm centre with 4 indicating loops, optical smoke detectors, air duct detector, manual signal transmitters, acoustic signalling devices, control and monitoring modules. (Detection and extinguishing of fire cases as quickly as possible: built-in fire alarm equipment).
- Due to the relatively small quantity of combustible materials in the KKÁT, it was not necessary to provide sprinkler system automatic fire extinguishing equipment or ones operating with water spray, water-mist, otherwise extinguishing with water and water spray, respectively in areas containing spent fuels is forbidden by prescriptions of the modern nuclear fire protection legislation. However, manual fire extinguishing devices are available at the whole facility site. (Detection and extinguishing of fire cases as quickly as possible: fire extinguisher).
- The KKÁT facility is divided into 3 fire sections by means of installation of fire retardant doors, motor-operated flap valves and fire barriers.

Fire safety improvements:
Within the operating period of 25 years elapsed since commissioning of the KKÁT in 1997, there were two periodical safety reviews in 2007 and 2017, furthermore one targeted safety review (stress test) was performed in 2016 which was required after the nuclear accident of Fukushima in 2011. Summarizing, the following findings have been made:

- During the periodical safety review, there was a task, among others, to justify that the fire safety of the already operating facility complies with the requirements prescribed in Chapter III *„FIRE PROTECTION REQUIREMENTS OF INTERIM DRY STORAGES OF SPENT NUCLEAR FUEL ELEMENTS”* in Attachment 1 of the ÖTM Order No 19/2007. (VIII. 29.) about special fire protection requirements related to application of nuclear energy and about the way of enforcing such requirements during activities of authorities [A21], which had been come into force in the meantime. This is the exclusive domestic fire protection regulation related to nuclear energy. The result of this task is that the requirements prescribed in the Decree are complied with by the facility. The requirements of the Decree were incorporated into the Fire Protection Regulation of the facility.

The concepts and tasks of the fire safety, the defence in depth and the fire hazard analysis were first presented in this Decree as part of the domestic nuclear fire protection requirements. The Decree has been replaced by the Decree 5/2015 (II.27.) of the Ministry of Interior. [A17] and its annexes, the Nuclear Fire Safety Code (NFSC), it has not changed fundamental principles of the Decree, only clarifications were issued.

- During the targeted safety review, the task was to study and assess how the KKÁT is protected against external hazards, to particularly specify the beyond design basis margins. Among others, the impact of extremely high temperature, forest fire, aircraft crash with fuel fire, etc. on the facility was studied and uncontrolled release of liquid radioactive wastes was assessed as part of the analyses. The KKÁT's Targeted Safety Review concluded that the facility has sufficient safety margins which to ensure compliance with the changed requirements, and the new regulations prescribed, after the Fukushima Daiichi accident.
- All of the three safety reviews stated that the fire safety of the facility operating for 25 years meets today's relevant requirements.

During the KKÁT's operating period of 25 years, a reconstruction was performed in 2018 on the built-in fire alarm equipment of the facility, due to the following reason:

- The manufacturer support of the KKÁT's built-in automatic fire alarm system, operating with a central unit of Siemens AlgoRex CI1145 ceased in March, 2018, including the detector, device and parts supply, as well as the technical support, therefore, the Licensee decided to perform a full reconstruction. The reconstruction was carried out in the same year.

Experience utilization and feedback:
The results of the safety reviews, as well as of the reconstruction of the built-in fire alarm equipment were presented towards the stakeholders and parties concerned within the frame of the annual fire protection trainings.

1.3.5 Waste Storage Facilities

Not applicable.

1.3.6 Facilities under decommissioning

Not applicable.

1.4 Defence in depth principle and its application

To enhance fire safety the principle of defence in depth is the basic and fundamental principle. Defence in depth is to prevent fires from starting, to detect and extinguish them as quickly as possible to mitigate damage, and to prevent the propagation and spreading of fires that have not yet been extinguished, so that their effects on the nuclear facility, and on the functioning of such facilities are minimised, i.e. to allow for the correction and compensation of defects at several interlocking levels of protection before they lead to serious consequences, thus preventing malfunctions from occurring with a high level of probability. Defence in depth is an interrelated set of technical solutions and measures in which the fire safety principle is achieved even if any of such solutions and measures proves ineffective.
The defence in depth principle is aimed to be met at two levels in the NAR. Firstly on the level of requirements, meaning that proper regulations are in place to ensure compliance with the principle and the international standards presented at the beginning of each sub-chapter, and secondly through the means of the actual practical approaches and technical solutions described for the different facilities.

1.4.1 Nuclear power plants (PAE)

WENRA	Hungarian regulations	
	Nuclear Safety Codes	**Nuclear Fire Safety Codes**
SRL SV 5.2: „The licensee shall implement the defence in depth concept for protection against internal hazards. This shall include provisions to prevent the occurrence of events induced by internal hazards, to detect these events and, if relevant, control and/or mitigate their consequences;”	„4.13.0.0200. To ensure fire protection of the operating nuclear power plant defence in depth shall be applied to provide the following tasks: a) prevention of fire; b) prompt detection and quick extinguishing of fires already developed in order to mitigate damages; also c) prevention of the spread of fires, thereby minimising their effects that jeopardise safety functions.”	“Annex I. Chapter I. 1.4. In order to increase fire safety, the principle of defence in depth, minimizing the possibility of fire origination and fire spread, including the spread of smoke and toxic combustion products, must be considered as a basic principle in planning.”

Correspondingly to the national and international regulations the concept of defence in depth is implemented through the following means in the PAE:

- **prevention of the occurrence of fires**

A set of technical and administrative measures have been taken to prevent fires. Pieces of the national legislation and the power plant's regulations limit the quantities of combustible materials, restrict ignition sources, regulate activities that may pose a fire hazard, and regularly monitor the compliance with the rules of operation by both the authorities and the operators. It is a specific requirement, for example, that when furniture in the process-related rooms is being replaced, only pieces of furniture made of certified "flame retardant" materials may be purchased.

- **prompt detection and quick extinguishing of fires in order to mitigate damage**

In process facilities, a practically complete fire alarm system was established, taking environmental impacts into account. In consideration of the parameters of combustible materials in the area, water, foam and gas extinguishers are installed.

- **prevention of the spread of fires that are not yet extinguished, thereby minimising their effects on the functioning of the facility**

Prevention of the propagation and spreading of fires in the process rooms of the nuclear power plant is a requirement in the relevant national legislation. The fire resistance parameters of buildings and structures within the area are regulated in the general fire safety requirements. The requirement for special nuclear fire protection is regulated in specific pieces of legislation. The same legislation also sets out, for example, requirements for fire doors and windows as well as requirements for the design of fire cells. These subjects are addressed in detail in later chapters of the NAR.

1.4.2 Research reactors

	Hungarian regulation	
WENRA	**Nuclear Safety Codes**	**Nuclear Fire Safety Codes**
WENRA SRL S 1.1: "The licensee shall implement the defence in depth principle to fire protection, providing measures to prevent fires from starting, to detect and extinguish quickly any fires that do start and to prevent the spread of fires and their effects in or to any area that may affect safety".	5.2.15.0100. Such systems, structures and components shall be designed for the operation of the research reactor that ensure timely detection of any potential fire or explosion and mitigation of its consequences." 5.2.15.0200. During the installation of systems, structures and components the physical separation of the systems, structures and components important to nuclear safety shall ensure the ineffectiveness of the consequences of a fire or explosion should such an event occur on the redundant systems, structures and component, or on other systems, structures and components important to nuclear safety.	"Annex I Chapter II. 1.4. In order to increase fire safety, the principle of defence in depth, minimizing the possibility of fire origination and fire spread, including the spread of smoke and toxic combustion products, must be considered as a basic principle in planning."

Correspondingly the concept of defence in depth is implemented through the following means in research reactors:

BKR

The concept of defence in depth in relation to fire protection for research reactors covers the following areas;

- Administrative and technical rules and regulations have been introduced to prevent fires, in line with the fire safety regulations of the premises and the institution. The regulations minimise the likelihood of fire occurring and control activities that may give rise to a fire hazard. The regulations control the execution of regular inspections both the authorities and the operators. For example:
  - A new requirement that is being introduced is that only superstructures or furniture made of 'non-combustible' materials may be procured when replacing installed equipment or furniture in the reactor hall;
  - No combustible material is stored in the technological premises.
- It is also in the licensee's interest to detect and extinguish fires as quickly as possible. A complete fire detection and intelligent fire alarm system is installed in the central building and in the technological facilities, taking into account the combustible materials installed and/or stored in the area and the environmental effects.

- For fire extinguishing, water extinguishing and gas extinguishing fixed and manual extinguishing systems are installed, taking into account the parameters of the combustible materials in the area.
- Preventing the spread of unextinguished fires in order to minimise their impact on the safety functions of the reactor itself and the interim on-site spent fuel storage. The specific fire safety requirements for the use of nuclear energy are regulated in specific legislation. The regulation also lays down the concept of defence in depth and the procedure for categorising systems performing a safety function in a safety class. These include the requirements for fire retardant doors and windows and the requirements for the design and maintenance of fire sections.

In order to maintain fire safety, the concept of defence in depth, minimising the possibility of occurrence and spreading of fire, should also be taken into account as a basic principle during operation.

In the preparation of the Nuclear Fire Safety Codes for the Budapest Research Reactor, particular attention was paid to the specific requirements of fire safety due to the use of nuclear energy. The requirements of Decree 5/2015 (II.27.) of the Ministry of the Interior [A17], the latest PSR-based test results and the new Fire Safety Analysis should be used as a basis for the new fire safety codes. The licensee shall operate systems and components important for nuclear safety in such a way that the frequency and effects of fire are minimised. The amount of flammable materials and potential sources of fire are controlled to prevent fires. The rules and procedures are set in the fire safety specifications, the control of the areas is the responsibility of the users and operators on a daily basis, the enforcement of the rules is the responsibility of the operators on duty, and in the longer term it is the responsibility of the management, which is documented by the operator during the annual walk downs. Non-compliances should be forwarded to the relevant area managers.

The spread of fire is prevented by fire-resistant (90-minutes) door(s) installed at the fire section boundary, as well as by properly sized and designed building structures in accordance with the regulations. In the basement of the building, a fire damper is installed in both main branches of the technological ventilation system. An additional barrier against the spreading of fire is the use of fire resisting walls used in cable tunnels and the properly designed and documented sealing of the passages.

The components of the defence in depth:
Technical protection equipment, systems and organisational (administrative) measures necessary for **fire prevention** are used:

- planned technical maintenance in the internal rules,
- exclusion of combustible materials from the premises,
- compliance with the rules on premises,
- compliance with storage requirements for chemicals,
- an adequate frequency of internal audits.

Installed heat and smoke detectors ensure the quickest possible **detection of fires** through their central fire alarm system and their display to the operational staff of the Reactor Department, as well as to the armed security guards system supervisors on 7/24-hour duty. In terms of technical solutions the detection of fires are ensured through:

- installed heat and smoke detectors,
- built-in automatic operating fire dampers,
- gas detectors.

Early **fire suppression** is ensured through:

- natural, technological, and a ventilation system latched to charging of the batteries,
- hand-held fire extinguishers.

Fire barriers have been installed to **delay and prevent the spread of fires**;

- Fire doors (8 pcs) to ensure the interoperability of the surfaces at the fire section boundary,
- Fire dampers (2 pcs) installed at the fire section boundary of the basement supply systems,
- Fire resisting walls in cable rooms.

BME OR
In order to maintain fire safety, the principle of defence in depth and the minimization of the possibility of fire ignition and fire spread must also be taken into account during operation. During the preparation of the fire protection regulations of the BME Training Reactor, special attention must be paid to the specific requirements of fire protection related to the use of nuclear energy.
In summary the defence in depth concept in the case of the BME OR training reactor consists of similar elements as in the case of the other nuclear facilities operated in Hungary:

- **Fire prevention:** Prevention of fire via administrative and engineering means and regulations which are in compliance with the internal fire protection requirements of the BME University. As part of this item the BME NTI (Institute of Nuclear Technologies – the operator organization of the reactor unit) issued and continuously updates its internal Fire Protection Regulation in order to minimize the probability of occurrence of fire cases and regulates activities that would increase this probability. The code sets the rules for scheduled inspections and walk-down and the means of fulfilment of the relevant regulatory requirements. In the BME OR facility it is ensured that SSCs relevant for nuclear safety are designed and operated in a manner that minimizes fire ignition probability. In order to prevent the occurrence of fires the amount of flammable and combustible materials are also minimized (e.g.: paraffin bricks for neutron radiation shielding, flammable furniture, paper, etc.).
- **Fire detection and alarm:** Within the reactor building, taking into account the stored or installed combustible/flammable materials and the possible environmental effects, a full scope fire detection and alarm system is installed.
- **Early fire suppression:** Adequate fire suppression and firefighting abilities within the facility was ensured via the selection of proper hand-held and portable fire extinguishers.
- **Delay or prevent spreading of fire**: Mitigation of consequences and spreading of fires that were failed to be suppressed in the early stages is ensured through complying the relevant national regulations, which sets the rules of protecting safety related SSCs as well as the rules for their classification.

The local Fire Protection Regulation of the BME OR facility setting the rules on the application of the defence-in-depth principle is based on the requirements set in the NFSC and will be updated based on the results of the PSR and the fire risk assessment currently under development.

1.4.3 Waste and spent fuel storage facilities (KKÁT)

WENRA	Hungarian regulation	
	Nuclear Safety Codes	**Nuclear Fire Safety Codes**
S-30: The licensee shall make design arrangements for fire safety on the basis of a fire safety analysis and implementation of defence in depth (prevention, detection, control and mitigation of a fire).	-	"Annex I. Chapter III. 1.4. In order to increase fire safety, the principle of defence in depth, minimizing the possibility of fire origination and fire spread, including the spread of smoke and toxic combustion products, must be considered as a basic principle in planning. 8.3. The fire protection design of a technological facility must be based on those determined by the fire risk analysis."

Application, in the KKÁT facility, of the principle of defence in depth is regulated by the domestic decrees mentioned in item 1.3.4. During activities, especially the technological ones, performed in the facility the principles, levels of defence in depth are considered, consequently the fire risk is minimized and the opportunity of occurrence of fire cases is impeded, in order to avoid release of radioactive materials. In order to realize it in the practice, in accordance with the non-nuclear national fire protection legislation, so called Fire Protection Regulation has been developed. The local Fire Protection Regulation fits into the integrated management system of the Licensee, also taking into account the prescriptions determined in the Nuclear Safety Code which specifies the requirements on the application of each level of defence in depth.

As the first level of defence in depth, in order to prevent occurrence of fire cases, the Licensee controls the presence of:

- combustible material,
- ignition source, and
- hot works.

During control of combustible material:

- the combustible materials / mixtures, transportation, usage and storage of which is subject to authorization, are separately handled. Also, the requirements determined in the safety data sheets have to be taken into account during the authorization procedure;
- the combustible wrapping/coating materials, devices, auxiliary materials, by default, are not allowed to be transported into the area of the facility. However, in justified cases (for example, when they serve as equipment protection) they are allowed to be transported into the area, but they have to be registered;
- Logged transient combustible materials (for example, materials, papers, etc. needed for office and social activities) are not required to be authorized.

During control of ignition source, the Licensee handles separately:

- the prohibition of smoking and open flame use (except for execution of non-regular hot works);
- the rotating, frictional parts, by means of complying with the fire protection rules;
- the usage of mobile heating devices, by means of complying with the fire protection rules;
- the usage of electrical equipment, by means of complying with the fire protection rules;
- the operation of lightning protection equipment, by means of complying with the fire protection rules.

In order to control the activities involving fire hazard:

- a non-regular activity involving fire hazard is solely allowed to be performed with a permit issued by the Licensee and based on the terms and conditions determined in such permit.

As the second level of defence in depth, in order to detect and extinguish the fire cases as quickly as possible:

- built-in fire alarm equipment is operated, and,
- manual fire extinguishing devices are available and ready to be used.

As the third level of defence in depth, in order to prevent the spreading of fires not yet extinguished:

- the technological facility is divided into fire sections, fire retardant doors, motor operated flap valves/fire dampers and fire barriers are installed.

In the facility, **in order to keep the fire risks at a minimum level** and to maintain the fire protection system in a good technical condition, regularly inspected, reviewed and maintained (repaired, if necessary) built-in fire alarm equipment, fire extinguishing devices, equipment ensuring fire-retardant sealing and technical (electrical, mechanical, pressure, etc.) equipment are operated, furthermore, safety signs complying with the relevant legislative requirements are installed.

1.4.4 Fuel cycle facilities

Not applicable.

1.5 Content of the NAR

The defence in depth principle is aimed to be met at two levels. Firstly on the level of requirements, meaning that proper regulations are in place to ensure compliance with the principle and the international standards presented at the beginning of each sub-chapter, and secondly through the means presented for the different facilities.

During the gap analyses of the Hungarian legal and regulatory framework no gaps were identified and it was concluded that the current regulations are in line with the expectations of the WENRA RLs regarding the defence in depth principle and its utilization.

At all facilities within the scope of NAR the principle of defence in depth, in line with the national and international practice, is implemented in three layers:

- the prevention of fire
- the timely detection of fire and early extinguishing of it
- the control and mitigation of fire to prevent its spreading and minimize its effects.

During the regulatory assessment of the answers provided by the licensees non-compliances were not identified and the answers were found to be satisfactory and in line with the content and scope requested by the technical specifications.

2 FIRE SAFETY ANALYSES

Fire safety analyses are an important part of a nuclear installation's safety demonstration. The term fire safety analysis covers both deterministic fire safety analyses such as a Fire Hazard Analysis (FHA) and probabilistic fire risk analysis (called Fire PSA). This approach is applied to NPPs and, where appropriate according to a graded approach, to research reactors and spent fuel storage facilities.

2.1 Nuclear power plants (PAE)

	Hungarian regulation	
WENRA	**Nuclear Safety Codes**	**Nuclear Fire Safety Codes**
SV 6.1 „ A fire hazard analysis shall be developed on a deterministic basis, covering at least: • all plant operational states of normal operating and shutdown, a single fire and consequential spread; • any plant location where fixed or transient combustible material is present; • credible combinations (see RL E6.1) of fire and other events (including external hazards). The deterministic analysis shall be complemented by PSA in order to evaluate the fire protection arrangements and to identify risks caused by fires. SV 6.2: The extent of reliance on on-site or off-site fire brigades shall be shown to be adequate in the fire hazard analysis. E 6.1: Credible combinations of individual events, including internal and external hazards, that could lead to anticipated operational occurrences or design basis accidents, shall be considered in the design. Deterministic and probabilistic assessment as well as engineering judgement can be used for the selection of the event combinations.	3.2.2.3200. All realistic combination of the individual occurrences shall be considered during design, including external and internal events, which may lead to DBC4 or DEC plant states. The event combinations to be taken into account in the design shall be selected by taking into account both engineering considerations and probabilistic analyses. 4.13.0.0310. A fire risk analysis shall be carried out and updated in order to demonstrate that: a) the fire safety goals are met, b) the fire safety planning principles are fulfilled, and c) the planning of fire protection measures is satisfactory, and all required administrative measures have been properly identified. 4.13.0.0320. The fire risk analysis shall be carried out on a deterministic basis, during which at least the following shall be taken into account: a) the start of a single fire in every normal operating and shutdown condition and its spread to places where the presence of any flammable material is possible for a long time or temporarily, b) plausible combinations of fire and postulated initiating events occurring independently of any fire. 4.13.0.0340. The safety impact of fires shall be evaluated also with level 1 probabilistic safety analysis. The analysis shall examine the contribution of accidental fires on the site and within the rooms of the nuclear power plant to core damage frequency.	Annex I Chapter I 8.1. The fire risk analysis must be prepared on a deterministic basis. … The fire risk analysis must also be prepared in relation to the operating nuclear power plant during the transformations that affect safety, as well as during the mandatory safety reviews. 8.5. Aspects of the preparation of the fire risk analysis: … c) determination of the probable fire events in all nuclear power plant operating conditions, which may affect nuclear safety through unintended operation and through the inoperability of the equipment … h) quantifying the fire risk, determining the frequency of zone damage resulting from fires as initial events i) analysis of the results, determination of the most frequent event chains. Based on this, the justified plan changes, or development of additional measures that reduce fire risk in accordance with the ALARA principle, …

2.1.1 Types and scope of the fire safety analyses

The deterministic fire risk analyses were made within the scope of Units 1 to 4. The analyses cover the nuclear power plant's units operating at full power, as well as operational conditions at low power and shutdown states of the reactor.

Regarding the probabilistic safety assessment the following PSA models were developed at the PAE:

- Level 1 PSA model for full-power POS for each unit, which takes into account internal initiating events, internal hazards (fire/flooding) and external hazards.
- Level 2 PSA model for full-power POS for each unit, which takes into account internal initiating events, internal hazards (fire/flooding) and external hazards.
- Level 1 PSA model for the full-power spent fuel pool POS (POS with the higher thermal power output, right after refuelling) at each unit, which takes into account internal initiating events, internal hazards (fire/flooding) and earthquake.
- Level 1 reactor PSA model for low-power and shutdown POSs for each unit, which takes into account internal initiating events, internal hazards (fire/flooding) and external hazards.
- Level 2 reactor PSA model for low-power and shutdown POSs for each unit, which takes into account internal initiating events, internal hazards (fire/flooding) and external hazards.
- Level 1 PSA model of the spent fuel pool for each unit, which takes into account internal initiating events, internal hazards (fire/flooding) and earthquake.

2.1.2 Key assumptions and methodologies

Deterministic fire risk assessment for Units 1 to 4

From 1997 to 1998, a comprehensive fire risk analysis was made for Units 1 to 4 of the Paks Nuclear Power Plant, based on the requirements in section 307 of Safety Series No. 50-SG-D2 (Rev. 2), Fire Protection in Nuclear Power Plants. The project has set 6 separate objectives for the fire risk analysis:

- Identification of components important from the perspective of safety.
- Analysis of foreseeable fire developments and of the consequences of fires in relation to safety-relevant components.
- Determination of the required fire resistance limit for fire barriers.
- Specification of the type of fire alarms and protection equipment to be installed.
- Identification of cases where additional fire separation or fire protection is required, in particular in the event of common cause failures, in order to maintain the overall function of components during and after a real fire.
- Demonstration that the objectives set out above are met, the safety systems performing fundamental safety functions shall be protected against the consequences of fire, the single failure criterion is met, etc.

Out of the several methods applicable for fire risk analysis, the FIVE (Fire Induced Vulnerability Evaluation) method developed by EPRI in 1991 was selected. Based on conservative assumptions and a plant-specific database, the FIVE method is a screening procedure used in the nuclear industry to assess fire events. Its purpose is to identify the operating equipment, cables and components that are necessary to achieve a safe shutdown and to prevent damage to the core during shutdown. The method takes into consideration all areas of the plant and focuses on the elements needed to achieve a safe shutdown without the plant being damaged by a potential fire.

The main steps of the fire risk analysis were the following:

- Identification of components important from the perspective of safety. Based on the Level 1 PSA model, the range of systems required for a safe shutdown in the event of a fire has been defined as those systems required to shut down and keep the reactor in what is called 'hot shutdown state', as such systems are sufficient to keep the reactor in a stable, safe state for 24 hours after a fire.
- Determination of the fire resistance limits for fire barriers.
- Specification of the type of fire alarms and fire protection equipment to be used.

- Identification of premises where a safe shutdown is still possible in the event of a potential fire, on the assumption that all equipment located there will be rendered inoperable.
- Identification of premises where a safe shutdown is impossible in the event of a potential fire, on the assumption that all equipment located there will be rendered inoperable.
- Probability calculation of the unavailability of redundant/alternative systems for the premises remaining after the above screening.
- Developing a COMPBRN IIIe fire model for the rooms not screened out. The performance of the COMPBRN calculation required very detailed knowledge of the premises: the inclusive dimensions of the room, the location of openings, the spatial location of cable trays, a survey of combustible materials in cable trays and an assessment of other combustible materials and ignition sources served as input data for the computer code. Dozens of fires were run in the course of the analysis. Each cable tray (or electrical cabinet) was taken once as an ignition source and once as an object jeopardised by fire. In each case, a temperature distribution as a function of time is generated to determine the time needed to damage the cables (227ºC). The time needed for damage to the cables was compared with the expected time of detecting and extinguishing the fire. A distinction was made between early damage of the modelled objects, when the available active fire protection tools cannot prevent the damage caused by fire, and 'late damage'.
- Development of a proposal for the 'critical' premises where the fire frequency causing damage remains above the screening limit (1.00E-06/reactor year).

Between 2000 and 2002, when the new reactor protection system was installed, the fire risk analysis of the units was reassessed. The set of systems needed for a safe shutdown did not change with the reconstruction of the reactor protection system which focused primarily for the replacement of the old I&C components. During reconstruction, some of the old reactor protection systems were completely eliminated while other systems were decommissioned only partially. The decommissioned elements as inputs were deleted from the FIVE database, while the components of the new reactor protection system were included as new input data in such database. Another change was the change in the fire load of affected premises.

The turbine hall was not the subjected to the comprehensive fire risk analysis for Units 1 to 4 because it was assessed in detail in a previous analysis carried out in 1993, therefore, only the results of the previous analysis were included. The objective of this previous analysis was to investigate what fires may start in the turbine hall, to identify the characteristics of large-scale fires and to calculate, by fire modelling, the fire load on the roof structure. The analysis was carried out using the HAZOP method. Large-scale fires resulting from oil spills have been identified as a major fire hazard source. The frequency of events leading to oil spill was calculated using the fault-tree method, while the probability of potentially emerging fires was calculated using an event tree. The combination of these were used to carry out a consequence analysis to investigate the impact of a large-scale fire. The results shown that a large-scale fire would result in the collapse of the roof structure.

Figure 2.1.2 – 1: Turbine hall of the PAE

Due to the significant cost implications of the passive protection of the roof structure, a new fire risk analysis was made in 1996. The objective was to reduce the impacts of potentially emerging fires through various interventions and to study consequences by means of more accurate fire modelling. The analysis was again based on the HAZOP method, with a new fault-tree and event-tree analysis. In the consequence analysis, the effects of fires of different extents were first investigated using the CFAST fire model, and then the temperature distribution in the hall was calculated using a more accurate gas dynamic fire model (CFD).

The temperature distribution due to the transient flows generated in the event of a potential fire scenario was modelled via a CFD gas dynamics fire model. The results showed that, at certain fire intensities and durations, the maximum gas temperature at the main parts of the roof does not exceed 200 °C for the structural elements.

The risk calculations carried out have shown that, if the measures considered absolutely necessary are implemented, the frequency of a large-scale fire is reduced to 5.5E-06, which is below the reasonable risk level acceptable in industrial practices.

The measures considered absolutely necessary to reduce the impact of fires (and their implementation) were the following:

- installation of water mist extinguishing equipment (completed, the systems were designed in consideration of the requirements of single failure tolerance),
- coordinated movement of scan-doors and smoke deflectors (completed),
- installation of a closed-circuit television network (it was installed),
- additions to the instructions about emergency recovery (completed),
- passive protection of cable ducts (installed along the riser cable routes pertaining to safety systems).

The IAEA's Safety Standards Series No. NS-G-2.1.1 Fire Safety in the Operation of Nuclear Power Plants, Chapter 4 specifies that a periodic review of the plant fire risk analysis is required.

The **revision of the fire risk analysis** was carried out **between 2015-2017** based on the supplement of the improved EPRI FIVE method (improved based on NUREG/CR-6850) to analyse the shutdown plant operational state of the reactors and on the deterministic fire risk analysis methods for the analysis of radioactive releases.

For power operation, the analysis method is essentially the same as the previous fire risk analysis method, except for some changes resulting from methodological developments. In the low power and shut down POSs the application of the EPRI FIVE method requires the set of systems included in the analysis to be extended. The reasoning for this approach is that two groups of systems/equipment, namely the PTI (Plant Trip Initiator) and SSE (Safe Shutdown Equipment), had to be taken into account in the analysis when it is carried out for low power and shut down POSs. In low power and shut down POSs, neither the PTI elements, nor the emergency shutdown elements of the SSE set play a role because the unit has already been shut down or is under shutdown (e.g.: the dropping of control rods cannot fail if the control rods are already in the core in the POS).

On the other hand, by analogy with the PTI, it is necessary to analyse the systems whose failure or malfunction, in addition to the shutdown of the reactor, necessitates a change in the system configuration in order to maintain a safe state. By analogy with the PTI, the analyst uses the category PSDTI (Plant Shutdown Transient Initiator), which is a category of such system/equipment failures due to fire that cause a malfunction during a shutdown. The PSDTI for a reactor in shutdown mode includes the failures that require some system configuration change to put the unit to a safe state. These failures can usually be failures inhibiting system function within such systems that ensure normal heat removal or subcritical conditions.

Similarly, what are called SCE (Safe Cooling Equipment), i.e. systems/equipment performing the function of safe cooling during a shutdown, have to be found by analogy with the SSE and analysed. This can be a different set of SSCs for each operational state of the plant, depending on how Unit parameters behave in one or another POS, on what the success criteria for maintaining safe operation are, and on the available system configuration affected by the dynamic maintenance process. Note here that SCE systems/equipment are not identical with equipment or systems providing normal heat removal during shutdowns, they should be included in the PSDTI group. SCE systems/equipment are systems/equipment providing alternative heat removal in case of loss of normal heat removal systems or of systems/equipment ensuring subcritical state, or systems/equipment ensuring subcritical state.

As soon as the shutdown PTI (PSDTI) and SCE elements are identified, and the frequency of fires in each fire stage, depending on the POS, is defined, the FIVE analytical steps are identical with the FIVE analytical steps for a unit operating at full power.

The application of EPRI's FIVE method to the analysis of the risk of radioactive releases caused by fire:
SIE - Safe Isolation Equipment are systems/equipment with a safe containment function and SCPCE - Safe Containment Pressure Control Equipment are systems/equipment that control the safe containment pressure. The latter includes all systems and equipment designed to protect the integrity of containment, such as sprinkler systems, emergency hydrogen recombiners, and in some cases, bubbler condenser trays, whose functioning is not affected by fire but are not guaranteed to succeed without a sprinkler.

As soon as SIE and SCPCE elements are identified, and are included in the qualitative criteria of filtration, the further FIVE analytical steps are identical with the FIVE analytical steps for a unit operating at rated power.

Probabilistic fire safety analysis of Unit 1 - 4.

In the probabilistic safety assessment the fire hazard is considered as a hazard that may lead to initiating events including multiple failures due to the damages caused by the fire. A general and initial assumption in the fire PSA is that if the occurrence of a fire is assumed in a fire cell (e.g.: room or electric cabinet) then the loss of any and all equipment within that section is also assumed. If the risk of losing any and all equipment within a fire section is significant that further and detailed analysis is carried out in order to reduce unreasonable conservativism. Firefighting and fire suppression systems are not considered within the models themselves, but the approach described in NUREG 6850 (in the case of automatic systems) or in NUREG 2169 (in the case of fire detection and firefighting units as a whole) is followed for the specific scenario and a fire suppression probability is calculated. The occurrence frequency of initiating events arising from fire hazards is calculated as the product of the fire occurrence frequency and fire suppression probability. The spreading of fire during a scenario is considered in the PSA models. The exception from this rule are rooms and areas separated by fire barriers and if the adequacy of these equipment as well as their closed state was confirmed during the dedicated walk-downs. The fire spreading frequency in other cases were calculated as the product of the sum of all occurrence frequency of fires in a fire section and the probability of spreading into neighbouring section. In the case of spacious rooms (e.g.: turbine hall) the probability of fire spreading is determined based on the size of a certain fire section, the assumed speed of fire spreading and the reaction time for the firefighting units to arrive at the location. These values were set by expert judgement based on the experience and information collected during dedicated walk downs.

2.1.3 Fire phenomena analyses: overview of models, data and consequences

Deterministic fire risk assessment, Units 1 -4

The residual deviations from the deterministic analysis were subsequently processed in the fire safety chapter of the Periodic Safety Review carried out on a 10 year basis, and the technical measures to address the residual risks were developed accordingly.

Detailed analyses of units 1 to 4 were made for the following areas:

- Reactor plant - building,
- Longitudinal and transverse electrical galleries,
- Diesel generator building,
- Transformer station,
- Turbine island,
- Unit-centred specific zones,
- Common fire zones of installations I and II.

Assessments:
The rooms assessed

Type	Fire zone	Unit 2	Unit 4	Unit 3		Unit 1	
RE	Reactor building	309	321	294		284	
EE	Electric gallery	202	198	204		207	
DE	Diesel generator building	62	27	24		62	
TR	Outdoor transformers	5	5	5		5	
TGH-III	Turbine island, Unit 3			36			
TGH-IV	Turbine island, Unit 4			50			
VK-II	II. Auxiliary building			120	Shared Units 3 and 4		
SV-II	Demineralised water tanks II.			6	Shared Units 3 and 4		
VKM-SZE/II	Water extraction equipment II. Filter house			13	Shared Units 3 and 4		
TGH-II	Turbine island, Unit 1					30	
TGH-II	Turbine island, Unit 2					55	
VE-I	I. Auxiliary building					130	Shared Units 1 and 2
SV-I	Demineralised water tanks I.					7	Shared Units 1 and 2
VKM-SZE/II	Water extraction equipment I. Filter house					21	Shared Units 1 and 2
VKM-VE	Water extraction equipment Control room					40	Shared Units 1 - 4
HGH	Chiller building					16	Shared Units 1 - 4
TSZ-I/1	Firewater pump station I/1					3	Shared Units 1 - 4
TSZ-I(12 bar)	Firewater pump station I/12 bar)					3	Shared Units 1 - 4
DTSZ	Firewater pump station for the diesel generators					3	Shared Units 1 - 4
KCS	Outdoor cable channels					101	Shared Units 1 - 4
Total		**578**	**551**	**752**		**967**	

Note: the sequence in the table means the chronology of assessments.

Data collection of assessments was done as detailed below:

- *Identification of systems required for safe shutdown:* in previous analyses, systems required for safe shutdown and cooling were considered. For Units 1 to 4, those systems have been updated and supplemented with systems for cooling during prolonged shutdown (24 hours) (residual heat removal) and systems serving to prevent radioactive releases exceeding (reaching) the public dosage limit.
- *Selecting SSCs necessary for safe shutdown*: the examined safety SSCs of units were selected using the power plant's PSA model.
- *Cabling* was assessed according to the power plant's cable database and specified on site via walk-downs:
    - o The cables belonging to different safety systems follow separate routes and mixing/common routes of redundant systems should in principle be avoided.
    - o Cable spaces in the power plant can also be classified as part of a safety system. The cables belonging to the safety system in question are usually routed in these rooms. This means that in the event of a fire in a given room, only one of the three redundant safety systems can be damaged.
    - o For technical cabling reasons, it was necessary to include cables belonging to a different system in the cable compartment of a given safety system. In such cases, the cables

of the two safety systems run along separate routes on separate support structures. Cables whose safety system differs from the classification of the premises have been equipped with a fire protection enclosure/coating.

- The parameters of fire sections have been taken into account.
- The need for compliance with the principle of defence in depth has been taken into account.
- The built-in fire protection systems have been taken into account.

In the analysis, full power, low power and shut down operational states were studied and:

- Compliance with national legal requirements was assessed.
- The interaction between safety systems has been assessed.
- The impact of active fire protection systems has been assessed.
- The impact of passive fire protection systems has been assessed.
- The impact of ventilation systems on fire spreading has been assessed.
- The risk of radioactive releases resulting from fires has been assessed.
- A separate assessment of the previous HAZOP study of the turbine hall was carried out.
- Those premises not screened out during the study where residual deviations from boundary conditions were identified were assessed and recommendations were made to address those deviations.
- The residual deviations from the deterministic analysis were subsequently processed in the fire safety chapter during the Periodic Safety Review, and the technical measures to address the residual risks were developed accordingly.

Probabilistic Fire Risk Assessment of Units 1 to 4

In the Fire PSA, the effect of fires of internal origin was taken into account. The ignition of the fire and the fire within the fire section was considered as the trigger event leading to an initiating event. The ignition of another fire as a result of the original fire, occurring due to electrical fault propagation through cable connections was screened out. The methodology is based on the NUREG CR6850 and the IAEA Safety Series No. 50-SG-D2 (Rev. 1). The deterministic part of the analysis and the cable data base is based on the result of the FIVE analysis, which was made parallel with the Fire PSA. The main steps of the analysis was the following:

- To determine the safety related structures, systems, components, and the fire sections.
- To define the initiating events caused by these SSCs and their cables. The SSCs which do not cause any initiating event were screened out.
- To determine the fire cases which are capable to cause these initiating events. In this step of the analysis was built the particular fire event trees. The frequencies of these initiating events was calculated by the summaries of the fire cases frequencies cause the same initiating event group.
- In the fourth step the spreading and the development of the particular fire cases was taken into account. The purpose of this step was to reduce the conservatism of the fire cases' analyses. In this step the effect of the fire extinguisher systems and fire brigade activities were also considered.
- In the fifth step the probabilistic model was developed and calculated by Risk Spectrum.

The calculated CDF or CDP can be compared with the value of the risk metrics of internal initiating events.

At full power the CDFs of the four units from the internal fire hazard are in the 10^{-6} / year order of magnitude. At the refuelling period the hazard values are one order of a magnitude less, the CDPs are in the 10^{-7} /year range.

According to the calculation results, the expected value of the CDF resulting from fires that can be assumed to occur during power operation of the units at their rated capacity is:

- for Unit 1: 2.30E-06/year,
- for Unit 2: 1.93E-06/year,
- for Unit 3: 3.01E-06/year,
- for Unit 4: 4.71E-06/year.

The expected value of the CDP resulting from fires assumed to occur in the "shutdown for overhaul" operational state of the units is:

- for Unit 1: 2.77E-07,
- for Unit 2: 3.84E-07,
- for Unit 3: 3.17E-07,
- for Unit 4: 2.79E-07.

The differences between the results obtained for different units can be explained by differences in the spatial arrangement of system components, in particular by differences in cabling.

2.1.4 Main results / dominant events (licensee´s experience)

No major fire ever occurred in the Paks Nuclear Power Plant. The fire risk analyses however identified deviations that had a negative impact on safety. Measures have been taken to address these deviations. The main technical measures that have been implemented are:

- In cable rooms where the cables of safety systems are functionally not completely separable, the cables have been equipped with flame-retardant coating along their entire length.
- In order to reduce water damage, the floor of cable compartments has been waterproofed.
- In order to reduce water damage, the heads of dry sprinkler fire extinguishers in the cable rooms have been replaced by ones with lower water flow rates in accordance with national standards.
- In the turbine building, the protection of some steel support structures has been ensured with an additional certified fire-retardant coating. (Figure Figure 2.1.**4-1**)
- To protect the equipment of oil systems in the turbine hall, water mist extinguishing equipment was installed. (Figure Figure 2.1.**4-2**)
- In the turbine building, salvagers have been installed around the oil system equipment to prevent possible oil spills.
- 35 local gas fire extinguishing systems per unit have been installed to protect the electrical cabinets of safety systems. (Figure Figure 2.1.**4-3**)
- The ventilation system piping in the safety system rooms has been fitted with additional certified fire protection cladding, which means the installation of fire dampers and of individual certified fire protection cladding on the piping. (Figure Figure 2.1.**4-4**)
- The construction of tanks for the temporary short-term storage of contaminated oil with built-in fire extinguishing equipment at 4 locations in the controlled access area is in progress at the time of writing this document.
- To ensure more consistent limitation of fire spreading in the power plant's units, new fire-retardant doors/ windows have been installed in several places.
- In process rooms where separation of safety systems was required, fire cells were installed.
- In the controlled access area, safe escape routes are provided by retrofitted fire-retardant doors in the passageways. In the corridors, normally open doors that close on a fire alarm segment the escape route. Escape staircases are available with pressurised, closed and fire doors.
- Installation of water mist extinguishing equipment (completed, the systems were designed in consideration of the requirements of single failure tolerance).
- Coordinated movement of scan-doors and smoke deflectors (completed).
- Installation of a closed-circuit television network ,
- Passive protection of cable ducts (installed along the riser cable routes pertaining to safety systems).

Figure 2.1.4-1: Additional passive fire protection of turbine oil tank support column

Figure 2.1.4-2: Water mist extinguishing equipment

Figure 2.1.4-3: Local gas extinguishing system in Electrical Building

Figure 2.1.4-4: Installation of fire damper and passive fire protection of any ventilation pipes

2.1.5 Periodic review and management of changes

2.1.5.1 Overview of actions

The design documentation for the planned modifications in the area of the operating units includes a fire safety chapter in accordance with national legislation. The mandatory content of every fire safety chapter is a fire risk analysis, which is a simplified engineering analysis that also serves as a change tracking tool. In addition, as part of the Periodic Safety Review of the plant, a full deterministic fire risk analysis is carried out every 10 years.

2.1.5.2 Implementation status of modifications/changes

Technical and administrative measures are/were taken to address the deviations identified by the fire risk analysis in a scheduled manner.

2.1.6 Licensee's experience of fire safety analyses

2.1.6.1 Overview of strengths and weaknesses identified

A strength in the field of fire protection is the Licensee's "due care" approach, which is supported by internal regulations, regular inspections, professional trend analysis based on the inspections, and the identification of focal points for the following period.
Another strength is the consistent implementation of fire risk analysis and the execution of tasks resulting from the risk analysis. The above also highlight certain weaknesses, which are of course coupled with proper corrective measures.

2.1.6.2 Lessons learned from events, reviews, fire safety related missions, etc.

The licensee shall implement the measures identified by the fire risk analysis to control and ensure fire safety in accordance with the legislation in force. The experiences gained in fire risk analysis and their use are detailed in section 2.1.4.

2.1.7 Regulator's assessment and conclusions on fire safety analyses

2.1.7.1 Overview of a strengths and weaknesses identified by the regulator

The continuous fire risk analysis activity of PAE, which includes both deterministic and probabilistic approaches, contributes to maintaining fire safety. Identified strengths in the Licensees approach can be summarized as the following:

- The probabilistic risk/safety assessment is updated and submitted regularly to the nuclear safety authority ensuring that the presented risk metrics are up to date and present the actual state of the facility.
- The Licensee has well developed and detailed internal procedures on how to identify, address and solve fire safety related issues, which includes the proper documentation of findings.
- The Licensee has a well-trained and qualified staff to check and assess the fire risks of the facility

However, the on-site inspection for most of the fire protection equipment and structures built as a result of the results and experiences of the fire risk analyses can only be carried out during unit shutdowns.

2.1.7.2 Lessons learned from inspection and assessment as part of the regulatory oversight

According to the results of the fire risk analysis and experience, the fire protection equipment and structures were built. Based on the continuous fire protection official inspections it can be concluded that they are operated as intended, and at the same time they comply with the regulations contained in the relevant fire protection legislation.

From the regulatory point of view it can be concluded that the deterministic fire risk and its analysis is in a unique inter-authority zone, which requires in depth understanding of the facility and the phenomena from both the nuclear and the fire safety authority. In order to overcome this issue the co-authorities need to work together when evaluating the related analyses and corrective actions.

The probabilistic risk assessment of internal and external fire is in a different position, solely reviewed and evaluated by the HAEA. In recent years/in the last decade several safety improvements were carried out on the facility to support life-time extension, power increase and various other applications. As it is usually the case, the original PSA models of the PAE was a simplified and conservative approximation of the actual plant design, which was satisfactory to justify that the adequate level of nuclear safety is satisfied by the design, but beyond fulfilling the generic PSA criteria the main conclusion of the HAEA was that it gave no room for PSA based applications or PSA based justifications for the modifications. To keep up with the national and international development in the field of PSA the HAEA requested a comprehensive review of the PAE’s PSA model that proposed an extensive PSA review project. During the project the PSA was amended/modified and improved by (including but not limited to):

- Reducing the level of conservative assumptions (e.g.: conservative assumption in unintentional boron dilution scenarios)
- Human reliability analysis was re-modelled based on modern techniques
- The external hazards in the models were complemented by various (less impactful) hazard sources
- Fire and flooding PSA was reassessed

The updated/amended PSA model was reviewed and evaluated in depth by the regulatory body in a 2 year long review project. At the end of the review project the regulatory body agreed and accepted that the new PSA model is at a satisfactory level to support various PSA based applications. In order to ensure that the PSA models and documentation are continuously able to support these applications the HAEA obligated the PAE to submit the updated PSA models and documentation for the HAEA annually. This means that the authority has continuous access to the most up-to-date version of both the PSA models and documentation which is considered to be a good practice, because:

- It ensures that all regulatory reviews, professional discussions, etc. are based on the same models and documents that the Licensee uses,
- It gave a chance to the HAEA to develop its own PSA applications, such as PSA based event analysis,
- It created the possibility for the HAEA to check the adequacy of the PSA calculations done by the Licensee via cross-checking it with its own results.

2.1.7.3 Conclusions drawn on the adequacy of the licensee's fire safety analyses

The fire risk analysis activity of the PAE reaches the expected level of quality, and in compliance with the relevant technical requirements and regulations.

The fire risk analysis was made based on the valid regulatory framework at the time of its preparation. Perceived risks were identified in the analysis. The licensee has determined the necessary corrective actions.

2.2 Research reactors

WENRA	Hungarian regulation	
	Nuclear Safety Codes	Nuclear Fire Safety Codes
S 3.1: A fire hazard analysis shall be carried out and kept updated to demonstrate that the fire safety objectives are met, that the fire design principles are satisfied, that the fire protection measures are appropriately designed and that any necessary administrative provisions are properly identified. S 3.2: The fire hazard analysis shall be developed on a deterministic basis, covering at least: • For all normal operating and shutdown states, a single fire and consequential spread, anywhere that there is fixed or transient combustible material; • Consideration of credible combination of fire and other PIEs likely to occur independently of a fire; • fire hazards due to experiments. S 3.3: The fire hazard analysis shall demonstrate how the possible consequential effects of fire and extinguishing systems operation have been taken into account. E 6.1: Credible combinations of individual events, including internal and external hazards, that could lead to anticipated operational occurrences or design basis accidents, shall be considered in the design. Deterministic assessment and probabilistic methods as well as engineering judgement can be used for the selection of the event combinations.	5.2.2.1200. The deterministic safety analysis shall contain the response of the research reactor to the postulated initiating events that may lead to anticipated operational occurrences or accident conditions. These analyses shall be used to design the systems important to nuclear safety and to ground the operational limits and conditions. 5.2.2.2700. All postulated initiating events, including the combinations of nuclear and conventional hazards and hazard factors, as well as the nuclear emergencies induced by conventional emergencies shall be analysed. The analysis shall be appropriately detailed to ground the compliance with the nuclear emergency preparedness requirements and to preliminary plan the protective actions for the public living off the site. All such processes and activities shall be identified in the analysis, in the case of which the postulated emergency requires the introduction of on-site or off-site protective actions.	Annex I Chapter II 8.1. The fire risk analysis must be prepared on a deterministic basis. The task of the fire risk analysis is to prove that the research reactor meets the fire protection and fire safety criteria defined in the general principles, and also the fire protection measures meet the requirements of nuclear safety and radiation protection. 8.4 During the design of a new research reactor, a fire risk analysis must be carried out for the first time as part of the construction license application documentation, then as part of the detailed construction plans, and then - also applied to an operating research reactor - during modifications that affect safety, as well as during mandatory safety reviews.

According to the scope of the TPR II both research reactors operated in Hungary were subjected to the self-assessment and review, therefore from sub-chapter 2.2.1 to 2.2.7 discusses the fire safety analysis of the BKR reactor, while from sub-chapter 2.2.8 to 2.2.14 the NAR describes the fire safety analysis of the BME OR reactor.

2.2.1 Types and scope of the fire safety analyses (BKR)

The basic purpose of maintaining and developing fire safety is to verify and prove that individual systems and system components are capable to perform the safety functions assigned to them even in case of suspected fires.

The fire safety analysis was carried out for the EK (Centre for Energy Research) BKR facility. The deterministic analyses cover the development and impact of fire in different technological, research and administrative areas. Due to its intended use, the BKR is characterised by the following operating conditions in terms of fire protection:

- Abandoned state:
    - If the reactor is in abandoned condition (no operational personnel on site), fire safety is supervised by the Armed Security Guards – through the fire alarm system and regular patrols.
    - If a fire is detected, the ASG Central Alarm Station guard on duty alerts the Central Main Duty Service of the BM OKF, the operator on duty of the BKR, and then, as agreed with him, the armed guards starts extinguishing the fire and, if possible, prevents the fire from spreading.
- Operational state:
    - The reactor is in operation and the reactor building is supervised by the operating staff. In this case, the alarm of the fire alarm is also detected in the control room and the real or false signal is checked by the staff. In this case it is irrelevant at the time the fire is detected, whether the reactor is in power mode or is shut down, since according to the provisions in force, the reactor must be shut down immediately if a fire is detected in the operating area.
    - When the reactor is shut down, cooling must be provided. The staff performs a walkthrough every four hours (twice per shift), during which they also check for fire safety. In the event of a fire, the operator on duty shall notify the Armed Security Guards and start to locate the fire.

2.2.2 Key assumptions and methodologies (BKR)

The simultaneous occurrence of several independent fires and the combined effects are excluded from the assessment. However, the effects on the nuclear safety of the reactor induced by a particular fire are investigated. Analysis activity includes:

- collection of baseline data, e.g.:
    - type of combustible materials, volume of combustible materials,
    - possible forms of damage caused by fire, risk of fire cases,
    - initiators of fire cases,
    - measures taken to stop or mitigate fire spreading,
- analysis of the spread of fire,
- assessment of compliance with fire safety.

BKR's deterministic fire safety analysis activity

In the interest of nuclear safety, the conservative engineering approach had to be supplemented by vulnerability assessment of technological systems and the effects of presumed fires on specific technological processes. This so-called sensitivity analysis was taken over by the operator from several methodologies used in national and international practice in order to develop the basics of the analysis. The purpose of the method is to determine the scope of the SSCs necessary to achieve safe shutdown state and to prevent core damage during shutdown. On this basis, the vulnerability to fire is examined, and then the classification of the risk units is determined.

2.2.3 Fire phenomena analyses: overview of models, data and consequences (BKR)

Fire safety analysis deals with the analysis of the development and impact of fire related to technological premises. During the investigation, the presumed fires had also to be analysed on the basis of the fire hazard classification of the installed materials and the fire risk weighting of the BKR's safety systems. For fire hazard classification, the following shall be investigated in relation to the presumed fire:

- Triggering cause,
- Fire spreading speed,
- Consequence of series of events,
- Impact on technological processes,
- Impact on safety systems,
- Impact on radiation safety.

In the analysis a summary has to be given of:

- Preventive technical protection,
- Organisational measures necessary for prevention.

From the aforementioned investigation, the probability of an initial event occurring and the assessment of the organisation of protection are established.

The systems performing safety functions shall be classified according to the following grouping, taking into account the weighted aspects of the assumed fires:

- High risk group:
  - Presumed fire in the control room,
  - Presumed fire in the high-current control unit.
- Low risk group:
  - Presumed fire in the reactor hall,
  - Presumed fire in the auxiliary plant,
  - Presumed fire in working rooms, corridors.
- Negligible risk group:
  - Premises incorporating passive safety systems without combustible material.

The safety systems assigned to each risk group are summarised in the following table:

Risk group – premises	Safety system
High risk group	
Presumed fire in the central control room	Safety Protection Logic System (BVLR)
	Recirculation ventilation system
Presumed fire in the high-voltage control unit	Uninterruptible power supply
	Control of diesel generators
Low risk group	
Presumed fire in the reactor hall	Automatic water refill/make-up system
	Quick water refill
Presumed fire in the auxiliary plant	Emergency power supply
Presumed fire in working rooms, corridors.	Does not compromise SSCs performing safety functions
Negligible risk group	
	Passive safety systems not containing combustible materials
Presumed fire in the reactor hall	Make-up water tanks
Presumed fire in the primary pump room	Water recuperative systems (AV1, AV2)
	Main isolation valve
Presumed fire in the primary pump room or storage room	Special sewerage system, liquid containers

In the fire safety analysis, the operator gives high priority to events affecting the safety systems that are crucial from the point of nuclear safety. The analysis of the safety systems, according to the above risk groups, has been summarised by the investigator as follows:

Presumed fire in the control room

Initiator:

- failure of low-current electrical equipment, fire caused by a short circuit,
- high-current power cable junction point overheating,
- human error during the performance of a flammable activity resulting in a fire case.

Consequences affecting reactor safety systems:

- The amount of combustible materials present is minimal and ignition sources are sufficiently far away from combustible materials (low ignition probability).
- In case of ignition of combustible materials, the fire protection devices detect the event in a timely manner, providing the possibility to intervene and minimise further effects. No built-in automatic fire extinguishing equipment is installed, manual fire extinguishing can be used to extinguish the fire in a timely and effective manner.
- In the event of a cable break or short circuit, the Safety Protection Logical System (BVLR) immediately shuts down the reactor.
- The failure of the automatic water refill system due to a fire does not compromise the safety of the reactor, as it only has a nuclear safety role, and must operate in the event of a loss of coolant in the primary circuit.
- The operation of the recirculation ventilation system may take place in the event of a nuclear accident, reactor shutdown caused by a fire, does not require the system to perform a safety function during the scenario.

Presumed fire in the high-current control unit

Initiator:

- failure of high-current electrical equipment, fire caused by a short circuit,
- high-current power cable connection point overheating,
- human error from the performance of a flammable activity resulting in a fire case.

Consequences affecting reactor safety systems:

- The amount of combustible materials present is minimal and ignition sources are sufficiently far away from combustible materials (low ignition probability).

- In case of ignition of combustible materials, the fire protection devices detect the event in a timely manner, providing the possibility to intervene and minimise further effects. There is no built-in automatic fire extinguishing system, manual fire extinguishing can extinguish the fire in a timely and effective manner.
- In the event of a failure of the emergency/safety power supply, the BVLR shall provide an immediate stop command. In the event of a suspected power failure, the control/safety rods enter the core and shut down the reactor.
- In the event of a failure of the active emergency cooling system, it is possible to manually supply cooling water into the reactor without the need for electricity.
- The failure of the active water recuperative systems (AV1, AV2) due to a fire does not compromise the safety of the reactor, as its safety role is only significant in the event of a loss of coolant scenario in the primary circuit.

Presumed fire in the reactor hall

Initiator:

- failure of low or high-current electrical equipment, fire caused by a short circuit,
- high-current power cable connection point overheating,
- breaching the rules on activities increasing the probability of a fire hazard.

Consequences affecting safety systems:

- The amount of combustible materials present is minimal and ignition sources are sufficiently far away from combustible materials (low ignition probability).
- In case of ignition of combustible materials, the fire protection devices detect the event in a timely manner, providing the possibility to intervene and minimise further effects. A built-in automatic fire extinguishing system has been installed in the reactor block, with automatic and manual fire extinguishing to put out the fire in a timely and efficient manner.
- The cables of the implementing participating in the reactor control and the signal cables of the sensors are routed to the central control unit via the cable space of the reactor bridge. The reactor hall is a fire section separated from the control room, which is capable of safely preventing the spread of any fire that may occur. In the cable space of the bridge, cables and signal lines with different functions are arranged on separate levels, and the signal cables of the sensor detectors are housed in a conduit made of armoured plate. A pipe system for the introduction of halon gas into the cable room is provided with hand-held and portable fire extinguishers located at the inlet side.
- Failure of the water refill systems is not expected, only smoke occurring in the event of a hall fire may cause manual intervention difficulties, although this can be carried out remotely from the control room. However, the metal 'accident cabinets' in the lobby of the control room contain protective clothing equipped with a closed system and fresh air ventilation, allowing manual intervention in a space filled with incidental smoke if necessary.
- The two parallel pressure ventilation systems of the technological ventilation are equipped with fire dampers at the boundaries of the fire section, which manually or thermally close the supply ducts, preventing the entry of external fire or smoke from entering the hall into the air duct. In the two parallel operating pressure ventilation systems of the process ventilation, a fire damper is installed at the border of the fire section, which closes the supply ducts by manual or thermal control, preventing the entry of external fire or smoke entering the hall through the air duct.

Presumed fire in the auxiliary building

Initiator:

- high-current power cable connection point overheating,
- diesel fuel ignition caused by human error.

Consequences affecting safety systems:

- The two diesel generators of the reactor's emergency power supply system are located in separate rooms with separate air spaces. The generators provide the backup (CW) power in the event of a loss of the normal power supply to both sides, when the reactor has already been shut down by the Safety Protection Logic System (BVLR) at the time of the event. The generators are also each other's back-ups, any failure triggers the start of the other machine. In the event of a fire in the auxiliary plant, the nuclear safety of the reactor is not compromised even if the two generators fail simultaneously.
- In case of ignition of combustible materials, the fire alarm system and the installed malfunction indicator and warning system detect the event in time. It also sends a warning signal to the high-current power and central control units, providing an opportunity to intervene and minimize further effects.

Presumed fire in working rooms, workshops, changing rooms, corridors.
Initiator:

- Fires resulting from the failure of low-current equipment,
- Incorrect positioning of electrical equipment,
- Human errors resulting in fire cases, which can spread to corridors.

Consequences affecting reactor safety systems:

- Does not compromise safety systems.
- In case of ignition of combustible materials, the fire protection devices detect the event in a timely manner, providing the possibility to intervene and minimise further effects and consequences.
- The spread of fires in the rooms and corridors is prevented by the metal doors of the priority rooms (power control room, reactor hall, basement operator corridors, battery room).

2.2.3.1 Passive safety systems containing no combustible material

Systems with a safety function classified as 'Negligible risk group' are not assumed to be damaged in the event of a fire in the assessment, and they are assumed to be able to perform their function even in the event of presumed fires.

2.2.4 Main results / dominant events (licensee´s experience) (BKR)

The fire safety analysis identified deviations that negatively affected fire safety. Corrective measures were developed to address these deviations:

- Recently, the responsible person holding a professional qualification has assessed the condition of the fire containment systems and since 2014 he has maintained them and has documented the inspections as required by the National Fire Protection Regulation.
- Parallel with the assessment, the experts established a new fire alarm system for the facility, based on the developed licensing plan.
- The introduction of annual trainings and audits, which are conducted online, also lead to the development of the fire safety culture.
- Many of the operating staff hold a fire safety qualification, depending on their position and/or duties.
- A deficiency identified during an analysis had to be corrected by rebuilding the temporary waste storage of room 102 in the reactor hall, using non-combustible materials for the structure and the cover. Furthermore, the area had to be equipped with hand-held fire extinguishers.
- A further major step forward in the field of fire safety is the installation of an automatic fire detection and extinguishing system in the reactor block of the Research Reactor. Commissioning procedure of the system was approved by the nuclear safety authority, while the designer

started to compile the license documentation for operational license application for the fire safety authority.

2.2.5 Periodic review and management of changes (BKR)

2.2.5.1 Overview of actions

The design documentation for the planned modifications at the BKR site includes a technical fire safety specification in accordance with fire safety legislation. The mandatory basis for all new fire safety specifications is a fire safety analysis, which contains engineering analyses, calculations and also functions as change tracking.

In addition, a full deterministic fire safety analysis is carried out every 10 years as part of the BKR Periodic Safety Review. During the PSR the fire risk analysis has to be updated and the internal fire protection regulations have to be updated based on the results of this analysis.

2.2.5.2 Implementation status of modifications/changes

The most recent TPR is currently in progress, the PSR documentation was submitted to the nuclear safety authority which currently is working on the review. Under the umbrella of the PSR the fire risk analysis was updated. Technical and administrative measures have been defined to deal with the deviations identified by the fire safety analysis in accordance with Chapter II of Decree 5/2015. (27. II.) of the Ministry of Interior. The measures identified will be implemented in a scheduled manner, such as:

- The fire safety analysis was updated (currently under regulatory review)
- The internal Fire Protection Regulation was updated, its internal review in ongoing
- Modifications for the internal regulations regarding the installing of experimental and measurement equipment has been finalized
- The checking of the cable ducts has been carried out, its documentation has been archived
- The organization of further modifications has been started.

In the assessment provided by the analysis, the operator shall provide for the changes. According to the relevant legislation, in case of changes to the safety systems of a nuclear facility (according to BIOS), a licensing documentation has to be submitted. The licensing documentation shall be developed in accordance with HAEA Guideline 5.1.42 and the applicable fire safety legislation for the area, where relevant.

2.2.6 Licensee's experience of fire safety analyses (BKR)

2.2.6.1 Overview of strengths and weaknesses identified

In the field of fire protection, the licensee highlights the implementation of the above-mentioned improvements and the introduction of good practices as positive changes. The operator intends to achieve further progress through internal regulations, trainings, regular inspections and the introduction of professional decisions based on the inspections. The decisions to address the deviations related to the technical and administrative improvements are supported by the planning of the modifications for the next period.

The consistent implementation of the fire safety analysis and the scheduled execution of the tasks arising from the safety analysis are also appropriate to be evaluated at a higher level than before.
The analyses determine the fact that the deviations are non-conformities, which of course are accompanied by corrective measures, but in some cases the obligation to develop and expand goes beyond the capabilities of the CER as operator. This reflects the weakness of the system, where the different functionalities and responsibilities of the owner, the maintainer, the operator of the nuclear facility and the operator of the site cannot ensure effective and timely changes.

Weaknesses arising from the age of the buildings are being identified, and during the reinforcement of the structural elements and the conservation activities, the installation of materials complying with the fire protection requirements must be checked by the experts of the Reactor Department.

2.2.6.2 Lessons learned from events, reviews, fire safety related missions, etc.

At the facility there have been no fires of a nature that could provide real lessons.
There has been only one recent fire safety incident at BKR:

- A fluorescent lamp fitting caught fire in one of the downstairs dosimetry laboratories.
- The improvement measure has been integrated into the overall renovation project, whereby the operator is constantly replacing old-type lighting fixtures with new, energy-efficient luminaires. This will remove from the system old types of lighting fixtures containing ignition devices and chokes, which pose a fire safety risk.

However regardless of lack of severe fire cases it is necessary to improve the Safety Culture due to the complexity of the site and the staff.

2.2.7 Regulator's assessment and conclusions on fire safety analyses (BKR)

2.2.7.1 Overview of a strengths and weaknesses identified by the regulator

Based on the review of the provided information in the NAR as well as the information and experience collected during the targeted on-site inspection the following strengths were identified at the BKR:

- Fire safety training is well developed at the operating organization and a significant part of the staff are certified fire safety engineers, which highly increases the quality of related analyses and assessment.

Identified weaknesses can be considered as the following:

- The responsibilities and authorities in the facility are underdeveloped and in many cases conflicting. Within a single fire section (e.g.: reactor hall and measurement hall which are in the same fire section) there are multiple areas under the authority of different personnel (e.g.: area managers, researchers working at a specific station, operator, etc.). This results in a situation when it is unclear who should remove unnecessary flammable materials, potential sources of fire, etc. Since the information of flammable materials, potential ignition sources, etc. are kept separately by the area managers it is a rather complicated task to carry out a comprehensive and proper fire risk assessment.
- An additional weakness that was identified during the site visit is the lack of personnel specifically focusing on the changes in laws and regulations, which would ensure that both the fire risk analyses and the internal Fire Protection Regulation is kept up to date.

2.2.7.2 Lessons learned from inspection and assessment as part of the regulatory oversight

One major lesson that was learned from the on-site inspection within the framework of the TPR II NAR development is that the regularity of the site visits of the co-authorities may need to be increased in order to properly discuss and check the fulfilment of the related requirements at the facility.

2.2.7.3 Conclusions drawn on the adequacy of the licensee's fire safety analyses

The fire safety analysis itself was reviewed and was found partly satisfactory. The new version of the analysis has not yet been officially submitted, but is under internal review at the Licensee. The preliminary review of the new "not-yet-submitted" version of the document was found to be adequate based on the limited amount of time and access to the document, but final conclusions can only be drawn once the new version is submitted to the co-authorities.

2.2.8 Types and scope of the fire safety analyses (BME OR)

The fire risk analysis of the BME OR is being developed in parallel with the development of the current TPR II NAR, therefore the information presented in this section can be considered as preliminary which only aims to present the nature of the ongoing work.

From a nuclear fire safety point of view, similarly to the BKR, the BME OR has two major states:

- **Abandoned state:** Weekend or evening/night conditions, when the operating staff is not on site. In such cases, fire safety is monitored by the porter service (porter, armed guard) and the BME dispatcher using the fire alarm system. If a fire is detected, the Fire Department and the Training Reactor standby officer are alerted.
- **Operational state:** On weekdays, during working hours, the operating staff exercises supervision in the reactor building. In this case, the fire alarm is detected in the control room as well, and the staff checks whether it is a real or false signal. According to the regulations in force, if a fire affecting the training reactor is detected, the reactor must be shut down immediately, which is initiated by the operator. If a fire is detected, the operator/sub-operator on duty notifies the BME dispatch centre and the fire department and begins to locate the fire.

The fire risk assessment takes both state into consideration in order to ensure the comprehensive nature of the assessment.

2.2.9 Key assumptions and methodologies (BME OR)

In the fire risk analyses the prime assumption is that the simultaneous occurrence of separate fire events, and independent initiating events with no correlation or causation to the fire case can be screened out from the assessment.

2.2.10 Fire phenomena analyses: overview of models, data and consequences (BME OR)

The fire risk assessment of the BME OR reactor facility applies the same principles and modelling techniques as the information presented in section 2.2.3 for the BKR reactor facility. Based on the results of the fire risk assessment the following parameters are identified:

- Occurrence frequency of fire events
- Evaluation of the adequacy of the fire protection concept and organization
- Fire classification

The systems performing the safety function/relevant for safety are classified, the risk groups are summarized in column 2 of the table below:

Risk group – premises	Safety system involved
High risk group	
Presumed fire in the control room	Safety Protection Logic System (BVLR)
Low risk group	
Presumed fire in the reactor hall	Manual water-refill systems
Presumed fire in the auxiliary room	Emergency power supply
Presumed fire in working rooms, corridors.	Does not compromise SSCs performing or affecting safety functions
Negligible risk group	
Fire scenarios/cases not affecting safety systems/affecting only passive systems without combustible materials. (e.g.: reactor hall, reactor cover area)	Water refill systems Liquid waste storage

During the fire risk analysis, the licensee paid special attention to the events affecting systems ensuring the nuclear safety of the reactor. The analysis of the safety systems summarized in the table above are presented in the following list:

Presumed fire case in the control room

Initiator:

- low current electrical equipment failure, fire caused by short circuit cases,
- overheating of high current/electrical cable junctions,
- human error during the performance of a fire hazardous activity resulting in a fire case (activity carried out while the reactor is in safe shut-down state with continuous fire safety oversights and in possession of an ignition permit).

Consequences affecting reactor safety systems:

- The amount of combustible materials present is minimal and ignition sources are sufficiently far away from combustible materials (low ignition probability).
- In case of ignition of combustible materials, the fire protection devices, due to the design of the fire detection and alarm system, detect the event in a timely manner, providing the possibility to intervene (practically immediately after detection) and minimise further effects. No built-in automatic fire extinguishing equipment is installed, manual fire extinguishing can be used to extinguish the fire in a timely and effective manner.
- In the event of a cable break or short circuit, the Safety Protection Logic System immediately shuts down the reactor.
- In the operational state there is always an operator and sub-operator in the control room, who will shut down the reactor event before the automatic actuation is generated.
- After the reactor was brought to a safe shut-down condition there is no further action to be taken to ensure nuclear safety. The residual heat generated in the reactor is removed via natural circulation of the 9 m^3 water content in the reactor vessel.
- If the occurring fire generates false signals the Safety Protection Logic System or one of the nuclear measurement chain will shut down the reactor.

Presumed fire in the reactor hall

Initiator:

- low or high current electronic equipment failure/fire cases caused by short circuit
- overheating of high-current cables at the junctions
- failure to follow the rules and regulations on fire hazardous activities in the reactor hall

Consequences affecting reactor safety systems:

- The amount of combustible materials present is minimal and ignition sources are sufficiently far away from combustible materials (low ignition probability).
- In case of ignition of combustible materials, the fire protection devices detect the event in a timely manner, providing the possibility to intervene and minimise further effects. No built-in automatic fire extinguishing equipment is installed, manual fire extinguishing can be used to extinguish the fire in a timely and effective manner.
- The cablework of the reactor protection system, including cables transmitting signals and electric power can reach the control room via the bridge in the reactor hall.
- The water refill system failures do not have to be taken into consideration, the major effect of the fire case is that the generated smoke may render manual actions harder than assumed.

Presumed fire in the auxiliary room

Initiator:

- overheating of high current/electrical cables at the junction point

Consequences affecting reactor safety systems:

- In case of ignition of combustible materials, the fire alarm system, as well as the built-in signalling and warning system, detect the event in time. It gives a warning signal, providing an opportunity to intervene and minimize further effects.
- SSCs located in the auxiliary room are not necessary for the functionality of the safety systems, nor to reach safe shut-down conditions with the reactor. In safe shut-down conditions forced circulation is not necessary to remove the generated residual heat.

Presumed fire in working rooms, corridors
Initiator:
- fire cases initiated via improper storage, installation of low-current electrical equipment, human errors leading to fire cases that may spread to neighbouring corridors

Consequences affecting reactor safety systems:
- The fire case does not affect SSCs performing safety functions.
- In case of ignition of combustible materials, the fire alarm system, as well as the built-in signalling and warning system, detect the event in time. It gives a warning signal, providing an opportunity to intervene and minimize further effects.
- The spreading of fires starting on the corridors is limited via the metal doors installed on premises which contain nuclear safety related SSCs.

2.2.11 Main results / dominant events (BME OR)

The fire risk analysis of the BME OR is being developed in parallel with the development of the current TPR II NAR. Its results are not verified and submitted to the co-authorities, therefore no official statements can be made based on it.

It should be stated however that no fire-event occurred in the BME OR facility since its commissioning (1971), but one trivial result of the fire risk analysis currently under development is that the facility's internal Fire Protection Regulation issued in 2015 has to be updated based on the new analysis, even though the document was updated multiple times in recent years.

2.2.12 Periodic review and management of changes (BME OR)

2.2.12.1 Overview of actions
The fire risk analysis of the BME OR is being developed in parallel with the development of the current TPR II NAR. Its results are not verified and submitted to the co-authorities, therefore no official statements can be made based on it. One of the major outcome of the PSR at the facility was that it identified the lack of this fire risk assessment.

2.2.12.2 Implementation status of modifications/changes
The fire risk analysis of the BME OR is being developed in parallel with the development of the current TPR II NAR.

2.2.13 Licensee's experience of fire safety analyses (BME OR)

2.2.13.1 Overview of strengths and weaknesses identified
The fire risk analysis of the BME OR is being developed in parallel with the development of the current TPR II NAR. Its results are not verified and submitted to the co-authorities, therefore no official statements can be made based on it.

2.2.13.2 Lessons learned from events, reviews, fire safety related missions, etc.
No fire-safety dedicated missions were carried out at the BME OR facility.

2.2.14 Regulator’s assessment and conclusions on fire safety analyses (BME OR)

2.2.14.1 Overview of a strengths and weaknesses identified by the regulator

The fire risk analysis of the BME OR is being developed in parallel with the development of the current TPR II NAR. Its results are not verified and submitted to the co-authorities, therefore no official statements can be made based on it.

2.2.14.2 Lessons learned from inspection and assessment as part of the regulatory oversight

The fire risk analysis of the BME OR is being developed in parallel with the development of the current TPR II NAR. Its results are not verified and submitted to the co-authorities, therefore no official statements can be made based on it.

2.2.14.3 Conclusions drawn on the adequacy of the licensee’s fire safety analyses

The fire risk analysis of the BME OR is being developed in parallel with the development of the current TPR II NAR. Its results are not verified and submitted to the co-authorities, therefore no official statements can be made based on it.

2.3 Fuel cycle facilities

Not applicable.

2.4 Dedicated spent fuel storage facilities (KKÁT)

WENRA	Hungarian regulation	
	Nuclear Safety Codes	Nuclear Fire Safety Codes
S-30: The licensee shall make design arrangements for fire safety on the basis of a fire safety analysis and implementation of defence in depth (prevention, detection, control and mitigation of a fire).	6.2.1.10600. Such systems, structures and components shall be designed for the operation of the interim storage facility that ensure timely detection of any potential fire or explosion and mitigation of its consequences. 6.2.1.2110. It shall be demonstrated that all potential hazards and hazard factors adequately comply with the requirements of the design specifications in accordance with the design, analysis and probabilistic principles. Only those hazards and hazard factors can be ruled out without any further assessment, about which it can be demonstrated that it doesn't affect adversely the safety of the interim storage facility.	Volume 1, Chapter III: 1.4 In order to increase fire safety, the principle of defence in depth, minimizing the possibility of fire origination and fire spread, including the spread of smoke and toxic combustion products, must be considered as a basic principle in planning. 8.3. The fire protection design of a technological facility must be based on those determined by the fire risk analysis.

2.4.1 Types and scope of the fire safety analyses

Deterministic fire hazard analysis:
The decree [A17], listed in item 1.3.4. prescribe to elaborate a deterministic fire hazard analysis for the facility, accordingly 9 deterministic fire risk analyses were developed during the last 15 years.

Probabilistic fire hazard analysis:
A dedicated fire PSA has not been developed for the KKÁT facility, since, there was no legislative requirements for development of such analysis. On the other hand it was not justified to make such analysis, since a large scale fire is not possible within the facility due to its special construction, as well as on account of the technological processes.

2.4.2 Key assumptions and methodologies

The deterministic fire hazard analysis presents to what extent the safety systems, components of the KKÁT's technology are endangered by fire, the occurrence probability of fires, the severity of damage related to nuclear safety and radiation protection, as well as the recommendations on tasks and technical solutions serving for mitigation of such damages.

2.4.3 Fire phenomena analyses: overview of models, data and consequences

Considering its architectural construction, the facility is a building consisting of steel and concrete, and this construction ensures the exclusion of occurrence and spreading of more significant fires. The steel structures are equipped with passive fire protection system and fire resistance enhancing coating.

Except for cables located in switchboards and on cable trays, the technological system installed in the facility contains limited quantities of combustible material.
Based on the result of the cable tray fire examinations, it has been concluded that it is not easy to cause an electrical fire. According to the results of the experiments, it can be stated that an overcurrent between 120 and 130 A is needed for ignition in case of small power cables. The average period of fire was 6 minutes, the cables located in cable trays other than one combusting did not start to combust and kept their operability during the whole time of the experiment. The power cables and the I&C cables

are physically separated and located in different cable trays. The cable trays of the I&C cables are equipped with a cover. The power cables are mainly armoured ones with Al conductor and PVC conductor- and sheath insulation.

Figure 2.4.3-1: 6 kV power cables of electrical switch room in KKÁT facility

The I&C cables are armoured with conductor of Cu and sheath insulation of PVC. A special cable with flexible conductor was installed at places where a flexible cable routing was necessary. Both ends of each cable are equipped with a durable marking. The material of the cable tray support is a sheet-iron of 2 mm with electrolytic galvanization. The fire protection of cabling is provided by a system of fire barriers.

Smaller local electrical or hydrocarbon fires may occur in the facility, however no fire event was identified during which such smaller fires could endanger long-term integrity of fuel assemblies and their protection systems that would fall into the design bases based on its occurrence frequency. It should be noted that the radiation protection instrument installed in the operator's cab of the refuelling machine and the extract fan of the refuelling machine are equipped with an independent uninterruptable power supply for a period of 2 hours to be used in case of loss of normal and auxiliary power supply. After the expiration of the 2 hours, in order to provide continuous operation, it is possible, to start a petrol-driven, low power auxiliary generator located outside of the building. Furthermore, after shut-down due to loss of power supply (for example during a fire scenario), the control and protection system always ensures avoidance of non-permitted operations occurring within the fuel loading process after recovery of the power supply.
A (fire) load caused by an internal explosion was not considered as part of the design basis since there is no explosive gas in the decay products nor in the filling gas of the storage tubes.
The quantity of combustion materials is also very low in the facility. The shielding of Jabroc 'N' of the refuelling machine is made of high density, strongly compacted, 12 angled beech wood with metal cover, which is retardant against combustion and flame spreading. Consequently, loss of some part of the shielding is improbable, therefore it is not considered by the fire hazard analysis as a realistic event that should be considered in the design basis.

Figure 2.4.3.-2: Tower of KKÁT facility refuelling machine. The 12 angled metal cover, under which the Jabroc 'N' beechwood is located, can be seen at the lower part.

Due to the relatively small quantity of combustible materials in the facility, it was not necessary to install fire extinguishing systems operating with water spray or water mist or any form of sprinkler system. It should be noted that the domestic regulations (mentioned in section 1.3), also forbid to extinguish with water and water-mist, respectively in the areas containing spent fuels. Portable fire extinguishing devices are however available and particular attention is paid to their operability by the Licensee. The first periodical intermediate maintenance will not be completed on the fire extinguishing devices of the Licensee, but they will be replaced with new ones equipped with the highest extinguishing performance available at the domestic market.

The fire hazard analysis of the facility includes the safety classification of the technological systems of the KKÁT facility, their safety functions and the fire load of their rooms, as well.

2.4.4 Main results / dominant events

It can be stated that the physical separation of systems, as well as the absence of combustible materials are reducing the possibility of fire spreading between the equipment concerned with the fire and the adjacent equipment, consequently every fire occurring in the facility can be considered as insignificant from a nuclear safety point of view.

In case of a fire occurring, the most significant consequence would be the loss of equipment power supply. It would cause a temporary delay in transportation of the fuel assemblies into or out of the facility, however it would not cause loss of isolation function and consequently have a negative impact on nuclear safety.

No event related to fire has been occurred during the period of operation of the facility.

2.4.5 Periodic review and management of changes

2.4.5.1 Overview of actions

The decrees [A17], [A21] mentioned in item 1.3.4. determine the cases in which it is obligated to perform a fire risk analysis. These cases are as follows:

- during the design of storage facility to be constructed, modified, enlarged, as part of the licensing documentation (for the first time),
- for an operating facility, during modifications having an impact on safety,
- during the obligatory safety reviews (periodical safety review to be performed every 10 years).

Within the period of 15 years, after entry into force of the Decree [A17], [A21], 9 deterministic fire risk analyses have been developed. In 8 cases it was developed due to modification, extension/construction of new storage units. In these cases a change tracking is also part of the analysis, while in 1 case it was developed as part of the 10-year Periodical Safety Review, which was a full scope fire hazard analysis that also took into consideration the events, modifications, changes in national and international best practices, etc. of the past 10 years.

2.4.5.2 Implementation status of modifications/changes

No statement giving cause for change has been made as a result of the fire risk analyses, since no significant non-conformity was identified.

2.4.6 Licensee's experience of fire safety analyses

2.4.6.1 Overview of strengths and weaknesses identified

It can be identified as a strength that the fire hazard analysis is consequently made in accordance with the relevant national legislation [A17].
The weaknesses that were identified by the fire risk analysis, have been eliminated via corrective actions.

2.4.6.2 Lessons learned from events, reviews, fire safety related missions, etc.

The KKÁT is a modularly extendable (and extending) facility, the construction stages of which fulfil the regulations in force, taking into account the compliance with the original fire protection principles. The fire risk analyses made for the different construction of new storage units or during the PSRs have not identified any increase in the fire risk. Missions related to the fire risk analysis have not been performed during the past 25-year operation.
The appropriateness of the original fire protection concept is justified by the fire risk analyses made for each construction stage.

2.4.7 Regulator's assessment and conclusions on fire safety analyses

2.4.7.1 Overview of a strengths and weaknesses identified by the regulator

The safety level established as a result of the KKÁT's deterministic fire risk analysis is adequate based on the experience of fire protection official inspections.

During the on-site inspection carried out within the framework of the TPR II self-assessment the co-authorities concluded that the Licensee has a strong commitment for fire safety, its internal procedures and practices regarding the fire risk assessment are of high quality that ensures the safe operation of the facility.

2.4.7.2 Lessons learned from inspection and assessment as part of the regulatory oversight

According to the results of the fire risk analysis and experience, the fire protection equipment and structures built in accordance with the continuous fire protection official inspections can be established that they are operated as intended, and they comply with the regulations set in the relevant fire protection legislation.

2.4.7.3 Conclusions drawn on the adequacy of the licensee's fire safety analyses

The fire risk analysis activity of the KKÁT reaches the expected level of quality, as proves the fulfilment of the necessary level of safety defined in the relevant technical requirements and regulations.

2.5 Waste storage facilities

Not applicable.

2.6 Facilities under decommissioning

Not applicable.

2.7 Licensee's experience of fire safety analyses

2.7.1 Nuclear power plants (PAE)

Fire risk analyses have been made at the nuclear power plant since the 1990s. The first version, still without the authority's obligations, was made in 1992. In the meantime, a reactor protection reconstruction was commenced, the design documentation of which strongly influenced the analysis, leading to a revision of it. The final fire risk analysis, including corrective actions to enhance safety, was completed in 2000. The necessary corrective actions have been implemented and are listed in section 2.1.4.

Legislation at national level was introduced in 2007, from when the 10-year recurring period for the PSR dates back.

The following fire risk analysis was completed in the period between 2014 and 2017. The conclusions were taken into account in the PSR in 2017.

2.7.2 Research reactors

BKR
Following the structure and content of the analysis:

1. Situation assessment: Documentation of what has been experienced during on-site visits to various technological and research premises, and examination of the materials and activities stored there.
2. Gathering the necessary knowledge: from the educational topics, through the classification of materials into fire risk classes, to the revision of fire extinguishers, including the fire safety standardisation of various equipment.
3. Processing data: Professional interpretation of the accumulated data, experience, and information to provide a basis for processing in accordance with the analysis of risk factors.
4. Presentation of the results in different aspects (e.g. territorial risks, legal non-compliances, etc.).
5. Specific highlighting and summary of risks at critical or unacceptable levels.

On this basis, proposals for improvement are being made:

- Develop proposals to reduce risks to acceptable levels,
- Additional tasks for further analysis may be needed, e.g. to define measurements.

The main experience/feedback regarding the fire safety analysis can be summarized as:

- Collecting of adequate input data has many difficulties and is one if not the most complex part of the analysis.
- Inadequacies in the handling of combustible materials stored in laboratories and measurement sites experienced during inspections must be corrected (use of suitable storage cabinets, management of joint storage, and up-to-date inventory-like documentation of the stored materials, with the name of the person responsible).
- The Licensee's experience is that the Licensee's internal inspection of fire protection devices and equipment (according to the National Fire Protection Regulation) is not standardized and cannot be followed, as several actors organize it independently.

BME OR
The fire risk analysis of the BME OR is being developed in parallel with the development of the current TPR II NAR. Its results are not verified and submitted to the co-authorities, therefore no official statements can be made based on it.

2.7.3 Fuel cycle facilities

Not applicable.

2.7.4 Dedicated spent fuel storage facilities (KKÁT)

The manufacturer support for the KKÁT's built-in automatic fire alarm system (installed at commissioning of the facility and operating with a central unit of Siemens AlgoRex CI1145) ceased in March of 2018, including the detector, device and replacement part supply, as well as the technical support, therefore the Licensee decided to perform a full reconstruction which was executed in 2018.
No deviation was revealed during the fire risk analyses, which would have had a negative impact on fire safety and for which a corrective action should have been taken.

2.7.5 Waste storage facilities

Not applicable.

2.7.6 Facilities under decommissioning

Not applicable.

2.8 Regulator's assessment and conclusions on fire safety analyses

As expected and required based on the principle of graded approach the most advanced fire risk assessment is carried out by the PAE, which applies and combines both deterministic and probabilistic assessment methodologies to ensure the comprehensive nature of the evaluation. Both the deterministic and probabilistic methods and tools of the PAE is considered highly developed and of high quality by the regulations, which are continuously monitored and reviewed by the authorities.

The regulatory review of the spent fuel storage facility (KKÁT) also concluded the fire risk assessment to be of high quality and in compliance with the relevant rules and regulations. Both the layout, the technology and applied construction materials ensure that the fire risk of the facility is minimized which conclusion is further verified by the results of the fire risk assessment.
The updated version of the fire risk assessment of the BKR facility was submitted only after the on-site inspection was carried out by the co-authorities therefore the comprehensive review of the assessment is carried out in parallel with the finalization of the NAR. Both the information presented in the NAR by the BKR as well as the preliminary results of the regulatory review indicate the assessment to be of high quality, adequate and in compliance with the relevant rules and regulations, but the final regulatory conclusion will be drawn at a later time once the review is finished.

Regarding the fire risk assessment of the BME OR training reactor facility the issue of the lack of submitted and approved fire risk assessment is persistent, therefore in-depth regulatory review or evaluation of assessment cannot be carried out at this point, hence no regulatory conclusions can be drawn.

3 FIRE PROTECTION CONCEPT AND ITS IMPLEMENTATION

The chapter is dedicated to present how the concept of fire protection is interpreted and implemented on the three levels of defence in depth with regard to fire safety at the various nuclear facilities within the scope of the NAR:

- Fire prevention
- Active fire protection
- Passive fire protection

3.1 Fire prevention

From the point of fire safety, the prevention of occurrence of fire is considered as the first level of defence in depth. Numerous measures are prescribed by the relevant Hungarian legislation in order to minimize the probability of occurrence of internal fires. These are typically the following ones:

1. Limitation of fire loads (minimization and separation of permanent and temporary combustible materials to the extent appropriate; location, spatial arrangement and features, etc. of combustible materials),
2. Limitation of ignition sources (reduction of quantity of ignition sources as far as possible, especially the potential ones; strict control, and separation from combustible materials, of every ignition source; control of hot works, etc.)
3. Limitation of oxygen (reduction of oxygen concentration, inert gas atmosphere, etc.)

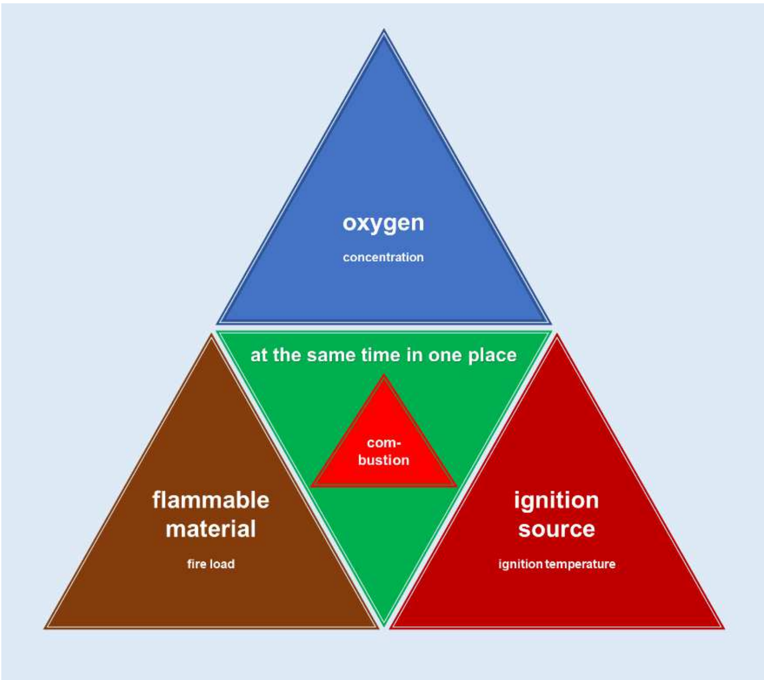

Fig. 3.1.-1. Conceptual representation on the prerequisites of fires

The relevant WENRA RLs and the related Hungarian regulations are presented for the different facilities in the following table.

WENRA	Hungarian regulation Nuclear Safety Codes	Nuclear Fire Safety Codes
Nuclear Power Plants		
SV 6.11: In order to prevent fires, procedures shall be established to control and minimize the amount of combustibles and the potential ignition sources. […]	4.13.0.1000. Internal regulating documents related to fire protection shall contain the specific requirements for the storage, transport and use of flammable materials. 4.13.0.0300. To prevent fires the amount of flammable materials shall be minimized. To ensure the fulfilment of fire protection measures an internal regulation shall be developed and implemented. The regulating documents shall include the inspection, maintenance and testing of fire barriers, fire alarm and fire suppression systems.	Annex I Chapter I 10.2. The internal controllers of the nuclear power plant must provide a suitable framework for the effective control of combustible materials in the entire area of the nuclear power plant. 10.3. The regulations must cover the transportation, storage, measurement, and use of combustible materials in any form, with particular regard to the areas and rooms of the nuclear power plant containing safety systems.
Research Reactors		
S 5.1: In order to prevent fires, procedures shall be established to control and minimize the amount of combustible materials and minimize the potential ignition sources that may affect items important to safety. […]	-	Annex I Chapter II 10.2. The internal regulatory documents of the research reactor must provide a suitable framework for the effective control of combustible materials in the entire area of the research reactor. 10.3. The internal controls must cover the transportation, storage, measurement, and use of combustible materials in any form, with particular regard to the areas and rooms of the research reactor containing safety systems.
Spent Fuel Storage Facilities		
S-26: The licensee shall establish operational limits and conditions (OLCs) in order to maintain the storage facility and waste and spent fuel packages or unpackaged spent fuel elements in a safe state during facility operation. S-27: The defined OLCs (see S-26) shall consider, in particular, and as appropriate: • (…) • potential aspects of gas generation from waste or spent fuel, in particular the hazards of fire ignition, explosion, waste and spent fuel package or unpackaged spent fuel element deformations and radiation protection aspects; • (…).	6.2.5.0400. During normal service, anticipated operational occurrences and design basis accidents the venting systems of the interim storage facility shall provide: e) minimization of the inherent risk in toxic and other chemical attributes of process materials as well as explosive mixtures of gases and steam;	Annex I Chapter III 7.2. In addition to what is specified in the relevant construction legislation, the architectural fire protection documentation must contain: e) the determination of the probability of a fire or explosive condition arising during the technological process supported by a fire risk analysis.

3.1.1 Design considerations and preventions means

3.1.1.1 Nuclear power plants (PAE)

During the design of the PAE the installed combustible materials values of all rooms of the facility were determined. This information is included in the plant’s fire risk assessment. In cases where new cables are being installed or old cables are being removed, these values are changing. If an equipment is being replaced with one which contains more combustible materials, the fire load parameter changes are tracked the same way. In cases of temporary fire load growth, the primary principle is that the fire load values have to be minimized.

3.1.1.2 Research reactors

BKR

Regarding **combustible materials** installed at the time of design, the fire load values of the rooms, safety systems and system components have been determined in the facility of the BKR, which do not exceed 500 MJ/m^2 in terms of nuclear technology. Temporary combustible materials stored during the period of operation, as identified in the actual fire safety analysis, are recorded in accordance with the provisions of the local Fire Protection Regulation of the Licensee and their entry is subject to authorisation.

In the event of a failure in the electrical supply, the failed component may become a potential **source of ignition**, hence a source of fire hazard. If the electrical systems are properly maintained and repaired, this hazard source can be eliminated to a degree. Also in the case of electricity supply, according to the concept of the defence in depth, the individual safety related equipment are fed in several stages and from several sides, hence a fire in a particular electrical system cannot jeopardize nuclear safety. It may be necessary to carry out occasional fire hazard activities during certain maintenance and repairs.
Its authorization is ensured through a regulated manner. When authorizing occasional fire hazard activities, special attention shall be paid to:

- the technical adequacy of the devices required for performing the activity,
- the existence of a valid fire safety certification required for the performance of the activity,
- the prohibition of the zones of the built-in fire alarm equipment,
- the need to remove or cover the built-in, temporary combustible material, other additional measures (ventilation, radiation protection measurement, the need for temporary fire stops),
- the presence of fire extinguishers,
- special fire protection knowledge,
- operator supervision,
- the return and inspection of the work area and the documentation and
- the organisation of the supervision of the given activity.

Fire safety regulation.
The purpose of the internal Fire Protection Regulation is to regulate fire protection activities in the area of the Budapest Research Reactor, to preserve the physical health of the workers, to defend the technological systems, to provide the necessary fire extinguishing and rescue services and to ensure the proper conditions for these services, as well as to define the fire protection duties of the managers, members of the fire protection organisation and the subordinate employees.

The Fire Protection Regulation of the BKR is an integral part of the Fire Protection Regulation of the Centre for Energy Research (Licensee organization), and by means of that, it is an integral part of the Fire Protection Regulation of the Csillebérc KFKI site, and it sets the institution's duties and obligations related to fire safety in accordance with them.

Scope of the Codes:

- The scope of the Codes covers all measures relating to fire protection (as defined by law or as reasonably applied in order to achieve it).
- The areal scope of the Code covers the entire area of the Budapest Research Reactor, including its external facilities.
- The personal scope of the Codes applies to all persons staying or working on the territory of the Budapest Research Reactor and its facilities.
- Under the current regulations of the internal Fire Protection Regulation of the BKR the Codes shall enter into force on the date of issue and shall remain in force until revoked, However the Fire Protection Regulation of the BKR are continuously updated.

General rules on fire safety
The Fire Protection Regulations of the Csillebérc Site are binding for all research institutes and other institutions operating on the KFKI site. Taking into account the Fire Protection Regulation of the operator of the site - in accordance with it - the heads of the institutions are obliged to prepare the local Fire Protection Regulation based on their local conditions, technologies and sources of danger, and to establish the conditions for fire prevention.

When preparing the Fire Protection Regulation for the BKR, the licensee paid special attention to the compliance with the specific requirements of fire safety related to the use of nuclear energy and the way they are enforced by the authorities in the course of their activities. Systems and system components important for nuclear safety must be operated in such a way that the frequency and effects of fire are minimised. To prevent fires, the amount of flammable material and the amount of potential sources of fire affecting safety-relevant systems and components should be controlled and minimised.

All employees and other people on the premises of the BKR shall implement and comply with the provisions of the Fire Protection Regulations applicable to their duties, without any special notice or action. The safety and actions of guests on the BKR site is the responsibility of their hosts.
Fire protection is an integral part of the work, and therefore preventive fire protection cannot be separated from the work processes. It is the duty of all senior managers to take into account and apply the relevant fire safety regulations and standards in their organisational, management and control activities.

KFKI site operator company shall perform the supervision, inspection and organization tasks affecting the general tasks related to fire protection, including fire prevention, throughout the site. The professional activities of the Centre for Energy Research related to institutional fire protection are carried out by the EK's entrusted institutional fire protection officer.

BME OR
The probability of occurrence of fire cases is reasonably low, which is ensured via the following means:
- fire occurrence prevention: the amount of combustible materials present is kept at the necessary minimum,
- the sources of ignition are sufficiently far from the combustible materials.

The fulfilment of the above criteria satisfies the fire protection regulations against fires occurring at the Training Reactor (Article 5.2.15 of Annex 5 of HAEA Decree 1/2022. (IV. 29.)), and also complies with Decree 5/2015. (II. 27.) of the Ministry of the Interior of the specific fire protection requirements related to the use of nuclear energy, therefore follows the principle of defence in depth.

3.1.1.3 Dedicated spent fuel storage facilities (KKÁT)
The factors considered from fire protection aspect during design of the storage facility are presented in detail in item 1.3.4. In order to prevent fire cases, the three conditions of burning, that is, combustible material (fire load), ignition source (ignition temperature) and oxygen (concentration), have to be taken into account from the aspect of their unity in space and time.

Combustible material (fire load):
Referring to the section 1.3.4., the facility has been designed with steel and concrete so that the steel structures are equipped with passive fire protection system (a system of fire retardance enhancing coatings). This solution is in accordance with the design principles prescribed in the Nuclear Fire Safety Code [A17], according to which
- „The building structures, systems and components which are important from the aspect of safety have to be designed and implemented in a way to minimize the impact of internal fires and explosions occurring as a result of external or internal events, simultaneously complying with the other safety aspects."

With respect to combustible materials to be built in as part of the design, the fire load values of the rooms and safety systems, components have been determined in the facility, such values do not exceed the extent of 500 MJ/m^2 in case of the nuclear technology.
As it is described in section 1.4.3., the temporary combustible materials to be considered during operation are recorded and allowed to be transported into the facility solely with a relevant permit and registration. It can be stated that the quantity of combustible materials in the facility is limited and regulated.

Ignition source (ignition temperature):
Among ignition sources, there are two which may be potentially dangerous: these are the electricity and the occasional activity involving fire hazard necessarily performed in case of maintenance or repair. However, referring to section 2.4.3, it can be seen that the electricity, as ignition source, would not cause any non-negligible impact on the nuclear safety.
As it can be seen in section 1.3.4, in order to operate the technology of the facility there is no need to execute any activity involving a fire hazard. However, it may occur during maintenance and repair that an activity involving a fire hazard has to be occasionally performed. Licensing of such activities in a regulated way is ensured. During licensing of such occasional hot works, particular attention is paid to the following aspects:

- technical appropriateness of devices necessary for performance of the given activity;
- availability of valid fire protection specialized exam in accordance with the relevant legislation;
- prohibition of zones of built-in fire alarm equipment;
- necessity of removing, covering of built-in and/or temporary combustible material;
- other supplementary measures (ventilation, radiation protection mobile aerosol measurement, necessity of temporary fire barriers);
- availability of fire extinguishing equipment; availability of special fire protection skills; supervision by operators; take-over and inspection of work area.

Oxygen (concentration):
In the facility there is no change in the atmospheric oxygen concentration, its volumetric percentage can be considered as permanent. A load caused by an internal explosion has not been taken into account during design, since there is no explosive gas in the fission products or in the storage gas of storage tubes.

3.1.2 Overview of arrangements for management and control of fire load and ignition sources

3.1.2.1 Nuclear power plants (PAE)

Fire-load parameters have been determined for all of the rooms of the NPP units. This information is included in the plant's fire risk assessment.

All design documentation of the planned modifications carried out on the operating plants, requires a fire protection chapter in compliance with the Hungarian regulations. Every fire protection chapter contains information about the spectated room's fire load, stating if its increases or decreases the amount of the combustible materials which is to be removed from or planted in the room due to the modification.
The standard fire load parameters are constant values, but they may vary in cases where new cables are being installed or old cables are being removed. If an equipment is being replaced with one which contains more combustible materials, the fire load parameter changes are tracked the same way. In such cases the fire load changes are included in the design documentation for the planned modifications. Consequently the actual values of the fire load are known and available at all times.

In cases of temporary fire load growth, the primary principle is that the fire load values have to be minimized. The way it can be achieved in practice is: Combustible materials delivery into the controlled access area is strictly regulated by administrative procedures. Every transport has its own, individual written permit. In these situations the main focus is not aimed at the materials themselves but usually their packaging. In several cases it contains a great risk to transport fragile equipment without its packaging. However all the combustible materials, specified by weight, location, the time duration until it is to be removed from the controlled access area and the responsible personnel are stated on the individual written permit. These transport permits are monitored at all times, the primary permit grants the inside transport whilst the secondary permit the outside transport and the permit only after the outside transport can be closed down. This procedure assures the unwanted and uncontrolled storage of any combustible materials. In course of the fire hazard analysis these information are taken into account.

The handling of the ignition sources are separated in two sections. In one hand the Licensee separate electrical equipment and in the other hand the hot works. The electrical equipment are located in their closed cabinets so they do not pose an any ignition source risks outside of the cabinets. In case of closure the amount of combustible materials inside the electrical cabinets are so minimal, that they burn out "in a flash" and pose no danger to the outside environment as a further ignition sources. Apart from this during the fire hazard analysis the electrical cabinets are treated as ignition sources and the FIVE analysis method contains their impact as an ignition source. The same applies to the high voltage cables as well. Substantive ignition sources are the hot works.

The ignition sources are managed in the hot work permit regulations. A hot work can only be done with a written proof permit. Such permit can be issued on the work permit itself. The general rules of the hot works are stated in the national regulations. Hot works inside of the plant area are further regulated by PAE internal regulations. The hot work permit has its unique identifier. The permit contains every detail about the work itself, such as the working personnel, the place, the time duration, the license numbers, the spectators name and location, the safety terms and the authorising signatures.

All of these works are supervised by the plant management, the fire protections division of the PAE, the national nuclear safety authority and the Hungarian fire protection authority as well.
The PAE has its own division for the prevention, fire extinguishing and disaster management tasks. This fire protection division's duties are regulated in the PAE's regulations.
The international organizations such as World Association of Nuclear Operators (WANO), IAEA and insurance companies are auditing the field of fire protection as a whole including the prevention and the rescue side as well.

3.1.2.2 Research reactors

BKR

The installed fire load values are basically constant, in the case of the BKR shall not exceed 500 MJ/m^2 for nuclear technology.

Temporary combustible materials stored during the period of operation, as identified in the current fire safety analysis, are recorded according to the internal Fire Protection Regulation of the Licensee and their entry is subject to authorisation.

In the event of a failure in the electrical supply systems, the faulty system component as a potential **source of ignition** may pose as a fire hazard. If the electrical systems are properly maintained and repaired, this source of danger can be minimized. Also in the case of electricity supply, according to the concept of defence in depth, the supply to each of the safety related systems are provided in several stages and from several redundant sources, so that a fire in a particular electrical system cannot have a non-negligible negative impact on nuclear safety.

Occasional fire risk relevant activities may be required during certain maintenance and repairs. It is ensured that this is authorised in a regulated manner.

When authorizing occasional fire hazardous activities, the licensee shall pay special attention to the technical adequacy of the equipment required for the performance of the activity, the existence of a valid fire safety examination required for the performance of the activity, the prohibition of zones with built-in fire alarms, the need to remove or cover built-in, temporary combustible material, the presence of additional measures (ventilation, radiation protection measurement, the need for temporary fire-breaks), the presence of fire extinguishers, the existence of special fire safety knowledge, operator supervision, the taking back and inspection of the work area, and the documentation thereof and the communication of the supervision of the given activity.

The Research Reactor has a fire protection organisation to carry out its preventive fire protection tasks. The structure and detailed tasks of the fire protection organisation are laid down in the internal Fire Protection Regulation. The Research Reactor **does not** have a fire brigade organisation.

According to the content of the fire risk analysis:

- The technological premises are supervised in line with daily activities. No unnecessary combustible materials or ignition sources (materials not related to the given technological process) are stored in the technological premises.
- For the research premises, it was concluded in the fire risk assessment that the priority of safety needs to be improved.

It was also concluded that the safety culture related to fire safety needs to be treated with a higher standard and in a more controlled manner. To achieve this, trainings need to be initiated and signs to raise awareness among users in the respective areas should be installed:

- Maintaining transport (escape) routes,
- Keeping the inspections of electrical equipment up to date,
- Request permission from the management of the Reactor Department before installing new meters or equipment.

The analytical documentation contains a separate chapter on ignition sources, which are also regulated for proper handling and maintenance.

BME OR

The fire risk analysis of the BME OR is being developed in parallel with the development of the current TPR II NAR. Its results are not verified and submitted to the co-authorities, therefore no official statements can be made based on it. Regarding the fire load calculations the following values were determined for the various areas and sections of the facility:

Premise/room	Fire load [MJ/m^2]
Technology room	33,38
Hot chamber lobby	4,21
Loading area	109,52
Lecture hall and circular gallery	52,38
Instrument room 110	124,17
Laboratory 109B	86,43
Laboratory 109A	312,59
Radiochemical laboratory 108	133,8
Instrument room 107	198,44
Office 106	213,76
Laboratory 105	134,15
Laboratory 105A	123,73
Reactor building lobby	11,33
Front desk area	474,42
Cafeteria	163,27
Dosimetrics 102	251,10
Female locker room	200
Male locker room	200
Shower	2,91
Locker rooms	200
Bathroom 1	21,66
Bathroom 2	19,38
Bathroom 3	11,51
Bathroom 4	21,66
Storage	55,08
Server room	164,96
Laboratory 200	128,48
Heating system room 203	40,68
Workshop 204	183,69
Workshop 205	107,61

Room 206	218,22
Laboratory 207	228,78
Laboratory 208A	118,68
Laboratory 208B	167,04
Office 209	364,85
Laboratory 210	499,70
Laboratory 211	355,53

3.1.2.3 Dedicated spent fuel storage facilities (KKÁT)

The fire load values of the rooms and safety systems and components of the KKÁT facility have been determined, see section 3.1.1.3. In the operating facility, during modifications concerning the fire protection, in addition to the fire protection documentation a fire hazard analysis is also developed in accordance with the requirements prescribed in the National Fire Safety Codes [A17]. The fire risk analysis deals with the fire load values of the facility, systems, or system components, the increase or decrease of risk, based on which the necessary measures can be taken. These are the permanent fire load values. In case of an operating facility, the temporary fire load is primarily represented by the temporary combustible materials transported into the facility in order to perform maintenance, repair and modifications. Precondition of such transportation into the facility is a permit and a registration [see section 1.4.3], the aim of which is to minimize and track, respectively the route, usage and possible storage of the temporary combustible materials in the facility.

With respect to the ignition sources, the safety and availability of the power supply systems is provided through maintaining them in good technical and physical condition (periodical inspection, review, maintenance, repair, if necessary).
Unintentional fire ignition in the case of hot works is ensured in the facility through a strict licensing procedure and work area hand-over take-over procedures.
The temporary fire load, the combustible material control, the safe management of ignition sources and occasional hot works are realized by means of complying with the rules prescribed in the local Fire Protection Regulation of the facility.

3.1.3 Licensee's experience of the implementation of the fire prevention

3.1.3.1 Overview of strengths and weaknesses

The current section contains the results of the self-assessment carried out by the licensees regarding the major strengths and weaknesses in the field of fire prevention. Regulatory assessment is presented in section 3.1.4.

3.1.3.1.1 Nuclear power plants (PAE)

Fire prevention activities are carried out as follows:

- The fundamental requirements are set in the national legislation.
- The requirements set in the national legislation are also checked by the national authorities.
- The nuclear safety authority and the fire safety authority may be present at each other's inspections.
- The fire safety authority is legally required to prepare a 5-year inspection plan. Such inspection plan covers the entire area of the nuclear power plant.
- The management of the nuclear power plant and its fire protection organisation monitor compliance with fire prevention rules on the basis of national legislation and relevant internal regulations. This regulation is part of the plant's internal management system.
- Experiences with the compliance with fire safety include:
    - o Even with regular inspections, there are still shortcomings that indicate non-compliance with the rules. These shortcomings are not serious and their number is not high.
- No shortcomings that would affect nuclear safety cannot be found.

3.1.3.1.2 Research reactors

BKR

To prevent fires from starting, to prevent them from spreading and to ensure the basic conditions for fighting fires:

- relevant fire safety legislation, official regulations has to be developed,
- a system of internal fire safety regulations has to be developed,
- the adequacy of the set rules must be observed during operation,
- education and training must be provided,
- and the management activities must be established to enforce them.

According to the experience of the operator, annual site visits, annual fire safety training and auditing, as well as regularly maintained technological and fire protection systems play an important role in the implementation of prevention.
The latter, the precise definition of maintenance duties and responsibilities, is important for the operator. Therefore, in the new internal Fire Protection Regulation, the unmanageability arising from the complexity of the site (various different experiments and experimental equipment is used and stored in the same fire sections) is specifically addressed so that each area has a responsible manager. There are no deficiencies in nuclear safety with regard to the Research Reactor.

BME OR
The safety inspections are carried out via annual walk-downs in the facility, during which the flammable and fire-hazardous materials are identified and removed if deemed unnecessary. In addition daily walk downs are carried out by the operator personal (at least twice per shift), during which fire safety aspects are also verified via observation. During such daily walk downs typically minor issues non-compliances can be occasionally identified such as oil spills around pump stations. In the case of such detection the corrective actions are initiated immediately, and the issue is resolved shortly, records on such issues are not written.

The fire alarm and fire suppression equipment is checked periodically (fire detection and alarm system is checked by the authority on a half year period and the fire extinguishers annually). As required by the national and local regulations the whole staff of the facility has to participate in annual fire safety education and training, to ensure that the knowledge and understanding of tasks and responsibilities are adequate. Deficiencies affecting nuclear safety have never been observed.

3.1.3.1.3 Dedicated spent fuel storage facilities (KKÁT)
Based on the Nuclear Fire Safety Code [A17], a fire protection organization is operated at the Licensee, the members of which are also responsible for inspection of fire protection requirements determined in the local Fire Protection Regulation of the facility. The full scope inspections are performed twice per year, while the expert-level inspections are carried out on a monthly basis. Experience gained during such inspections shows that there was a deficiency related to control of combustible materials, but it was not jeopardizing nuclear safety, and which was eliminated after the attention of stakeholders had been drawn to it. In summary it can be stated that the fire protection rules are met.

3.1.3.2 Lessons learned from events, reviews fire safety related missions, etc.
3.1.3.2.1 Nuclear power plants (PAE)
Every event (in this case related to fire protection) in the PAE and other NPPs are being analysed by the Licensee. In case of any valuable experience occurs a deeper analyzation takes place and all the information as well as the solution are shared with other NPPs.
Any proposal motioned by missions carried out by international organizations and missions (WANO, OSART, insurance company reviews) are being processed by the plant staff and corrective actions are carried out in a scheduled way.

Any (minor) discrepancies revealed by the regulators (e.g.: missing signs, fire doors propped beyond approved intervals, etc.) are solved in a similar scheduled way.

3.1.3.2.2 Research reactors
BKR
In the case of the Research Reactor, lessons learned from its own single fire event were used to improve fire safety, but no other events were processed during this period. There were no fire safety missions at the BKR since its start of operation.

BME OR

Since the commissioning of the BME OR there was no fire event within the facility. Missions dedicated for fire safety has not been carried out in the facility.

3.1.3.2.3 Dedicated spent fuel storage facilities (KKÁT)

In the KKÁT facility, during its operating period of 25 years, there has been no fire case, and missions related to fire safety have not been performed.

The requirements related to execution of the comprehensive fire protection inspection to be completed by the fire protection authorities in the facility per 3 - 5 years, are regulated by the Decree [A18] mentioned in section 1.3.4 and, after its modification, the NFSC, respectively. Deficiencies discovered during the comprehensive fire protection inspections were eliminated (such as: lack of signs).

3.1.3.3 Overview of actions and implementation status

3.1.3.3.1 Nuclear power plants (PAE)

The implementations at fire protection area described in other chapters. The PAE's operational life time has been extended by 20 years with the condition to carry out a comprehensive PSR after 10 year of extended operation. As of today further life time extension possibilities are under investigation. Consequently the subject of implementation is not actual.

3.1.3.3.2 Research reactors

BKR

The deviations and deficiencies found during the previous fire risk analyses have been addressed and corresponding corrective actions are carried out in a scheduled manner. Non-compliances identified in the latest analysis are being addressed, such as:

- Fire alarm system replacement,
- Cable duct checking and repair (if necessary),
- Recalculation of the required gasoline supply for the storage tank, reduction of the fuel quantity.

The provisions taken for the removal of undesirable combustible/hazardous materials, route obstructions and electrical equipment unfit for use recorded during each visit may be implemented continuously through actions taken year after year. In order to achieve this regular monitoring, implementation and documentation of the annual visit is required.

BME OR
The firs fire risk analysis is currently in development in parallel with the development of the TPR II NAR. Verified and submitted version of the analysis is currently not available. The BME OR facility has no design lifetime. In compliance with the relevant regulations the facility is assessed in a 10 year period during the PSRs and the operational license is renewed based on its results. The current operational license is valid until 2027.

Since the reconstruction of the reactor building in 2016 the transport of materials into the facility is strictly limited. Due to the size of the building and the tools, equipment, and materials inside, the area is quite spacious, which helps to ensure fire safety within the facility.

3.1.3.3.3 Dedicated spent fuel storage facilities (KKÁT)
The deficiencies revealed during the inspections performed by the fire protection authorities, were eliminated. No deficiency was stated during the last fire protection authority inspection performed in 2022.

3.1.4 Regulator's assessment of the fire prevention

3.1.4.1 Overview of strengths and weaknesses in the fire prevention
As a result of the fire protection official inspections, it can be established that the fire prevention activities of PAE and KKÁT comply with the provisions of the relevant technical requirements and legislation.

From the point of view of the regulatory practice it can be stated that the HAEA carries out supervision related to fire prevention in cooperation with the fire safety authority, the BM OKF. In general it can be stated that all fire-hazardous activities can only be carried out/started in possession of a fire-ignition permit, which is an internal permit of the Licensee. The appropriate organizational unit of the Licensee is responsible for issuing the fire ignition permit.

Regarding the planning of the regulatory supervision the BM OKF prepares a three-year periodic plan for the PAE which is then sent to the HAEA for review. Based on the plan, the BM OKF regularly checks the adequacy and availability of fire protection systems and devices. As a recent amendment to the practice from this year, the HAEA also joined the inspections of the BM OKF in several times which can be identified as a strength in the regulatory practice.

3.1.4.2 Lessons learned from inspection and assessment on the fire prevention as part of its regulatory oversight
According to the results of the fire protection official inspections, it can be concluded that for the preparation of the PAE's fire protection official inspection plan, unit shutdown periods and various technological features must be taken into account.

Irregularities, deficiencies and non-compliances discovered during the periodic fire protection official inspections of KKÁT were immediately eliminated.

3.2 Active fire protection

Detecting and extinguishing the igniting fires quickly, thus limiting the damage is the second level of defence in depth with respect to nuclear fire safety.

3.2.1 Fire detection and alarm provisions

WENRA	Hungarian regulation	
	Nuclear Safety Codes	Nuclear Fire Safety Codes
Nuclear Power Plants		
SV 6.8: Fire detection and alarm features, with detailed annunciation of the location of a fire to the control room personnel, shall be installed at the plant and their adequacy shall be supported by results of the fire hazard assessment. These features shall be provided with non-interruptible emergency power supplies and failures of the cable connections shall be announced to the main control room. SV 6.11: […] In order to ensure the operability of the fire protection measures, procedures shall be established and implemented. They shall include examination, inspection, and maintenance and testing of fire barriers, fire detection, alarm features and extinguishing systems.	3.3.7.0200. Each fire compartment shall be equipped with a fire alarm. The fire signal provided shall be informative in the unit control room with respect to the exact location of the fire. These systems shall be supplied with an uninterruptible safety power supply and appropriate fire-proof cabling. 3.4.4.1200. The following requirements shall be taken into consideration during the design of the unit main control room in accordance with Section 3.4.4.0100: cc) information from fire alarm systems and the operation of fire extinguisher systems of priority importance, 3.3.7.0400. The fire extinguishing system shall cover the areas within the nuclear power plant important from the point of view of safety. The coverage shall be verified by fire risk analysis.	Annex I Chapter I. 6.2. Adequate control of the fire must be understood as a combination of the use of built-in fire alarm and extinguishing devices and the ability to extinguish manually. 6.9. Fire sections containing technological rooms must have a full fire alarm system. 6.11. The cables of the fire protection systems must be protected against mechanical damage by appropriate placement or mechanical protection. 10.7. The regulatory system of the nuclear power plant must define the requirements for periodic inspection, testing and maintenance of the built-in fire protection equipment, tools and devices, in accordance with the legal requirements, as well as the requirements of the safety standards defined in the Nuclear Safety Regulations. Where the law imposes requirements, this inspection-maintenance cycle should be adapted to the areas where the service of the area encounters obstacles due to radiation conditions, temperature, or other technological reasons.

WENRA	Hungarian regulation	
	Nuclear Safety Codes	Nuclear Fire Safety Codes
Research Reactors		
S 4.1: Each fire compartment or fire cell shall be equipped with fire detection and alarm features, with detailed annunciation for the control room staff of the location of a fire. These features shall be provided with non-interruptible emergency power supplies and appropriate fire resistant supply cables. S 5.1: […] In order to ensure the operability of the fire protection measures, procedures shall be established and implemented. They shall include inspection, maintenance and testing of fire barriers, fire detection and extinguishing systems.	-	Annex I Chapter II. 6.8. Fire sections containing technological rooms must have a full fire alarm system… 6.10 The cables of the fire protection systems must be protected against mechanical damage by appropriate placement or mechanical protection. 10.7. In the control system of the research reactor, the requirements for periodic inspection, testing and maintenance of the built-in fire protection equipment, tools and devices must be defined, in accordance with the legal requirements, as well as the requirements of the safety standards defined in the Nuclear Safety Regulations.
Spent Fuel Storage Facilities		
SV 6.8: Fire detection and alarm features, with detailed annunciation of the location of a fire to the control room personnel, shall be installed at the plant and their adequacy shall be supported by results of the fire hazard assessment. These features shall be provided with non-interruptible emergency power supplies and failures of the cable connections shall be announced to the main control room.	-	Annex I. Chapter III. 6.4. Fire sections containing technological rooms must have a full fire alarm system. 6.9. The cables of the fire protection systems must be protected against mechanical damage by appropriate placement or mechanical protection. 9.9. The requirements for the periodic control, review and maintenance of the built-in fire protection equipment, devices and appliances must be defined in the storage's control system, in accordance with the legal requirements, as well as the requirements of the safety standards defined in the Nuclear Safety Regulations.

3.2.1.1 Design approach

3.2.1.1.1 Nuclear power plants (PAE)

Fire alarms are provided by means of fire alarm systems installed in substantially all process rooms of the nuclear power plant units. Exceptions are rooms where extreme climatic or radiation conditions do not make it possible to install such fire detecting/alarm equipment. The number of such rooms is low and in such rooms, the process-related signals are taken into account during the identification of fire cases. The fire alarm system is focused on the units of the nuclear power plant, with fire alarms primarily being displayed in a unit's control room. Alarms outside a unit are made by the computer system. Fire alarm centres are located in separate fire sections in each reactor unit while the control panel is located in the unit's control room. It has a direct connection to the fire extinguishing control panel in the unit's control room. The current fire alarm system is built in accordance with standard EN 54.

The availability of the fire alarm system to protect the area in question was examined when the fire risk analysis was carried out. The fire risk analysis identified that transverse corridor A008/2-2 and transverse corridor A008/4-4 next to the wall of the turbine hall contain an oil manipulation tank where spent oil is temporarily stored. Supplementary flame sensor is going to be installed to protect the area. The project is ongoing.

In the fire risk analysis subsection of the fire safety chapter in the design documentation for modifications, a possible modification to the fire alarm system design is always checked to ensure that no necessary modification to the fire alarm system was overlooked.

3.2.1.1.2 Research reactors

BKR

From a nuclear fire safety point of view, the reactor can be in the following states:

- Abandoned state: The reactor is in abandoned condition (no operational personnel on site), fire safety is monitored by the Armed Security Guards (ASG) – with the help of the fire alarm system and during regular patrols. If a fire is detected, the ASG alerts the OKF Operation Control, the BKR operator on duty, and they shall start to extinguish the fire or prevent its further spread as far as possible in a manner agreed with the officer on duty.
- Operational State: The reactor building is supervised by the operating staff. In this case, the fire alarm is also detected in the control room and the validity of the signal is checked by the staff. In this case it is irrelevant whether the reactor is in operation or is shut down mode, since according to the procedures and regulations in force, the reactor must be put to shut down state immediately if a fire is detected in the operating area. When the reactor is in shut down, cooling must be provided. The staff performs a site visit every four hours, during which they also check for fire safety issues. In the event of a fire, the operator on duty shall notify the Armed Security Guards and start to locate the fire and it is the duty of the Armed Security Guards to notify the OKF Operation Control.

BME OR

The fire detection and alarm system of the BME OR facility transmit the alarm signals to the Property and Institutional Security Department operated by the BME Chancellery, and also generate a local alarm. Based on these, the janitor/front desk service personnel providing the 24-hour porter service of the training reactor and the BME dispatcher immediately call the emergency operator on duty, call 112 and start the alarm. Specialists of the Metropolitan Disaster Management Directorate participate in the annual emergency response exercises, which ensures that they are aware of the specifics (layout, content, etc.) of the facility. In the reactor building - in accordance with the purpose and classification of the given room - extinguishing devices with foam, powder and CO_2 gas are installed in quantities corresponding to the fire protection plans.

From a nuclear fire safety point of view, similarly to the BKR, the BME OR has two major mode/state:

- **Abandoned state:** Weekend or evening/night conditions, when the operating staff is not on site). In such cases, fire safety is monitored by the porter service (porter, armed guard) and the BME dispatcher using the fire alarm system. If a fire is detected, the Fire Department and the Training Reactor standby officer are alerted.
- **Operational state:** On weekdays, during working hours, the operating staff exercises supervision in the reactor building. In this case, the fire alarm is detected in the control room as well, and the staff checks whether it is a real or false signal. According to the regulations in force, if a fire affecting the training reactor is detected, the reactor must be shut down immediately, which is initiated by the operator. If a fire is detected, the operator/sub-operator on duty notifies the BME dispatch centre and the fire department and begins to locate the fire.

3.2.1.1.3 Dedicated spent fuel storage facilities (KKÁT)

The second level of defence in depth, that is, detection of fire cases as quickly as possible, is provided by the built-in fire alarm equipment of the KKÁT facility. The protection level of the built-in fire alarm equipment, based on the coverage provided by automatic detectors, provides a full scope protection. As in the case of the PAE, the only exception to this rule are areas were reliable operation of detectors cannot be provided due to extreme radiation or climatic conditions (see for example: the loading hall where manual signal transmitters are installed), or spaces containing spent fuels where fire ignition is impossible due to the absence of combustible material, ignition source and oxygen.

The facility is divided into 2x3 signalling zones and 2 alarm zones. The audible warning devices operating as part of the fire alarm system serve for indicating the fire alarm in the building, which are connected to three independent supervised control module outputs. In case of fire alarm, all of the audible warning devices start to operate without delay via audible warning lines.

The applied built-in digital signal filtering algorithms of the automatic detectors, as well as the advanced assessment methods of the fire alarm centre, provide an effective solution for elimination of false signals. All of the installed automatic detectors, manual signal transmitters and modules are equipped with two-side isolators, consequently loss of maximum one detector may occur in case of any single failure of the addressing loop. The protection of the building is ensured by a returning addressing loop, therefore the impact of the failure is limited even in case of double failure of any signalling circuit. The fire alarm system is fully automatic, consequently it does not need the operator's intervention. Accordingly, an operator error originating from user's omission is screened out from consideration.

The fire alarm centre is located in the control room, therefore its supervision is ensured during the normal working hours. In order to accelerate the detection of fire by means of the quickest identification of signals of the fire alarm centre and to provide the most important information needed for intervention of the fire extinguishing units, the fire alarm centre itself ensures detailed information. With help of the 48 LED displays, even without operator actions, the system presents a quick and comprehensive picture about the source of the fire alarm and the actual condition of fire protection systems of the building.

The continuous surveillance is provided by the signals transmitted into the permanent surveillance place established in the Guard Security Centre, which includes transmitting of a concentrated fire alarm and a concentrated error indication. Such signals are taken and displayed by the fire alarm centre of the Guard Security Centre.
The KKÁT's built-in fire alarm equipment also has a connection with the mechanical equipment, electrical equipment which are important from the aspect of the building's fire protection. With respect to connection between the fire alarm system and other systems (for example, mechanical machinery), the design boundary of the fire alarm system is the connection line of the module ensuring / picking up the handed over / taken over contact.

The equipment has the following main connections:

- Monitored equipment:
  - Auxiliary power supply unit
- Controlled equipment
  - Closing of windows
  - Closing of ventilation recirculation
  - Audible warning lines
  - Fire signal transmission

The fire alarm centre ensures text information and gives an audible warning about all monitored signals at least at the permanent surveillance place. The fire alarm system is equipped with two independent uninterruptable power supply units:

- batteries, located at the fire alarm centre, which provide uninterruptable power supply for the fire alarm centre, as well as for the components connected into the addressing loop;
- batteries located in the cabinet of the power supply unit, which provide uninterruptable power supply for the audible warning devices / light signalling devices.

Construction of both uninterruptable power supply units ensures to cover the 24-hour steady state plus 30-minutes of alarm state. The built-in fire alarm equipment is classified into safety class.

- its safety class: Important
- Its safety function: bf8 (Fire Protection)

3.2.1.2 Types, main characteristics and performance expectations

3.2.1.2.1 Nuclear power plants (PAE)

The nuclear power plant is protected by a fire alarm system made by SIEMENS. The fire alarm system was designed with self-return loops. The sensors and detectors installed in the areas are designed and installed in consideration of the fire characteristics of the combustible materials present in the room in question.
The following detectors have been designed and installed according to the fire characteristics:

- smoke detectors,
- thermal sensors,
- combined thermal and smoke sensors,
- aspirating smoke detectors,
- in-line smoke detectors.

Fire alarm loops are closed, and in case of a detector failure or loop breakage, only one detector may fail. The signalling system is designed to include sound and light signals in accordance with the relevant standard (EN 54). Afterglow safety signs are installed in accordance with European standards (practically identical to national standards).
A computer monitoring system is installed to monitor the fire alarm system. The computer system transmits detailed information to the control room of the power plant, to the Fire Department of the nuclear power plant, which employs full-time firefighters, and to the organisation responsible to supervise and maintain the fire alarm system. The operator terminal of the monitoring system is also installed in the Unit control room to facilitate any necessary intervention by the control room personnel.

Regardless of the operation of the fire extinguishing system, the alerted full-time industrial fire brigade of the facility can start extinguishing the fire within a maximum of 10 minutes from the start of the fire alarm with fire extinguishers installed in the premises or with equipment installed on fire-fighting vehicles.

3.2.1.2.2 Research reactors

BKR

As described in the previous sections a new intelligent redundant, decentralised, modular structure, analogue intelligent fire alarm centre (SecuriFire 2000) was installed and commissioned at the facility in 2013, which was equipped with addressable automatic sensors and manual call points. The fire alarm system has been installed at the 'EK- site' level (new control centre, new network, new equipment), a unified fire alarm system has been installed in the area of the Reactor Department, and the secondary display is installed in the control room and the central display in the emergency room of the Armed Security Guards.

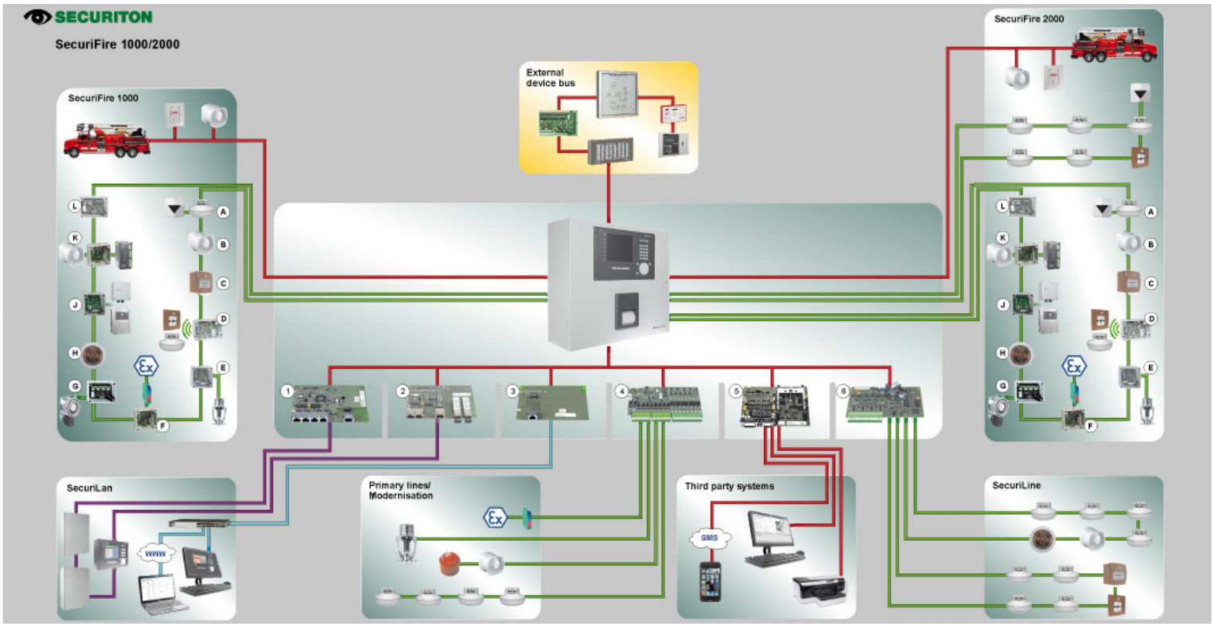

Fig. 3.2.1.2.2-1: Fire protection control layout for the BKR

Intelligent fire alarm centre SecuriFire 2000
As standard, the centre can handle 2 sensor rings, i.e. a total of 500 devices. In case of an expansion request, by using new fire alarm centers, the interface provides the opportunity to connect the central units to the network and to manage the signals from one (or more) points.
Each centre is a stand-alone unit with a power supply and batteries, which is used not only to connect sensors and controls, but also to connect external centers, fire brigade control panels, printers, etc.

Specifications:

- 2 pcs batteries for emergency power supply
- Management of 2 pcs sensor rings as standard, expandable to 4
- The installation with 2 sensor rings can be networked
- Bus driver remote control units for fire brigade operators, level displays
- Relay outputs, supervised inputs and outputs, outputs suitable for transfer signal
- Easy-to-use configuration and installation software
- Event memory for real-time storage of up to 65000 events
- Remote system access via TCP/IP connection
- Serial data interfaces for connecting higher level computer systems or fire alarm monitoring systems
- Comprehensive, built-in surge protection

The sensor rings are connected to the SCP-2020 sub-centres, which have a built-in control unit and an interface unit for external control units. In the event of the current expansion, 1 pce central unit type SCP-2020 (with built-in control unit) will be installed in the room of the Armed Security Guards, where permanent 24-hour supervision is provided.
In the fire alarm system, in this stage, 2 pcs sensor rings connecting to the above mentioned fire alarm centre will be installed:

- Sensor ring No. 1: sensors/manual call points of building No. 10,
- Sensor ring No. 2: for devices in other buildings outside building No. 10 included in the modernization.

The signalling ring consists of recipient automatic sensors and recipient manual call points. These devices are connected to a ring system that can be fed from both sides, thus increasing the safety of detection. If the sensor line is interrupted by a single cable break, address retrieval from both ends of the ring is maintained. A maximum of 250 addresses (sensor, manual call points, address module, expansion module) can be installed in a signalling ring. Each element has its own isolators which are activated in the event of a single short circuit on the ring. In this case, the wiring between the sensors on either side of the short circuit is isolated. The addresses on either side of the short circuit remain operational and information is still available from there.

The existing fire alarm system is divided into areas and zones (groups). 1 zone can contain up to 63 detectors. Manual call points and automatic detectors are assigned to separate zones.

Automatic point detectors (28 pcs):

- Combined smoke and heat detector Securistar MCD 573

The new point detectors to be installed are combined sensors that can be set either in software mode or only in 'smoke' or 'heat' only sensor mode. In each room, detectors will be installed according to the features of the activity and the fire characteristics of the material stored there. Most of the detectors are smoke detectors. In rooms where smoke or vapour is expected to be generated during operation, detectors programmed as heat velocity sensors are installed.

Manual call points (15 pcs):

- MCP545-1N Addressable indoor manual call point
- MCP545-4n Addressable outdoor manual call point

Manual call points along escape routes and exits allow fire alarms. In addition, it has been considered that a manual call point should be available within 30 metres of any point in the building. Depending on the location of the installation point, the manual call points were installed either indoors or outdoors.

Supervision and management
In addition to the control unit installed in the fire alarm centre at the Armed Security Guards, a control unit with a colour TFT display will also be placed in the control room on the 1st floor of the reactor (building 10), which, unlike before, will provide a full range of handling and display options.
The central unit and the control unit are connected by a BUS system of fireproof wiring, which is installed in the substructure between the two buildings.
Considering that the water tightness of the substructure cannot be guaranteed in all places, an outdoor UTP cable is also installed (and connected) between the fire alarm centre and the external operator display unit as an 'emergency alarm' branch (as redundant wiring) between the centre and the control panel.

BME OR
In the BME OR facility a Siemens Cerberus CS1140 fire alarm system is installed, which is a modular microprocessor-controlled fire detection system. The location of the fire detection and fire extinguishing equipment is indicated on the following figures:

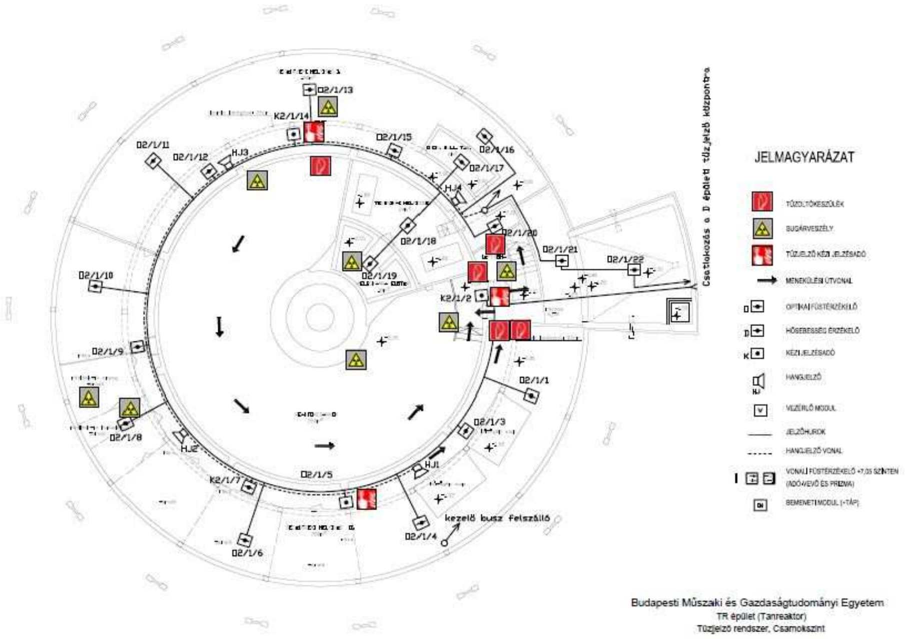

Fig. 3.2.1.2.2-1: Location of fire alarm and fire suppression equipment in the basement

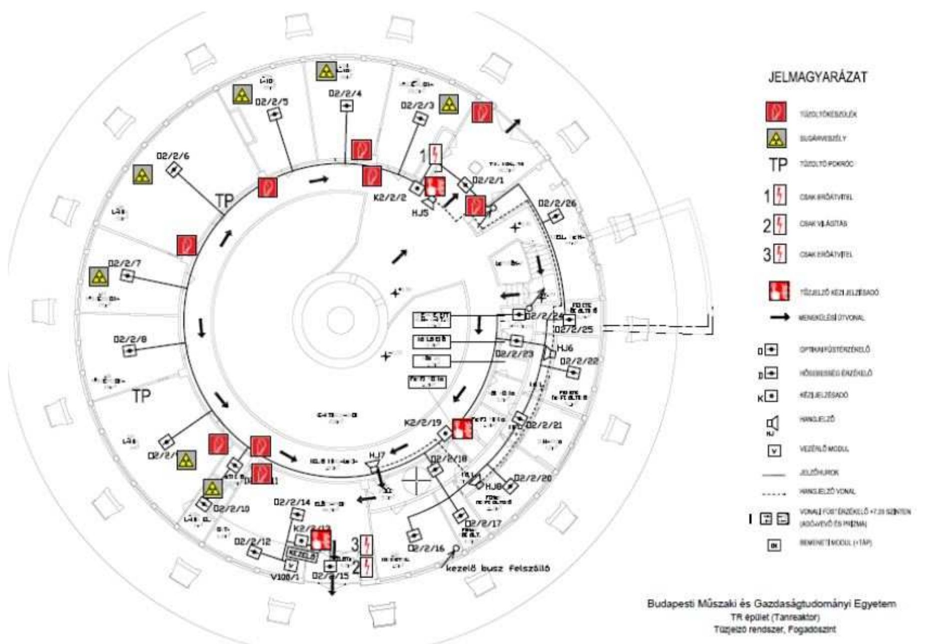

Fig. 3.2.1.2.2-2: Location of fire alarm and fire suppression equipment on the ground floor

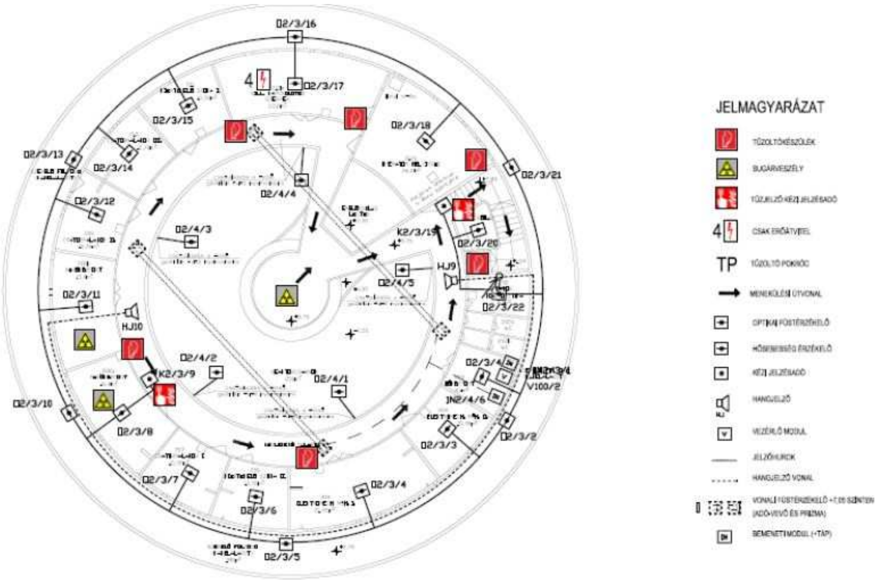

Fig. 3.2.1.2.2-3: Location of fire alarm and fire suppression equipment in the upper floor

3.2.1.2.3 Dedicated spent fuel storage facilities (KKÁT)

After reconstruction of the built-in fire alarm equipment mentioned in section 1.3.4., an intelligent fire alarm loop, manufactured by Siemens, has been installed which consists of optical smoke detectors, air duct detectors, outdoor manual signal transmitters, audible warning and light signalling devices and matching modules.

Fire alarm centre:
The Siemens Sinteso FC2040 type fire alarm centre is an analogue intelligent addressed device with 4 signalling loops. 126 addressable devices (detector, manual signal transmitter or module) can be connected onto one addressing loop of the centre. With help of the text information appearing on the graphic liquid crystal display and of the indications available on the 48 LED board, the centre immediately and unambiguously provides an indication about its all possible conditions (error, system error, fire, prohibition). The centre is operated directly on the central unit, in Hungarian language, in a menu system with windows and in a user-friendly way.

Optical smoke detectors:
The FDO241 type optical smoke detector is a wide spectrum addressed detector operating according to the principle of light-scattering, which, with help of the built-in advanced signal processing algorithm, reliably filters out the disturbing circumstances and indicates the fire in its early stage. The parameters of the detector can be adjusted with more sensitivity positions, consequently it can be fitted even better to the operating environment and to operational habits/practices. The detector is equipped with two-side short-circuit isolator, therefore in case of wire failure it automatically isolates the failed wire section, thereby ensuring further operation of the system and limiting faults.

Air duct detectors:
The FDBZ290 type air duct detector house is a passive detector unit without fan. The air sample, via the air duct and by means of pressure difference occurring in the ventilation system, continuously flows into the sampling chamber. In the chamber, the smoke detection is ensured by an FDOOT241-A9 multi-sensor detector mounted with a socket of FDB222. The air duct detector reliably operates if the ventilation system operates and there is an air stream. The air being under monitoring is normally clean and free of dust and aerosols. When the built-in smoke detector detects a given smoke concentration, the device forwards the signal related to the given hazard level to the centre, and this results in the necessary alarm. The secondary display located on the smoke detector indicates the hazard with light signal.

Manual signal transmitter:

The FDM226-RP type manual signal transmitter is an addressed loop-supplied device, which provides an opportunity of indicating the fire detection by means of manually pushing a button. The FDM226-RP type manual signal transmitter is equipped with a two-side isolator, therefore in case of a wiring fault the undisturbed operation is ensured with separation of the failed wiring section. The FDM226-RP is a directly operated indication device, accordingly the indicating panel must be pushed for fire alarm.

Audible warning, light signalling devices:
FLASHNI FL/RL/R/D type high performance outdoor audible warning and light signalling device equipped with a siren and flasher bulb, which is capable of ensuring an acoustical capacity of 103 dB.

Control and monitoring (I/O) modules:
Each module is equipped with a two-side short-circuit isolator, therefore it automatically separates the failed wiring section in case of a wiring fault, in this way ensuring further operation of the system and limitation of failures.

Cabling:
The addressing loop is installed with fire alarm cables of JB-Y(St)Y 1x2x1 mm^2. The control wiring and the audible warning-light signalling wiring are installed with function maintaining cabling of SR114H cables, and then XPS NoBurn, then YB-H(St)H 2x1 mm^2 and function maintaining support structure, respectively.

3.2.1.3 Alternative/temporary provisions

3.2.1.3.1 Nuclear power plants (PAE)

In the event of a limited operational status of the fire alarm system in a particular room, fire alarms will be provided under the staff's supervision. This includes work involving the formation of dust, fumes and/or smoke. That substitution action has a temporal limitation.

3.2.1.3.2 Research reactors

BKR

Occasional flammable activities or work involving dust/smoke generation may be required during certain maintenance and repairs. It is ensured that this is authorised in a regulated manner.
When authorizing occasional fire hazardous activities, the licensee shall pay special attention to the technical adequacy of the equipment required for the performance of the activity, the existence of a valid fire safety examination required for the performance of the activity, the prohibition of zones with built-in fire alarms, the need to remove or cover built-in, transient combustible material, the presence of additional measures (ventilation, radiation protection measurement, the need for temporary fire stops), the presence of fire extinguishers, the existence of special fire safety knowledge, operator supervision, taking back and inspection of the work area, and the documentation thereof and the communication of the supervision of the given activity.

BME OR

Normally no such activities are carried out in the facility, however during certain maintenance activities for example, which may result in fire or smoke generation the activity is subjected to authorization by the fire protection officer of the university. Such activity permits are provided on a case-by-case basis. Only the fire protection officer is authorized to turn off sections of the fire alarm system and only after the BME dispatcher was informed. A similar procedure is followed when the system is turned back on, namely that it can only be carried out by the fire protection officer and the dispatcher must be informed when the process is finished.

3.2.1.3.3 Dedicated spent fuel storage facilities (KKÁT)

The measures to be taken in case of limitation of operability of the built-in fire alarm equipment, are regulated by the local fire safety regulations of the KKÁT facility. The limitation and the exemption from that are subject to an internal permit which is issued by the person authorized to do so and the member of the fire protection organization, respectively with consideration of nuclear, radiological and fire risk. During the authorization procedure, the compensating factors are determined, for example:

- switch off of loop, zone, device;
- restriction of temporary combustible material, ignition source;

- usage of fire spread impeding devices;
- continuous personal surveillance, etc.

If the limitation means partial or full shut-down, then switching-off of the fire alarm equipment must be announced in advance towards the fire protection authority.

3.2.2 Fire suppression provisions

WENRA	Hungarian regulation	
	Nuclear Safety Codes	Nuclear Fire Safety Codes
	Nuclear Power Plants	
SV 6.9: Suitable fire extinguishing features shall be in place according to the fire hazard assessment. They shall be designed and located such that their rupture, spurious or inadvertent operation does not inadmissibly impair the SSCs important to safety. SV 6.10: The fire water distribution network for fire hydrants outside buildings and the internal standpipes shall provide adequate coverage of all plant areas. The coverage shall be justified by the fire hazard assessment. SV 6.11: […] In order to ensure the operability of the fire protection measures, procedures shall be established and implemented. They shall include examination, inspection, maintenance and testing of fire barriers, fire detection, alarm features and extinguishing systems.	3.3.7.0300. Built-in or mobile, automatic or manual extinguishing systems shall be installed, which shall be so designed and placed that the failure or unintentional operation thereof does not affect significantly the ability to perform the safety functions of systems, structures and system components important from the point of view of nuclear safety. 3.3.7.0400. The fire extinguishing system shall cover the areas within the nuclear power plant important from the point of view of safety. The coverage shall be verified by fire risk analysis	Annex I. Chapter I. 6.6. The extinguishing system should be automatic if possible, taking into account that the extinguishing does not have a harmful effect on other safety systems. 6.7. It is acceptable to install a fire extinguisher that can only be started manually, and to operate equipment designed for automatic operation in manual mode, if unjustified operation may occur and this may have a detrimental effect on the safety of the nuclear power plant. 10.7. The regulatory system of the nuclear power plant must define the requirements for periodic inspection, testing and maintenance of the built-in fire protection equipment, tools and devices, in accordance with the legal requirements, as well as the requirements of the safety standards defined in the Nuclear Safety Regulations. Where the law imposes requirements, this inspection-maintenance cycle should be adapted to the areas where the service of the area encounters obstacles due to radiation conditions, temperature, or other technological reasons.

WENRA	Hungarian regulation	
	Nuclear Safety Codes	Nuclear Fire Safety Codes
Research Reactors		
S 4.2: Fixed or mobile, automated or manual extinguishing systems shall be installed. They shall be designed and located so that their rupture, spurious or inadvertent operation does not significantly impair the capability of SSCs important to safety to carry out their safety functions. S 4.3: The distribution loop for fire hydrants outside building and the internal standpipes shall provide adequate coverage of areas of the research reactor relevant to safety. The coverage shall be justified by the fire hazard analysis. S 5.1: […] In order to ensure the operability of the fire protection measures, procedures shall be established and implemented. They shall include inspection, maintenance and testing of fire barriers, fire detection and extinguishing systems.	-	Annex I Chapter II. 6.3. The design of fire alarm and extinguishing systems must be based on the results of the fire risk analysis. 6.5. The extinguishing system must be automatic. The extinguishing system must be designed in such a way that the extinguishing does not have a harmful effect on other safety systems. 6.6. An extinguishing device with manual start-up can only be installed, and an extinguishing device designed for automatic mode can be operated in manual mode if the possibility of unjustified operation may occur and this may have a detrimental effect on the safety of the research reactor.
Spent Fuel Storage Facilities		
SV 6.9: Suitable fire extinguishing features shall be in place according to the fire hazard assessment. They shall be designed and located such that their rupture, spurious or inadvertent operation does not inadmissibly impair the SSCs important to safety. SV 6.10: The fire water distribution network for fire hydrants outside buildings and the internal standpipes shall provide adequate coverage of all plant areas. The coverage shall be justified by the fire hazard assessment.	-	Annex I. Chapter III. 6.3. The design of fire alarm and extinguishing systems must be based on the results of the fire risk analysis. 6.6. Extinguishing with water or water mist cannot be used in areas containing spent fuel. 6.7. The extinguishing system must be automatic. The extinguishing system must be designed in such a way that the extinguishing does not have a harmful effect on other safety systems. 6.8. Manually activated fire extinguishers can only be installed, and fire extinguishers designed for automatic operation can only be operated in manual operation if there is a possibility of unjustified operation and this could have a detrimental effect on the safety of the storage facility.

3.2.2.1 Design approach

3.2.2.1.1 Nuclear power plant (PAE)

In the nuclear power plant site, fires are extinguished with extinguishing agents optimally suited to extinguish fires of combustible materials typical of the area.

- Dry pipe sprinkler systems extinguishing with water for the protection of cable rooms, primary oily rooms, outdoor transformers,
- Water mist extinguishing systems for the protection of diesel generator rooms and turbine oil systems,
- Stable foam extinguishing systems to protect turbine oil tanks,
- Built-in gas extinguishing systems ensuring fire suppression in whole rooms - for the protection of reactor protection rooms, units' computer rooms, emergency control rooms and refuelling control rooms as well as the simulator,
- Built-in local gas extinguishing systems for the protection of cabinets at risk in control rooms

Unit 1 of the nuclear power plant was commissioned and started generating electricity for the grid in 1982. At that time, the plant did not have a fire risk analysis, which is now an additional requirement under national regulations. Fire extinguishing systems were installed in accordance with national legislation and standards of the respective age. The fire alarm system installed at the time of the plant's construction was replaced over a longer period of time, when the current system was installed, taking into account the EN54 standard. During the 10-year review of the fire risk analysis, the need for new fire extinguishing systems to reduce the risk was examined when risk in the areas concerned was assessed. Accordingly, local gas extinguishing systems were designed and installed, 35 systems per unit in the instrumentation and control rooms, as well as water mist extinguishing systems for the turbine oil system, in total 8 per turbine unit, along with the water mist extinguishing systems for the diesel generator units. For details see section 3.2.2.2.1. In the subsequent period, in the fire risk analysis subsection of the fire safety chapter in the design documentation for modifications the fire risk analysis regularly looks at a possible modification to the fire alarm system design. It is to be noted that as of yet this was not necessary.

3.2.2.1.2 Research reactors

BKR

During the reconstruction of the reactor structures in the 1990s, fire protection plans were drawn up with the approval of the fire safety authority. These fire protection plans include the division of the buildings into fire sections, as well as the fire risk classification of each fire section. The plans describe the quantity and type of extinguishing agents required, based on the fire risk classification, the type of combustible materials and the risk class. In places where extinguishing the fire with water is prohibited (e.g. nuclear, radiation classified premises), powder based hand-held fire extinguishers and CO_2 automatic extinguisher systems are installed in quantities appropriate to the fire protection plans. In summary the available fire suppression provisions are the following:

- Primary protection is 10 pcs wall hydrants fed from the water network,
- Secondary protection is provided by a 300 m^3 firewater storage basin with pump station,
- 14 above-ground hydrants connected to the firewater system,
- 10 pcs wall hydrants installed in the reactor building,
- Hand and portable fire extinguishers installed on the BKR site, 110 pcs,
- Automatic carbon dioxide extinguishing system for extinguishing the cable rooms of the reactor block, 1 pce.

The licensing process for the new automatic reactor block fire extinguishing system has been completed, and the construction of the system is scheduled for the 2nd or 3rd quarter of 2023. The local system will consist of the Sigma XT fire extinguishing control centre and Wagner CO_2 gas extinguishing equipment designed for the reactor block area, with an automatic operation and display (signal processing) system compatible with the existing fire alarm system. The automatic CO_2 extinguishing system will be the fire detection and extinguishing system for the cable tunnel on the reactor body, replacing the manually operated Halon extinguishers that have been available until now.

BME OR

The fire-fighting water sources comply primarily with the rules valid at the time of commissioning of the facility, however they are maintained and inspected according to the currently valid rules and regulations. In places where it is forbidden to extinguish with water (e.g. in rooms classified as nuclear, radiation hazard), powder and CO_2 extinguishers are installed in quantities corresponding to the fire protection plans. Manual and portable fire extinguishers placed in the area are regularly maintained. The replacement and creation of adequate reserves of fire extinguishers are the responsibility of the operational organization of the BME University, which is different from the reactor operator organization.

3.2.2.1.3 Dedicated spent fuel storage facilities (KKÁT)

The extinguishing of fire cases as quickly as possible also belongs to the second level of defence in depth. The arrangement of the KKÁT facility, as well as its construction made of steel and concrete ensure that there is no opportunity for occurrence and spreading of more significant fires, therefore automatic fire extinguishing equipment operating with water spray, water mist or having a sprinkler system have not been installed as part of the design. It has to be noted that the domestic decrees, come into force in the meanwhile and mentioned in section 1.3.4, forbid to extinguish with water and water-mist in the areas containing spent fuels.

Smaller, local electrical or carbon hydride fires may occur, which can be extinguished with manual (portable) fire extinguishing device, however, there are no predictable situations during which such smaller fires possibly endanger the long-term integrity of fuel assemblies and their protection system.

In the KKÁT facility only hand-held (portable) fire extinguishing equipment is available and kept in store as fire extinguishing devices. A particular attention is paid for the provision of their appropriateness and operability, therefore they are replaced with ones having the highest fire class available at the market, with a period of 5 years which is stricter than what is prescribed by the national fire protection requirements.

3.2.2.2 Types, main characteristics and performance expectations

3.2.2.2.1 Nuclear power plants (PAE)

Dry pipe sprinkler systems extinguishing with water

- The systems protect the cable compartments as well as the oil pump rooms in the controlled access area, and the extinguishing systems are connected to the fire water system. The sprinkler heads are all VIKING 10 mm.
- The operating pressure of the systems is 8 bar.
- In the cable compartments of the controlled access area, the system operates automatically.
- The time for fire extinguishing is 5 minutes according to national regulations.
- It is installed to protect 5 oil system rooms and 38 cable rooms per unit.

Water mist extinguishing systems for the protection of turbine oil systems

- The system is installed as an autonomous system with 4 extinguishing zones per turbine-generator unit. The components of the system (2 pieces of 600-litre demineralised water tanks, nitrogen cylinders and control unit) are installed in a container. The sprinkler heads cover the intended fire zones. The zone to be extinguished is protected by fire alarm equipment.
- Autonomous adjacent systems are also backups for each other, in line with the principle of single failure tolerance. Fire is extinguished in 30-second waves.
- The systems are in the medium pressure level, their operating pressure is 16 bar.

Water mist extinguishing systems to protect diesel generators

- The components of the system (a 600-litre demineralised water tank, nitrogen cylinders and control unit) are installed in a container. The zone to be extinguished is protected by fire alarm equipment. Sprinklers cover the fire zones in the machinery space. In addition to protecting adjacent diesel units, the autonomous systems are also backups for each other, in line with the principle of single failure tolerance.

- The systems are in the medium pressure level, their operating pressure is 16 bar.

Stable foam extinguishing systems

- These systems protect the main oil tanks and gravity oil tanks of turbines.
- For extinguishing, 1 cubic metre of foam concentrate is available per two turbine units (one reactor unit), mixed at a rate of 4%.
- Since the oil tanks are located in a concrete salvager "rooms", and foam extinguishers are used to flood these rooms. The zone to be extinguished is also protected by fire alarm equipment.
- The room to be extinguished is selected on a foam solution manifold.
- The extinguishing is manually triggered either from the unit’s main control room or on site, the extinguishing time is 10 minutes.
- The systems form a medium foam with a 200 foam yield.

Built-in gas extinguishing systems

- Built-in gas extinguishing systems providing spatial extinguishing. The systems are automatically triggered, with a 30-second delay after a fire alarm.
- They have been installed to protect the units' emergency control rooms, units' computer rooms, units' reactor protection rooms and refuelling machine control rooms and the simulator.
- The extinguishing gas is available in 100-150 litre containers, under pressure, in a protected room.

Built-in local gas extinguishing systems

- The extinguishers were installed as a safety enhancement measure, at 35 locations per unit, following a fire risk analysis. The extinguishers are set up for local protection of the safety relay cabinets. The extinguishing gas under pressure is available in a 5-litre container mounted on the side of a cabinet of the group of cabinets to be protected.
- Fire extinguishing is basically done as follows: starting from the cylinder valve, "Firetrace" detection tubes are introduced into the cabinets. Where a fire occurs, the tube bursts, the extinguishing gas is released and extinguishes the fire. The cylinder valve is equipped with a pressure sensor, the release of gas generates a fire alarm on the fire alarm system.

3.2.2.2.2 Research reactors

BKR

During the reconstruction of the reactor structures in the 1990s, fire protection plans were drawn up with the approval of the fire safety authority. These fire protection plans include the division of the buildings into fire sections and a detailed description of these sections. The plans describe the quantity and type of extinguishing agents required, based on the fire risk classification, the type of combustible materials and the risk class. In places where extinguishing the fire with water is prohibited (e.g. nuclear, radiation classified premises), powder fire extinguishers and CO_2 automatic extinguisher systems are installed in quantities appropriate to the fire protection plans.

The required quantity of extinguishing water, calculated on the basis of the fire section, is 3,300 l/min, as required by the legislation in force at the time of construction, which must be provided for 1.5 hours, taking into account a fire load of 500 MJ/m^2. This is ensured by the 300 m^3 fire water reservoir constructed in the open area of the sports ground in the immediate vicinity of KFKI. The reservoir is filled from a branch of the municipal water supply system on Konkoly Thege Miklós road, with a filling time of approximately 14 hours. The draining of the reservoir is only allowed for the duration of the maintenance after prior notification of the competent fire protection authority.

In the vicinity of the reactor building, the 3300 l/min of fire water is available at a pressure of 2 bar under the most unfavourable outflow conditions. This volume is supplied by 2 pumps from the pool, so that while one is in operation, the other is available as a reserve. The pumps are located in an underground pump shaft connected to the reservoir, with an associated 200 l air tank and compressor to ensure that any leakage does not cause frequent pump starts. The electricity supply of the pumps is provided by an independent double branching from the Reactor Department's main distributor.

The extinguishing water obtained from the fire water pipeline and of the appropriate pressure, reaches the circular network around the reactor building via the fire water supply pipeline, from which it also reaches both staircases of building 10 via two branching. At every branching per level an upcommer piping (left and right) is installed with a capacity of 200 l/min per hydrant. There are 14 outdoor above-ground hydrants on the fire water backbone piping. The main ring can be sectioned at two points by sliding valves, which are in open condition as default. In the event of a pump failure, the ring main can be connected to the municipal water network.

Fire-fighting water sources shall comply with the rules in force at the time of installation. They are maintained and inspected in accordance with the currently valid National Fire Protection Regulation. Approximately 110 hand-held and portable fire extinguishers are provided in the area of the RD. An integral part of the fire protection equipment is the fire alarm system installed in the research reactor area in 2013, to which the automatic extinguishing system of the facility is connected.

Description of the built-in automatic CO_2 extinguishing system installed:
When designing the built-in automatic extinguishing system, it was required that the extinguisher should be an autonomous carbon dioxide extinguishing system, but should provide a transfer signal to the SecuriFire2000 fire alarm system installed in the area. Taking into account the requirements, a WAGNER CO_2 extinguishing system controlled via an autonomous extinguishing control centre type SigmaXT is being installed to solve the task. The extinguishing system is designed to protect assets and technology by rapidly suppressing fires detected in the initial phase and preventing burn-back. In this case, 1 extinguishing sector has been established, consisting of the following 3 extinguishing zones:

- cable bridge room,
- the left cable room in the outer wall of the reactor,
- the right cable room in the outer wall of the reactor.

Aspiration detector type Securiton SecuriRAS ASD535-4 consisting of:

- 2 pcs high sensitivity smoke detectors,
- 2 pcs 'Y' shaped suction tubes,
- a signal processing unit with a level display (on front panel),
- 2 pcs relay panels RIM35 (in a device housing),
- interface modules (BX-IM4).

Fire extinguishing control centre and external operator display unit:

- The extinguishing system is controlled by the extinguishing control centre SIGMA XT.
- The extinguishing control centre receives the fire alarms from the aspiration system per pipe branch, and
- in the event of a fire alarm coming from both zones (pipe branches), issue an extinguishing start command to the extinguishing plant. The extinguishing control signal is connected to the designated input of the extinguishing plant (pilot cylinder starter magnet) by means of fireproof cabling.
- An external operator display unit will be installed in the Control Room.

Audible and optical warning signals:
In addition to the control and signal reception functions, the extinguishing control centre performs the local audio signalling tasks, so the audible and optical signals (totally 4 pcs) and display panels with audible and optical signals ('Fire extinguishing starts. Leave the room!' and 'No entry! Automatic fire extinguishing in progress', 2 plus 2 in total) are also connected to the extinguishing centre

- in the upstairs corridor in front of the control room,
- in the ground floor corridor,
- on both sides of the 'podest' in the reactor room.

In the event of a pre-alarm (fire alarm 1), the audible and optical signals are activated, and in the event of fire extinguishing (fire alarm 2), the panels (also) are activated.

The signal of the events listed below will be transferred to the building fire alarm system:

- fire and fault indications of the aspirating sensor,
- fault indication of the separate power supply,
- the main operating signs of the extinguishing centre, and
- signals from the CO_2 extinguishing station

are connected to the existing fire alarm system through the input modules in the detection ring of the existing fire alarm system.

BME OR

There is no automatic fire suppression system within the BME OR facility. Internal fire-fighting capability is ensured via hand-held and portable fire extinguishers in compliance with the national regulations. There are a total of 23 manual fire extinguishers in the training reactor:

- Neuruppin – PG 6 Euros-S 6 kg/l (Extinguishing performance class: 43A) – 3 pcs,
- Neuruppin – KS 5 BG 5 kg/l (Extinguishing performance class: 89 B) – 2 pcs,
- Neuruppin – S 6 DN eco-classic 6 kg/l (Extinguishing performance class: 21A) – 11 pcs,
- Neuruppin – KS 2 BG 2 kg/l (Extinguishing performance class: 34B) – 7pcs.

3.2.2.2.3 Dedicated spent fuel storage facilities (KKÁT)

In the KKÁT facility a total of 36 hand-held and portable fire extinguishing devices (10 pieces manufactured in 2020 and 26 pieces manufactured in 2021) are available and kept in store, with the following distribution:

- dry chemical extinguishers with a charge weight of 6 kg, with a fire class of 34A 183B C - 9 pcs
- dry chemical extinguishers with a charge weight of 6 kg, with a fire class of 55A 233B C - 21 pcs
- CO_2 manual extinguishers with a charge weight of 5 kg, with a fire class of 89B - 6 pcs

3.2.2.3 Management of harmful effects and consequential hazards

3.2.2.3.1 Nuclear power plants (PAE)

In order to manage and mitigate potential harmful effects and consequential hazards the following requirements are set:

- Only carbon dioxide fire extinguishers can be used in the environment of open primary circuit equipment (e.g.: during maintenance, during shut down with atmospheric pressure in the system).
- In the vicinity of electrical equipment only powder and carbon-dioxide based fire extinguishing systems are allowed to be installed. The foam extinguishers installed in the power plant cannot be used to extinguish these fires.
- The fire department of the nuclear power plant can extinguish electrical fires with water using the special jet tubes, while taking into account the protective distances allowed for the voltage levels. The fire department of the nuclear power plant receives theoretical practical training for these activities twice a year. The jet tubes are inspected annually.

3.2.2.3.2 Research reactors

BKR

In places where extinguishing the fire with water is prohibited (e.g. nuclear, radiation classified premises), a powder based hand-held and portable fire extinguisher and an automatic system for extinguishing with CO_2 is used. The CO_2 fire extinguishing system of the refurbished reactor block does not contain enough gas, either, given the amount of air in the reactor hall, which would have a detrimental effect on the workers there. The system is installed in the enclosed cable room, so it cannot be approached closely.

BME OR

In places where extinguishing the fire with water is prohibited (e.g. nuclear, radiation classified premises), a powder based of CO_2 based hand-held and portable fire extinguishers are installed according to the relevant national regulations.

3.2.2.3.3 Dedicated spent fuel storage facilities (KKÁT)

During possible usage of hand-held and portable fire extinguishing devices stored in the KKÁT facility, harmful impact and consequences concerning nuclear safety do not have to be considered.

3.2.2.4 Alternative/temporary provisions

3.2.2.4.1 Nuclear power plants (PAE)

In the case of inoperable fire extinguishing systems, protection is provided by personal supervision. In case of an active fire alarm, personal supervision ensures the fire extinguishing capability with the fire extinguisher on site or provided. By personal supervision a trained firefighter equipped with protective equipment or an operating worker is meant, in compliance with the national regulations.

3.2.2.4.2 Research reactors

BKR

If the operating personnel are in charge and the extinguishing system is not in operation, protection can be provided by personnel supervision by the extinguishing capability of an extinguisher of the appropriate size and type installed on site. If the system is left in an abandoned state, then operating personnel responding to an alarm from the Armed Security Guards (ASG) may commence extinguishing the local fire after a significant time delay. During this time, the professional firefighting members may arrive on the scene.

BME OR

Within the BME OR reactor building hand-held and portable fire extinguishers are placed every few meters, therefore in case of malfunction a different extinguisher is available in a short distance. Incidental fire-hazardous activities (e.g. maintenance involving welding) are regulated by the requirements of the National Fire Protection Regulation, which require the contractor to place an additional fire extinguisher at the location of the activity.

It is necessary for the fire protection officer to notify the BME dispatcher about the deactivation (and later re-activation) of the fire alarm system before starting the activity if it involves flame and/or smoke generation. If a fire occurs with the fire alarm section turned off, the staff immediately detects it and extinguishes it with a manual fire extinguisher. Only one section can always be switched off, all other section must remain operational.

3.2.2.4.3 Dedicated spent fuel storage facilities (KKÁT)

The measures to be taken in case of limitation of operability of the manual fire extinguishing devices are regulated by the internal Fire Protection Regulation of the KKÁT facility. In such cases the members of the fire protection organization must be informed who will immediately perform the replacement from the stock of spare fire extinguishing devices.

3.2.3 Administrative and organisational fire protection issues

WENRA	Hungarian regulation	
	Nuclear Safety Codes	Nuclear Fire Safety Codes
	Nuclear Power Plants	
SV 5.10: Adequate organisational arrangements, including minimum staffing levels, equipment, fitness for duty, skills and training, and procedures shall be in place to ensure safety, as identified by the hazard assessment. SV 6.11: In order to prevent fires, procedures shall be established to control and minimize the amount of combustibles and the potential ignition sources. In order to ensure the operability of the fire protection measures, procedures shall be established and implemented. They shall include examination, inspection, maintenance and testing of fire barriers, fire detection, alarm features and extinguishing systems. SV 6.12: Written procedures that clearly define the responsibility and actions of staff in responding to any fire in the plant shall be in place and kept up to date. A firefighting strategy shall be developed, kept up-to date, and appropriate training provided, to cover each area in which a fire might affect SSCs important to safety. SV 6.13: If plant internal firefighting capability is supported by offsite resources, there shall be proper coordination between the plant personnel and the offsite response group, in order to ensure that the latter is familiar with the hazards of the plant. Emergency training, drills and exercises shall be performed. SV 6.14: If plant personnel are required for firefighting, their organization, minimum staffing level, equipment, fitness requirements, skills and training shall be documented and their adequacy shall be confirmed by a competent person.	4.4.1.0100. The necessary number and knowledge of personnel that is required for safe operation shall be analysed systemically, as specified in documents. 4.4.1.0300. The licensee shall ensure the availability of the necessary and sufficient personnel required for safe operation. 4.4.1.0600. The operating personnel shall at all times fulfil the requirements of numbers, qualifications, training, experience, commitment toward nuclear safety, health status, physical and psychological suitability, which are defined in writing for each given task. The aforementioned shall ensure that the operating personnel are able to perform their duties even in the case of DBC2-4 and DEC1-2. The fulfilment of requirements shall be documented. 4.13.0.0600. An internal regulation shall be developed and continuously updated that clearly defines the responsibilities of personnel working independently on the site of the nuclear power plant, and the required actions in order to protect the nuclear power plant against fires. 4.13.0.0700. The organizational responsibilities and tasks shall be defined in the field of fire protection and these shall be reflected in the organizational structure and the related job descriptions. 4.13.0.0800. If fire extinguishing tasks are provided by an external organization then coordination shall be facilitated between the external response organization and the fire protection personnel of the licensee in order to ensure that the external organization is aware of the dangers of the nuclear power plant.	4. § (1) Fire protection organization must be established to perform preventive fire protection tasks in the nuclear power plant. 4. § (4) The personnel of the nuclear power plant must be given theoretical and practical training, which, depending on the job, includes, in addition to general fire protection knowledge, the handling and use of hand-held fire extinguishers, respiratory protection and personal protective equipment. Annex I. Chapter I. 10.12. In the regulatory system of the nuclear power plant, the conditions for manual fire extinguishing by external forces, the tasks related to the coordination of the coordinated activities of the firefighting units and the nuclear power plant personnel must be defined…

WENRA	Hungarian regulation Nuclear Safety Codes	Nuclear Fire Safety Codes
	Research Reactors	
S 5.1: In order to prevent fires, procedures shall be established to control and minimize the amount of combustible materials and minimize the potential ignition sources that may affect items important to safety. In order to ensure the operability of the fire protection measures, procedures shall be established and implemented. They shall include inspection, maintenance and testing of fire barriers, fire detection and extinguishing systems. S 6.1: The licensee shall implement adequate arrangements for controlling and ensuring fire safety, as identified by the fire hazard analysis. S 6.2: Written emergency procedures that clearly define the responsibility and actions of site personnel in responding to any fire in the research reactor shall be established and kept up to date. A firefighting strategy shall be developed, kept up-to date, and trained for, to cover each area in which a fire might affect items important to safety and protection of radioactive materials. S 6.3: When reliance for manual firefighting capability is placed on an offsite resource, there shall be proper coordination between the licensee's response group and the off-site response group, in order to ensure that the latter is familiar with the hazards of the research reactor. S 6.4: If site personnel is required to be involved in firefighting, their organization, minimum staffing level, equipment, fitness requirements, and training shall be documented and their adequacy shall be confirmed by a competent person.	5.2.15.0600. During the design and construction of the research reactor and its systems, structures and components, beyond the requirements of Sections 5.1.15.0100.-5.2.15.0500. the respective, effective fire protection regulations and technical requirements shall be ensured. 5.3.18.0100. The licensee shall comply with the fire protection legislations. The licensee, in cooperation with competent national, regional and local organizations, shall prepare for the protection against fire and the technical rescue. 5.3.18.0200. The workers shall support the fire fighters to commence, as soon as possible, the fight against the fire on the spot of the fire. Consequently, fire protection rules and a fire alarm plan shall be developed for the entire site of the nuclear facility.	4. § (1) Fire protection organization must be established to perform preventive fire protection tasks in the research reactor. 4. § (4) The personnel of the research reactor must be given theoretical and practical training, which, depending on the job, includes, in addition to general fire protection knowledge, the handling and use of hand-held fire extinguishers, respiratory protection and personal protective equipment. Annex I. Chapter II. 10.8. In addition to the provisions of the relevant fire protection legislation, the research reactor's fire protection regulations must also meet the requirements of the Nuclear Safety Regulations.

WENRA	Hungarian regulation	
	Nuclear Safety Codes	Nuclear Fire Safety Codes
Spent Fuel Storage Facilities		
For interim spent fuel storage facilities no such WENRA SRLs exist.	6.2.1.10800. Considering the effect of a fire or explosion, the concerned process systems and the risk of fire-fighting, the equipment to detect fire or explosion shall be designed to automatically provide warning signal for the workers to be able to perform the necessary protection measures. 6.2.1.10900. In the case of inflammable solid and liquid wastes, the conditions of effective fire alarm and fire-fighting shall be established in such a way that prevents, to the extent possible, any release of the radioactive materials contained in the system during the fire and fire-fighting. 6.2.1.11000. The consequences of the fire and fire-fighting, as well as the way how the generated waste can be collected shall be taken into account in the design.	Annex I. Chapter III. 5.3. Systems containing flammable liquids and gases must have adequate protection to prevent leaks and spills, as well as have built-in safety elements that limit leaks and spills in the event of a malfunction. 6.1. In order to ensure the protection of safety systems and system components, the facility must have appropriate devices capable of keeping the fire under proper control. 6.2. Keeping the fire under proper control is the right combination of the use of built-in fire extinguishers and the ability to manually extinguish the fire.

3.2.3.1 Overview of firefighting strategies, administrative arrangements and assurance

3.2.3.1.1 Nuclear power plants (PAE)

At the nuclear power plant, a team of fire protection engineers is integrated into the safety organisation to perform preventive fire protection tasks, including PAE internal regulations and control tasks. In accordance with the national regulations in force, the nuclear power plant has an industrial fire brigade available with a 24-hour on-call service. Their training, service design and equipment are identical with those of the PFHs and professional fire brigades. In addition, in case of fire, plant personnel trained in fire-fighting, with breathing apparatus and fire-fighting uniforms are available for intervention and handling of the technological process, both by specialised area and by shift.

Operational and maintenance staff employed by the plant undergo annual fire-fighting training. The plant staff and the fire brigade participate in several joint drills per year in different areas of the nuclear power plant units according to a common training plan. Firefighting and damage control plans are available for the intervention. Joint drills with professional fire brigades are carried out with the fire brigades whose intervention is planned in the event of a fire. The effectiveness of the joint intervention is verified via annual drills.

3.2.3.1.2 Research reactors

BKR

There is no fire brigade on the site. If a fire threatens human life, the first and most important thing is to save lives. Depending on the nature of the fire, the circumstances in which it was detected and the number of people on the scene, the following actions may be necessary.

- For incipient, non-extensive fires:
  - preparation for firefighting (if necessary),
  - starting to extinguish the fire,
  - fire notification.
- For fires that have already spread and where the use of fire-fighting tools, equipment and materials at the workplace no longer seems sufficient for effective extinguishing of the fire:
  - Start the preparation for the firefighting,
  - fire notification.

When starting to extinguish a fire, the fire-fighting equipment, supplies and materials available at the workplace shall be used.
In the context of fire-fighting preparation, the following actions must be carried out simultaneously or in the appropriate order:

- the shutdown of technologies and other machinery that can be stopped in a specific sequence for safety reasons,
- closing of natural and artificial ventilation systems,
- removal of hazardous substances (gas cylinders, radiators, flammable and explosive substances, etc.) from the vicinity of the site,
- freeing up transport routes,
- disconnection of relevant electrical systems,
- shutdown of utilities (gas, etc. pipelines), except for the extinguishing water system, if possible, with the involvement of the technical supervisor of the institution and / or the KFKI site (KFKI Ükft. Energy Supply Group).

BME OR
The administrative and organizational issues of active fire protection is regulated via the internal Fire Protection Regulation of the facility. The facility does not have on-site fire brigades and fire departments. As a general consideration if the fire threatens human life, then the primary goal is to avoid the loss of life. Routes significant for transport and firefighting as well as the routes leading to water sources must be kept unobstructed at all times and in a condition that is suitable for the movement and operation of firefighting vehicles. Access to the switches of relevant electrical equipment, the opening and closing mechanism of the utility, the manual signal of the fire alarm, the pressure booster pump, the operating mechanism and openings of the heat and smoke exhaust, as well as the fire protection equipment and devices both in the reactor building and in the surrounding area must be permanently ensured and they must not be blocked even temporarily.

Door and window structures considered for evacuation and escape must not be closed while there are people in the premises. Explosive and flammable materials may not be placed in the escape routes and stairwells of the buildings. Escape routes of buildings cannot be narrowed.

Once a fire is detected, its extinguishing shall begin while taking into consideration the following:

- Everyone is obliged to participate in extinguishing fires to the extent realistically expectable and follow the orders of the personnel charged with leading the firefighting activity.
- In the event of a fire, before the fire extinguishing can begin, it has to be ensured that there are no people in the area threatened by the fire. The first goal must always be to save people and prevent accidents.
- In the case of an electrical fire, the power must first be disconnected, and in the case of a natural gas fire, the main gas shut-off valve must be closed. It is forbidden to put out the natural gas fires until the disconnection assembly of the affected equipment or line has been blocked. Up until that point the goal is to cool the environment in order to prevent the spread of the fire.

3.2.3.1.3 Dedicated spent fuel storage facilities (KKÁT)
As part of execution of its fundamental tasks prescribed by the relevant legislation, KKÁT, as the Licensee, developed a local Fire Protection Regulation in which the fire protection, fire safety requirements, as well as the method of complying with them, are determined taking into account the fire protection laws, the fire protection technical guidelines and the national standards, and if such requirements are fulfilled, especially during operation of the facility and handling of spent fuel, then it is possible to reduce the fire risks, consequently significant fire cases can be prevented. In order to do so, the Licensee created and operates a fire protection organization. Considering the negligible fire risk factors detailed in the previous chapters, the fire protection organization does not include fire

extinguishing staff and devices. In the Fire Protection Regulation, the following items have been determined:

- the organization of fire protection of the KKÁT, as well as its management, tasks, procedures and internal regulations, furthermore the persons performing fire protection tasks, as well and their tasks,
- the nuclear facility, as well as the fire protection requirements to be applied during design, licensing, construction processes of systems, components, buildings of such facility (fire protection design requirements, principles, designer rights, conditions of elaboration of fire hazard analysis, fire protection rules of construction activity),
- the nuclear facility, as well as the fire protection requirements to be applied during operation activities of systems, components, buildings of such facility (requirements and implementation of defence in depth from fire protection aspect, fire protection rules of activity, condition maintenance of fire protection technical systems),
- the fire protection inspections, during which the members of the fire protection organization perform an internal inspection on a six months basis,
- the fire protection training, education, which complies with the regulations set in the Nuclear Safety Codes [A19], which is implemented at four levels (initial, refreshing, developmental, extraordinary), and which is obligatory for all employees to participate in
- matters to be managed and procedures on making contact with the authorities, during which, in cases prescribed in the national fire protection laws, licensing, announcing/notification obligations are fulfilled,
- the measures to be taken in case of fire (alarm, fire indication, escape, lifesaving, fire extinguishing),
- the fire investigations, during which, in accordance with the Nuclear Safety Code legislation [A19] requirements and the fire protection Act [A5] requirements, has to be made by the fire protection authority and the competent internal organization,
- the fire protection sanctions, which are initiated by the employer in case of a fire protection violation endangering the facility's safety.

The task of the fire protection organization is to make the requirements set in the local fire protection regulation known by the stakeholders, to comply with them and to make the stakeholders comply them. The internal Fire Protection Regulation also covers the requirements of the fire safety culture.

3.2.3.2 Firefighting capabilities, responsibilities, organisation and documentation onsite and offsite

On the part of the professional fire headquarters, the availability and professional use of resources necessary for intervention is ensured for all facilities. Local and regional members of disaster management also have vehicles and operating personnel equipped with all the special skills necessary for the quick and efficient elimination of suspected incidents in the facilities, in order to protect human life and material assets.

Taking into account the special circumstances of each facility, the professional fire headquarters have prepared a Firefighting and Technical Rescue Plan (FTRP) in compliance with their obligations set out in the applicable law (Act XXXI of 1996 on the protection against fire, technical rescue and the Fire Department). For the preparation of the FTRP, the facilities provided all the necessary data.
Detailed rules for preparing the FTRP established in Decree 39/2011. (XI. 15.) of the Ministry of the Interior, on the general rules of firefighting and technical rescue activities of the fire department.

The FTRP is a special plan to support firefighting and technical rescue, containing the firefighting force and equipment needed, which also contains the most important data from the rescue and fire protection's point of view of the given facility, area, supplemented with drawings and text. Changes in the data of the FTRP must be continuously investigated, for which the head of the obliged facility or area is responsible. The procedure created in this way and established by law ensures that possible incidents requiring firefighting or technical rescue in the facilities are handled professionally, ensuring the protection of human life and material assets.

3.2.3.2.1 Nuclear power plants (PAE)

In the event of a fire, the first responder is the Nuclear Power Plant's professional industrial Fire Brigade. 18 trained firefighters per shift are available for deployment all the time. Their technical equipment consists of 2 truck-mounted monitors, a monitor with mixed water-powder-foam extinguishing agent, a cherry-picker (aerial work platform), a command vehicle to control the extinguishing operation, a number of foam extinguishing trailers and an ambulance equipped for medical first aid.

- The training and physical preparedness training of the fire brigade is carried out according to a pre-planned, signed training plan with a daily breakdown.
- The theoretical and practical knowledge of firefighting staff is checked through examinations.
- Firefighters take physical fitness tests per age group.
- The results of these exams also have an impact on their regular salary.
- Operational staff with the same equipment as firefighters are trained for any necessary technological intervention.
- Firefighting and damage control plans for 18 areas of the power plant are available for manual fire extinguishing.

At the nuclear power plant, written policies and procedures are available to regulate, among other things, preventive and rescue fire protection. The preventive fire protection policy includes the duties and responsibilities of managers, of the fire protection organisation and of the employees. These regulations include rules on training and testing of workers in fire safety, minimisation and control of combustible materials, and rules for carrying out activities involving a fire risk.

The inspection requirements for fire-retardant structures, the inspection and maintenance requirements for fixed fire detection and fire extinguishing equipment, the requirements for periodic cleaning of ventilation systems, the requirements for the inspection of fire extinguishers and the fixed fire water system are regulated in accordance with the applicable national regulations.

3.2.3.2.2 Research reactors

BKR

As it was described in the previous section, the BKR facility has no fire-brigade on site. The local rules of conduct to be followed in the event of a fire shall be laid down in the workplace fire safety instructions. Until the arrival of units of Professional Firefighting Headquarter, the on-site tasks shall be managed by the senior manager present. The location of the dead or extinguished fire shall be left untouched until the fire test is carried out. The head of the institution is responsible for its custody. In nuclear rated rooms (radiation hazard sign) the following regulations shall be followed:

- do not extinguish the fire with water,
- the use of a respirator or gas mask is mandatory when extinguishing the fire,
- entry only in the presence of a dosimetrician.

The control room service shall deactivate the ventilation systems in the event of a fire. The management issues of fire protection are included in the chapter titled 'Fire protection organization and tasks of the Research Reactor' of the Reactor Department's local FPR, where the organization of the management and the assigned tasks are also described in detail.

The following extinguishing systems are available:

- Primary protection is 10 pcs wall hydrants fed from the water mains,
- For secondary protection, the 300 m^3 firewater storage basin with pumping station,
- 14 pcs above ground hydrants connected to the firewater system,
- 10 pcs wall hydrants installed in the reactor building,
- Hand-held and portable fire extinguishers on the premises, 110 pcs.
- Automatic CO_2 extinguishing system for the reactor block cable room.

In the event of a fire, the Armed Security Guards on duty must be notified as soon as possible and they will alert the Central Main Duty Service of the BM OKF on duty in the area. External firefighters are provided with regular walk-downs in the area, thanks to which they have adequate knowledge on the layout of the facility, and a fire protection map is also provided for them.

BME OR

In the case of a fire, the dispatcher of the university and the standby operator of the reactor must be notified as soon as possible, who will alert the regionally competent Professional Firefighting Headquarter.

3.2.3.2.3 Dedicated spent fuel storage facilities (KKÁT)

Considering the negligible fire risk factors detailed in the previous sections, as well as in the absence of legislative obligation, there is no facility fire brigade in the KKÁT facility. In case of a possible fire case, the primary intervener is the Professional Firefighting Headquarters of Paks (Paks PFH). In order to facilitate the work of the Paks PFH, the KKÁT facility has a Fire Extinguishing- and Technical Save Plan (FTRP). The Paks PFH is responsible for elaboration of the FTRP, but the facility-related and technological input data needed for elaboration of such plan are provided by the Licensee. The tasks and activities prescribed in the FTRP are annually practiced by the Paks PFH, the representative of the Licensee also participates in such drills.

3.2.3.3 Specific provisions, e.g. loss of access

3.2.3.3.1 Nuclear power plants (PAE)

The nuclear power plant's emergency response instructions describe what to do in emergency, including events of fire. The regulation describes in detail what procedures must be followed.

3.2.3.3.2 Research reactors

BKR

In the event of a fire, fire-fighting units have to wait for the reactor's operator staff, because the priority areas for physical protection and radiation protection are closed even during outages.

BME OR

In the case of a fire event the operator on standby has to arrive to the facility before the fire brigades and other personal can enter the facility due to security/physical protection reasons resulting in closed sections within the building.

3.2.3.3.3 Dedicated spent fuel storage facilities (KKÁT)

In addition to relevant legislation, standards, guides, technical guidelines, there are no further special regulations for the KKÁT facility since a fire extinguishing situation causing loss of access (fire extinguishing access) route is not possible, taking into account the factors, determined in section 1.3.4.

3.3 Passive fire protection

Preventing the spread of those fires which have not been extinguished, thus minimizing their effects on essential plant functions is the third level of defence according to the defence in depth principles of nuclear fire safety.

3.3.1 Prevention of fire spreading (barriers)

WENRA	Hungarian regulation Nuclear Safety Codes	 Nuclear Fire Safety Codes
Nuclear Power Plants		
SV 6.5: Use of a fire compartment approach is preferred. The fire resistance rating of the fire barriers of the fire compartment shall be sufficiently high so that the total combustion of the fire load in the compartment can occur without breaching the barriers taking into account the fire hazard analysis. If a fire compartment [1] approach is not practicable, fire cells shall be used and duly justified by the fire hazard analysis. For fire barrier resistance assessment oxygen availability within and oxygen supply to the fire compartment shall be conservatively considered and justified. SV6.11: […] In order to ensure the operability of the fire protection measures, procedures shall be established and implemented. They shall include examination, inspection, maintenance and testing of fire barriers, fire detection, alarm features and extinguishing systems.	3.3.7.0100. Those systems, structures and system components important to nuclear safety shall be so designed and positioned that the frequency and the effects of fire are minimal. It shall be ensured that the nuclear power plant can be shut down both during and following a fire, and that the residual heat can be removed, that radioactive material can be prevented from release into the environment and the operating mode of the nuclear power plant can be monitored. In the buildings encompassing systems, structures and system components important to nuclear safety, the rooms comprising the redundant or diverse systems, structures and system components shall be established as separate fire compartments. If this is not accomplishable, fire cells equipped with active and passive fire protection equipment shall be applied in accordance with the fire risk analysis.	Annex I Chapter I. 3.6. In addition to complying with general fire protection principles, the fire section and the fire cell must have a design that excludes the risk of damage to the redundant safety system for a predetermined period of time in the event of a fire. 3.9. In the case of fire sections that have an impact on nuclear safety, the fire resistance performance requirement of fire protection structures must be supported by a fire risk analysis. During the analysis, to verify the fire resistance performance of the fire sections, the hermetic conduit structures built into them, as well as the building structures bordering the fire cells and fire-stop closures - with the exception of fire-stop doors and windows, the fire effects (standard hydrocarbon fire, cellulose fire or latent fire) to be used in the laboratory test or in the dimensioning calculations must be selected in accordance with the characteristics taken into account in the design and the modelling of the local operating conditions. In the case of fire-resistant doors and windows, the fire effect according to the cellulose-fire curve must be taken into account. 3.12. The requirements for the design of the fire sections, the determination of the dimensions of the fire section, and the provision of heat and smoke evacuation are subordinated to the requirements of nuclear safety and the functional design of the nuclear power plant. Deviations in this direction must be supported by a fire risk analysis.

WENRA	Hungarian regulation Nuclear Safety Codes	Nuclear Fire Safety Codes
	Research Reactors	
WENRA S 2.2: Buildings that contain SSCs important to safety shall be suitably* fire resistant. *In accordance with the results of the fire hazard analysis. WENRA S 2.3: Buildings that contain equipment that is important to safety shall be subdivided into compartments that segregate such items from fire loads and segregate redundant or diverse trains of a safety system from each other. When a fire compartment approach is not practicable, fire cells shall be used, providing a balance between passive and active means, as justified by fire hazard analysis. WENRA S 2.4: Buildings that contain radioactive materials that could cause radioactive releases in case of fire shall be designed to minimize such releases.	5.2.15.0200. During the installation of systems, structures and components the physical separation of the systems, structures and components important to nuclear safety shall ensure the ineffectiveness of the consequences of a fire or explosion should such an event occur on the redundant systems, structures and component, or on other systems, structures and components important to nuclear safety. 5.2.15.0400. In the case of inflammable solid and liquid wastes, the conditions of effective fire alarm and fire-fighting shall be established in such a way that prevents, to the extent possible, any release of the radioactive materials contained in the system during the fire and fire-fighting.	Annex I. Chapter II. 3.8. In the case of fire sections that have an impact on nuclear safety, the fire resistance performance requirement of fire protection structures must be supported by a fire risk analysis. During the analysis, to verify the fire resistance performance of the fire sections, the hermetic conduit structures built into them, as well as the building structures bordering the fire cells and fire-stop closures - with the exception of fire-stop doors and windows, the fire effects (standard hydrocarbon fire, cellulose fire or latent fire) to be used in the laboratory test or in the dimensioning calculations must be selected in accordance with the characteristics taken into account in the design and the modelling of the local operating conditions. In the case of fire-resistant doors and windows, the fire effect according to the cellulose-fire curve must be taken into account. 3.10. If the fire protection requirements of the separation of safety systems - placement in separate fire sections - conflict with the functional design of the research reactor, it is necessary to ensure the separation of security systems from a fire protection point of view with distance protection and the creation of a fire cell. The adequacy of these solutions must be supported by fire risk analyses. 3.11. The requirements for the design of the fire sections, the determination of the dimensions of the fire section, and the provision of heat and smoke evacuation are subordinated to the requirements of nuclear safety and the functional design of the nuclear power plant. Deviations in this direction must be supported by a fire risk analysis.

WENRA	Hungarian regulation	
	Nuclear Safety Codes	Nuclear Fire Safety Codes
Spent Fuel Storage Facilities		
SV 6.5: Use of a fire compartment approach is preferred. The fire resistance rating of the fire barriers of the fire compartment shall be sufficiently high so that the total combustion of the fire load in the compartment can occur without breaching the barriers taking into account the fire hazard analysis. If a fire compartment [1] approach is not practicable, fire cells shall be used and duly justified by the fire hazard analysis. For fire barrier resistance assessment oxygen availability within and oxygen supply to the fire compartment shall be conservatively considered and justified.	-	Annex I. Chapter III. 3.1. Rooms of safety-important systems must be separated from places with a fire load of over 1,500 MJ/m^2, and from each other by means of fire partitions or the creation of fire cells. 3.2. In addition to the general principles of fire protection, the fire section and the fire cell must be designed in such a way that in the event of a fire, the risk of damage to a system important for safety is excluded. 3.3. In the case of fire sections that have an impact on nuclear safety, the fire resistance performance requirement of fire protection structures must be supported by a fire risk analysis. In the course of the analysis, to verify the fire resistance performance of the fire sections, as well as the building structures bordering the fire cells and the fireproof closures - with the exception of the fireproof doors and windows, fire effects - standard hydrocarbon fire, cellulose fire or latent fire - to be used in the laboratory test or in the sizing calculations must be selected in accordance with the features considered in the design and modelling the local operating conditions. In the case of fire-resistant doors and windows, the fire effect according to the cellulose-fire curve must be taken into account. 3.4. If the fire protection requirements for the separation of safety-important systems and their placement in separate fire sections conflict with the requirements for the functional design of the storage facility, it is necessary to ensure the separation of security systems from a fire protection point of view with distance protection and the creation of a fire cell. The adequacy of these solutions must be supported by fire risk analyses.

3.3.1.1 Design approach

3.3.1.1.1 Nuclear power plants (PAE)

There was no national legislation regulating fire safety in nuclear power plants at the time of the construction of the nuclear power plant's units (unit 1, 2, 3 and 4 were commissioned in 1982, 1983, 1986 and 1987, respectively). Fire safety was regulated by legislation and standards in general.
Following a fire in a thermal power plant at the time of the constructions of the Paks nuclear power plant, a Hungarian invention was used to construct the penetrations of cables through walls and slabs in a fire-retardant way. This fire-resistant product, called POLYPLAST-POLYSTOP, has been used in many countries because of its simplicity and low price. Its fire resistance limit has been certified to provide 90 minutes of protection in a fire test carried out under qualified national regulations, for which a national certification has been issued.

The alignment of fire safety requirements with international regulations began in the late 1980s. The alignment took place in several steps:

- First, doors/windows were replaced by fire-resistant ones. Here, two categories of initial values were established according to the fire load of the rooms:
  - The higher fire load values were related to cable compartments, where the physically feasible limit of 90 minutes was set. Within what is physically feasible, the requirements of an internationally stringent set of qualification criteria had to be met (500 C° temperature on the saved side or flashover to the saved side).
  - A 60-minute limit was set for the separation of electrical distribution and mechanical process rooms. The door types used have been nationally certified.
- As the next step, the impact of the ventilation system on fire propagation from a nuclear safety point of view was investigated. The ventilation system is piped through several rooms and these rooms may contain different safety system elements, thus in the event of a fire, the hot air and smoke from the ventilation system may serve as an ignition source for redundant safety system components different from the original fire source. To exclude this possibility, the ventilation systems in the rooms were designed to prevent fires from spreading. Where it was justified, wall penetrations of the rooms were fitted with fire dampers. However, where through-pipes saturated with hot gas can serve as an ignition source, the pipeline sections were fitted with a certified fire-retardant coating.
- Following the publication of the first National Fire Code in 2007, the Hungarian national legislation has been increasingly adapted to international requirements, and the national regulatory framework in the field of fire protection and nuclear safety has been developed in several steps. It can be stated today that the matter of fire prevention is covered in detail by national legislation. There are national regulations specific to nuclear installations that take international requirements into account.
- In addition, the Nuclear Safety Codes also includes fire safety regulations at the requirement level.

Modifications are designed in accordance with the current national legislation and design documents are required to include a fire safety chapter. Such design documents are prepared by qualified fire protection designers and checked and reviewed by certified engineers.

Fire protection equipment is inspected and maintained in accordance with current pieces of national legislation, which cover international requirements. This is detailed in the plant's system of internal regulations.
Fire safety inspections of operating nuclear power plant units as well as of units under maintenance are carried out on a regular basis. The inspection covers compliance with the operating rules.

The fire safety authority is legally obliged to carry out a full inspection of the power plant and its auxiliary installations on a scheduled basis over a period of 5 years.

Cable compartments, electrical distribution rooms, instrumentation and control rooms, process rooms are equipped with fire-resistant walls, ceilings, fire-resistant doors/windows in accordance with the applicable national legislation.

With regard to building structures, the basic building structures are given, there are no substantial changes. In the case of structural alterations, the fire safety chapter in the architect's design documentation shall include the fire safety implications of the alteration, corresponding to the extent of alteration. Fire safety requirements for building structures are regulated by national legislation. Architectural alterations may extend to: Elimination or demolition of a building structure, construction of a new building structure, alteration of an existing building structure (creating an opening in the building structure, walling in an opening in the building structure, breaking of a hermetic wall cladding, affixing a structure to the building structure, installation of a new opening). If any of these alterations are required, the possible technical solution shall be developed in the design documentation, including fire safety requirements. The fire safety chapter of the design documentation may be prepared by a qualified architect with a nationally valid certification and a unique identification, or by a fire protection expert or by a fire protection designer.

It is a general rule in the nuclear power plant that the most frequent cable runs through building structures require technical measures to be taken, as the combustibility of cable insulation is a problem from the point of view of fire propagation. Consequently, cables can run through a wall-slab structure with a fire barrier only. Fire barrier penetrations are classified structures and the relevant fire protection parameters are laid down in national legislation. The routing of cables through building structures is carried out within a controlled framework. The opening and closing of fire barriers can happen on the basis of what is called "fire barrier closing technology", which includes specific, individually validated products, with installation methods developed by the manufacturers. The technology is approved by the nuclear safety authority.

New cables can be pulled in based on what is called qualified fire barrier breakthrough technology, where fire barriers can only be open for the duration of the work while at the end of the shift, some companies' product called "bagged fire gas closure" can be used as temporary closure where the intumescent material in the bags ensure the sealing of the opening.
Specific products, technology and time are specified to permanently close fire barrier openings. The technology specifies item by item which fire barrier must be closed with which technical solution. The above is done based on an individual approval of the entire route in the form of a table which is part of the construction documentation.

Only windows/doors with valid certification may be installed as fire inhibiting windows/doors. The fire resistance parameters for fire-resistant doors/windows are defined in national legislation as a function of fire load values.
By default, fire doors in the nuclear power plant must be closed. Exceptions to this rule are doors along the corridors in the controlled access area which are open and fixed with a holding magnet to provide an escape route and which close on a fire alarm.
When open, a fire door may be propped open in a controlled manner during maintenance work related to cable pulling, with workers on site. The second exception is the transport of materials for the duration of transportation/delivery. For stairway doors in the controlled access area or for access doors to cable compartments, a specially designed locking device is available.
Inspections of fire doors are carried out on a scheduled basis in accordance with national regulations, and any deficiencies are recorded. It should be noted here that deficiencies may also be recorded during shift workers' walkarounds.

However, due to the industrial nature of the plant, doors may also be damaged by wear and tear. Damaged fire doors are recorded in the maintenance system for repair. Fire door repairs may be carried out on site by a qualified contractor using technology approved by the Building Certification Institute.

3.3.1.1.2 Research reactors

BKR

Architecturally, the research reactor is divided into two separate fire sections, namely:

- the reactor and measurement hall,
- the central building.

Within these the localisation of conditional fires and prevention of further fire spread is ensured via additional fire retardant measures. 90-minute single or double fire doors with appropriate certification and documentation (ET-90, KT-90) have been installed at the fire section boundaries (1989). In the case of basement ventilation systems, it may cause the automatic operation of the fire damper(s) at the fire section boundary (thermal cut-off) to prevent further fire spread. It is important to note, however, that the fire sectioning in question meets the requirements at the time of design. It does not meet current requirements or is difficult to verify (e.g.: well-maintained but old fire retardant doors from the time of construction with proper documentation). It is an existing condition.

The corridors and floor cable rooms are divided into three fire sections with built-in fire walls. The fire sectioning of the cable rooms under the corridors means the closure of the entire cross-section of the cable tunnel. Cables performing different functions, such as power transmission, control and communication cables, are separated and placed on separate shelves. The points where the cables enter the building and the riser cable runs in the corridors are provided with fire section closures at ceiling level. The closures are designed so that a fire in one section cannot spread to the adjacent section, thus preventing the fire from spreading further.

The cables - on both sides of the fire section - are coated with Polistop-K fire protection material for a length of approx. 0.5 m, the gaps between the masonry are filled with Poliplast-K seal. The riser cable bundles are coated with Polistop-K protection for a length of 1 m in both directions on the plane of the passage, the ceiling outlets are closed with perlite concrete, the gaps between the cables are sealed with Poliplast-K fire protection material. Cable passages connected to facilities outside the main building are also equipped with fire sectioning. The cables in the courtyard block channel are coated with Polistop-K fire protection material in the cable ducts for a length of approx. 0.5 m from the end of the connecting pipe, the gaps between the cables are sealed with Poliplast-K mass. Fire barriers have been installed to delay and prevent the spread of fires:

- Fire doors (8 pcs) to ensure the interoperability of the surfaces at the fire section boundary,
- Fire dampers (2 pcs) installed at the fire section boundary of the basement ventilation systems,
- Fire resisting divisions in cable rooms.

BME OR
The BME OR facility consists of a single fire section. Within the facility no fire sectioning (e.g.: fire cells), and due to the „single fire section approach" fire retardant coating/fire dumpers/etc. are not applied.

3.3.1.1.3 Dedicated spent fuel storage facilities (KKÁT)
The third level of defence in depth, that is, the prevention of spreading of fires, is ensured by the fire sections, fire barriers of the KKÁT facility. Based on its function and structural arrangement, the KKÁT facility consists of three fire sections:

- reception building (in which the electrical room is separated by means of fire-retardant door),
- social block,
- chambers, air routes and loading hall.

The fire sections are separated from each other with building structures, fire-retardant doors (with fire resistance limit values of 60 and 90 minutes, respectively) which meet the relevant combustibility / fire protection class and fire resistance limit value requirements; the required fire retardant seals of pipe and cable connections routed through the wall and floor openings of the boundary structures, are implemented according to the relevant mechanical, air engineering and electrical design documentations.

3.3.1.2 Description of fire compartments and/or cells design and key features
3.3.1.2.1 Nuclear power plants (PAE)
The requirements for the design of passive fire protection are laid down in the relevant Hungarian legislation in force. National legislation applies to the requirements for building structures. Penetrations through walls and ceilings are made with certified fire-retardant structures. Technological process rooms are designed as fire sections. Fire cells have been designed and implemented where cables from one safety system have been routed through a room belonging to another safety system in a fire-retardant manner as required. The structure is certified. Two kinds are used in the nuclear power plant. One solution is the concrete ducts built in cable compartments, then called "fire section in fire section", to lead cable lines that are different from the safety classification of the given cable compartment, according to the initial design specifications of the power plant. The other solution is a qualified cable duct made of fire-resistant boards for conducting cable lines of a safety class different from that of the room.

The fire-resistant doors/windows in process rooms are of certified structures. The ventilation system design preventing the spread of fire is achieved by using both a fire damper and pipe cladding with certified fire resistance parameters.

3.3.1.2.2 Research reactors
BKR
Architecturally, the research reactor is divided into two separate fire sections, namely the reactor and measurement hall and the central building. Within these, additional fire sections were created to ensure the localisation of conditional fires and to prevent further fire spread. 90-minute single or double fire doors with appropriate certification and documentation (ET-90, KT-90) have been installed at the fire section boundaries (1989). In the case of basement ventilation systems, it may cause the automatic operation of the fire damper(s) at the fire section boundary (thermal cut-off) to prevent further fire spread.

The passive fire protection structures are regularly and contractually maintained protection devices by external contractors. It is important to note, however, that the fire compartmentation in question meets the requirements set at the time of design, but does not meet current requirements or is difficult to verify. It is an existing condition.

ID	Fire section/m^2	Fire resistance limits (hour)
1	5-storey part of the central building 2196 m^2	fire retardant walls: 5 hours fire doors: 1.5 hours roof ceiling: 1.5 hours
2	Area under the reactor hall	fire retardant walls: 5 hours

	494 m^2	fire doors: 1.5 hours roof ceiling: 1.5 hours
3	Reactor and measurement hall, and lock building / 1143m^2	fire retardant walls: 5 hours fire doors: 1.5 hours

The central building includes the reactor control room, the technology-related water preparation room of the reactor cooling water system, electrical switch rooms, battery room, ventilation machine rooms, workshops, chemical laboratories and offices. A significant amount of space in the building is occupied by the control, signalling and operating safety equipment associated with the reactor system. The building has a central corridor layout with a staircase at each end. The ground floor entrance is in the central axis of the building.

The second fire section has two traffic corridors opening into the central corridor of fire section 1. It includes the reactor, the reactor's primary cooling system, the hot cells and other service technological rooms.

Additional fire (number 3) sections are sections of cable ducts that are isolated by fire barriers. The corridor floor ducts in the basement, ground floor and first floor are divided into three sections by the installation of fire stops every 15-20 m. (Fire stops made of Polistop-Poliplast). Heat and smoke detectors installed in the floor ducts provide additional protection.

During the renovations to support the continuous operation, the cable passages are planned to be closed by a specialist. The existing cable closures will be continuously reviewed during the year 2023 by BKR’s own colleagues with specialised qualifications and certifications. Based on the results of the inspection, unsatisfactory or missing seals will be repaired by a contracted external specialists.
The inspection and maintenance of fire protection equipment is carried out in accordance with the current national fire safety legislation, which covers international requirements. The internal regulatory document of the Research Reactor covers this in detail.

BME OR
The BME OR facility consists of a single fire section. Within the facility no fire sectioning (e.g.: fire cells), and due to the „single fire section approach" fire retardant coating/fire dumpers/etc. are not applied.

3.3.1.2.3 Dedicated spent fuel storage facilities (KKÁT)
The requirements for establishment of the passive fire protection are determined by the national fire protection legislation. The requirements for the building structures are also determined by the national fire protection legislation. The wall and floor penetrations are implemented with qualified fire barriers, while the passages are equipped with qualified fire-retardant doors (with fire resistance limit values of 60 and 90 minutes, respectively). There are no fire cells in the facility.
In case of ventilation systems, obstruction of fire spreading is provided by motor-operated flap valve/fire dampers. 11 pieces of fire-retardant doors are installed in the facility, at the fire section boundaries, as well as for protection of staircases and corridors. The steel structures are equipped with passive fire protection system, fire-retardant coating, which ensures, in accordance with the relevant legislation, a protection of 30 minutes against impact of the fire.

The building is a modular one, consequently the fire resistance requirements of the building structures are based on the legal environment which was valid in the period of development of the licensing documentation in the different stages. During construction of the stage I, the architectural fire protection requirements were based on the series of standards MSZ 595 (Hungarian standards). During licensing period of the stage II, the architectural fire protection requirements were based on Attachment No 5 of the Decree about determination of technical requirements of fire protection and civil defence [A22]. With respect to the phase 1 of stage III, the National Fire Protection Regulation, issued with the decree [A8], includes the fire protection requirements for buildings and structures. With respect to the phase 2 of stage III, the National Fire Protection Regulation, issued with the decree [A9], includes the fire protection requirements for buildings and structures. With respect to the phase 3 of stage III, the National Fire Protection Regulation, issued with the decree [A11] includes the fire protection requirements for buildings and structures.

The KKÁT facility is divided into 3 fire section by means of installation of fire retardant doors, motor-operated flap valves and fire barriers.

	Fire section/m^2	Fire resistance limits (hour)
1	Social premises 140 m^2	fire retardant walls: 1,8 hours fire doors: 1,5 hours roof ceiling: 0,25 hours
2	Loading area 1356 m^2	fire retardant walls: 4,0 hours fire doors: 1,0 hours ceiling: 1,5 hours roof ceiling: 0,25 hours
3	Chambers, air channels, loading hall, room KT202 5650 m^2	fire retardant walls: 1,5 hours fire doors: 1,0 hours

3.3.1.3 Performance assurance through lifetime

3.3.1.3.1 Nuclear power plants (PAE)

For the entire lifetime of the plant, an annually renewed "Final Safety Report" is available, with a fire safety chapter within it. Therefore the status must be updated annually to meet the legislative requirements in force. If there are deviations, appropriate actions should be taken to bring the situation up to standard.

A Periodic Safety Report must be prepared every 10 years in accordance with national regulations, with a fire safety chapter based on a fire risk analysis. The requirements can change over the 10-year period in the light of international and national experience and regulations. Those revised requirements also set out the requirements for fire risk analysis. The Periodic Safety Review (PSR) prepared on the basis of such analysis sets out safety improvement measures, the implementation of which will improve the safety of the units in the plant.

3.3.1.3.2 Research reactors

BKR

The adequate level of fire safety can be justified on the basis of the results of the Periodic Safety Reviews and the Fire Safety Analysis carried out in parallel. Based on the established fire safety regulations, it is necessary to ensure the maintenance of the protection system.

BME OR

For the entire operational lifetime of the facility the Final Safety Assessment Report is available and updated annually. The report contains the justifications of the fulfilment of all criteria regarding fire safety and fire protection (hence any and all deviations from the relevant rules and regulations must be checked on a yearly basis). In case of identified non-compliances corrective actions must be formulated and implemented. The subject of fire safety however is not presented as a separate chapter. The details on fire safety and fire protection rules and regulations are presented in the local Fire Protection Regulation.

In line with the national regulations a Periodic Safety Review must be carried out on a 10 year basis, and according to the currently valid legislation this must contain a fire safety chapter which shall be based on the results of the fire risk assessment. These currently valid rules and regulations are based on the changes made in the national and international regulatory frameworks and standards in the last 10 years. According to the currently valid legislation if non-compliances are identified during the Periodic Safety Review then corresponding corrective actions shall be formulated and implemented. The fire risk assessment for the BME OR facility is currently under development.

3.3.1.3.3 Dedicated spent fuel storage facilities (KKÁT)

During elaboration of the Periodical Safety Report which is prepared on a 10 year basis according to the regulations in-force, it is obligatory to justify whether the storage facility complies with the relevant actual legislative requirements. The local FPR of the KKÁT facility regulates the inspection, review, maintenance of the fire retardant doors, to be performed by the operator, as well as the requirements for limitation of their operability, furthermore the necessity of installation of temporary fire barriers.

3.3.2 Ventilation systems

WENRA	Hungarian regulation	
	Nuclear Safety Codes	Nuclear Fire Safety Codes
	Nuclear Power Plants	
SV 6.6: Ventilation systems shall be arranged such that each fire compartment fulfils its segregation purpose in case of fire and designed such that the ventilation of other fire compartments which contain other trains of the safety system is maintained as far as required to fulfil their safety functions. SV 6.7: If parts of the ventilation systems (such as connecting ducts, fan rooms and filters) are located outside fire compartments they shall have a fire resistance consistent with the fire hazard analyses or be capable of isolation from fire effects by appropriately rated fire dampers.	3.3.7.0500. The ventilation systems shall so be arranged that in the event of fire each fire compartment performs its separation function. 3.4.7.0400. During the design of the ventilation systems, the following shall be ensured as general requirements: a) taking into consideration external effects and climatic conditions such as external fire or explosion, extreme wind speed, risk of obstruction due to snow or other kinds of contamination, high humidity, risk of entry of chemicals, b) performance of fire protection and fire restriction functions, also c) the ventilation systems, if necessary, shall be suitable for the removal of smoke generated in case of a fire, the restoration of normal air conditions, at the same time the spreading of fire through the ventilation systems shall be prevented. 3.3.7.0600. Those parts of the ventilation systems which are situated outside of the fire compartments, shall possess the same fire resistance qualification as the fire compartment or their insulation shall be provided by fire flaps of the appropriate category.	Annex I. Chapter I. 2.4.During planning, in order to reduce the risk of fire and increase fire safety, the following must be taken into account: a) a fire in one security system cannot endanger another security system,… 3.9. In the case of fire sections that have an impact on nuclear safety, the fire resistance performance requirement of fire protection structures must be supported by a fire risk analysis... 3.13. Heat and smoke exhaust system can only be set up in the room of the technological facility in a place where the escape of radioactive materials is excluded 5.7. Where there is a possibility of hydrogen evolution, adequate protection must be installed (e.g. recombinator, ventilation, hydrogen burner).

WENRA	Hungarian regulation Nuclear Safety Codes	Nuclear Fire Safety Codes
	Research Reactors	
S 4.4: Ventilation systems shall be arranged such that each fire compartment fully fulfils its segregation purpose in case of fire. S 4.5: Parts of ventilation systems (such as connecting ducts, fan rooms and filters) that are located outside fire compartments shall have the same fire resistance as the compartment or be capable of isolation from it by appropriately rated fire dampers.	-	Annex I. Chapter II. 2.4.During planning, in order to reduce the risk of fire and increase fire safety, the following must be taken into account: a) a fire in one security system cannot endanger another security system,… 3.8. In the case of fire sections that have an impact on nuclear safety, the fire resistance performance requirement of fire protection structures must be supported by a fire risk analysis… 3.12. Heat and smoke exhaust system can only be set up in the room of the technological facility in a place where the escape of radioactive materials is excluded 5.5. In the systems of the research reactor, where there is a possibility of hydrogen evolution, it is necessary to build adequate protection (recombinator, ventilation, hydrogen burner, etc.).

WENRA SRLs have not yet been developed specifically with respect to issues concerning ventilation systems for installations under decommissioning, waste storage facilities, dedicated spent fuel storage facilities and fuel cycle facilities, and therefore no such comparison can be carried out for the interim spent fuel storage facilities within the scope of the Hungarian NAR. Ventilation considerations are however significant for the confinement of radioactive materials in the event of fires and as such covered in the NFSC Chapter III.

3.3.2.1 Ventilation system design: segregation and isolation provisions (as applicable)

3.3.2.1.1 Nuclear power plants (PAE)

Ventilation systems should be designed to prevent the spread of fire through them. For such purposes, two technical solutions have been developed. The design to prevent the spread of fire is achieved by using both a certified fire damper and pipe cladding with certified fire resistance parameters. The developed solutions prevent fire from spreading for up to 90 minutes.

Fire spread prevention in ventilation system piping shall be as follows: The ventilation system piping can be split into sections by installing qualified ventilation dampers. In some sections the piping is fitted with certified thermal insulation. In addition, the periodic cleaning of ventilation systems is carried out within a controlled framework via an approved process.

3.3.2.1.2 Research reactors

BKR

The ventilation ducts are made of steel, located vertically in the utility shafts and horizontally under the false floor of the corridors. The ventilation systems are generally of depression design (the extracted air is about 10% more than the intake air). Fire dampers are installed in the 2 pcs pressure systems of the technological ventilation at the boundary of fire section 1. The dampers can be closed automatically and manually, and reopened manually. The signal of the fire damper position and the switch for manual closing are located in the reactor control unit. In case of fire, the ventilation systems shall be switched off/on by the control room service.

In the battery room in the basement of the central building, 14.6 m^3/hour flammable gas can be generated when charging the 244 installed cells at the maximum charging current. The concentration must not exceed the lower explosion limit of 20%. This is ensured by injecting 2450 m^3/h dilution air of ventilation system N-2 and by exhausting of system S-6. The operation of the charging equipment and the operation of the ventilation system is electrically interlocked. During the period outside the operating hours of the fans, the required amount of air exchange is naturally ensured through the air duct network.

Although the battery room has windows that open outdoors, these do not meet the requirements for fissure surfaces. Therefore, as an additional safety condition, the room is equipped with self-contained mechanical ventilation with gas detectors. The system automatically switches on the emergency ventilation at 20% of the lower explosion limit, switches off the charging equipment at 40% and de-energises everything except the ventilation system.
Also in the basement of the central building is the room of the boiler fired by natural gas, which produces hot water for domestic needs. The ventilation, the combustion air supply and the fivefold air exchange are of gravity system through 1 pce courtyard window of 1 x 1x0,5 m^2. In the absence of fissure opening surfaces, the room is equipped with 1 pce emergency ventilation system controlled by a gas detector. The control starts the ventilation at 20% of the dangerous concentration, shuts off the gas line at 40% and de-energises everything except the ventilation.

BME OR
Due to the structural design of the building and for safety reasons, the reactor building was made with fixed windows that are not suitable for ventilation, so the necessary air exchange of the building can only be ensured by artificial ventilation. The ventilation of the building is provided by the VTS Ventus VS-75-R-V type suction fan installed in room 67 of the "T" building, and the VTS Ventus VS-75-R-E/H type supply air treatment machine installed in the +0.35 m level ventilation engine room of the reactor building. Both machines have a frequency regulator. The main parameters of the fans:
Suction fan:

- Type: VTS VS-75-R-V
- Fan type code: VS 75/100 DRCT.DR.FAN 3 v.2
- Nominal flow rate: 12640 m^3/h
- Nominal speed: 2443 1/min
- Static pressure: 1000 Pa
- Dynamic pressure: 147 Pa.

Supply air treatment:

- Fan type code: VS 75/100 DRCT.DR.FAN 3 v.2
- Nominal flow rate: 11,000 m^3/h
- Nominal speed: 2481 1/min
- Static pressure: 1505 Pa
- Dynamic pressure: 112 Pa.
- Electrical data: 3*400V/50Hz, P=7.5kW

The average air circulation of the reactor building is currently around 11,000 m^3/h. The radiation protection control and monitoring of the exhausted air is continuous. Inside the building, a depression develops in the vicinity of the reactor cover and in the technological room at the -2.55 m level. This depression is ensured via the extraction channel running under the reactor cover and around the reactor tank. In the auxiliary rooms only air extraction is applied, which ensures depression. This solution ensures the depression of the reactor cover and the room containing the primary circuit.

The fresh air is conveyed by the pressure fan through the air intake formwork of the ventilation machine housing and through the bag air filters into the distribution air duct. The supply air duct splits into two after the pressure fan, one branch supplies the area of the reactor hall, the other branch provides fresh air to the rooms located at the +0.35 m and +3.75 m levels. The extraction is ensured by the exhaust grids located on the built-in air duct located in a circle next to the reactor hall crane, the exhaust air duct that runs around under the reactor cover, and the exhaust air duct network through the exhaust grids located in the rooms, on the 6th floor of the "T" building. It is connected to an exhaust fan installed in room 67. The air from the suction nozzle of the exhaust fan is released to the outside through the air outlet located on the roof of the "T" building. There is feedback signal from the system to the control room regarding the functionality of the ventilation system. The ventilation system cannot be sectioned. In case of fire or other malfunction, it is stopped manually.

3.3.2.1.3 Dedicated spent fuel storage facilities (KKÁT)

The ventilation equipment of the KKÁT, located in the reception building, is designed for performing the following four fundamental tasks:

- to supply the ventilated areas with clean air handled by means of which it can be ensured that its temperature and moisture content are suitable for the operators in the given rooms, for the function of the room and the technology located in the room, as well as for the equipment installed there,
- to prevent spreading of radioactive contamination from potentially active work areas to clean workplaces,
- to remove air from work areas, simultaneously to prevent release of air extracted from a potentially active area, without any handling and control, to the environment,
- to take away excess heat occurred in each room and to cooperate with the technology operating in the building, as well as to remove smoke from ventilated rooms in case of fire.

The ventilation equipment can be divided into the following three different subsystems:

- inlet system which carries fresh (partly recirculated) air into each ventilated room after appropriate handling,
- inactive, clean exhaust system which exhausts air from inactive rooms and, in order to ensure heat recovery, recirculates such air into the inlet system,
- active exhaust system which exhausts air from potentially active areas and, after appropriate handling, in a controlled way, releases such air into the environment.

The first fundamental task is performed by the inlet system. The central air handling unit located in the ventilation machine house, inhales fresh air from outdoor, mixes it with the recirculated air, then heats up the mixed air with the pre-heater until +5 °C in the winter season, filters it in two stages, post-heats it until 20 °C in the winter season, while in the summer season, cools it down until 18 °C with help of direct evaporator of the air cooled cooling equipment. The ventilating air is forwarded by double (working – standby) inlet fans through an air duct network into the ventilated areas. The inlet system is a multizone one, in each zone, if necessary, electrical post-heaters and air humidifiers perform post-handling of the ventilating air. It is ensured by the design of the system that it is capable of providing both functions of air heating and air cooling, supplementing, at certain places, with normal operation and emergency local electrical heating devices.

The second fundamental task is performed by the inlet and exhaust systems together, in a way that they generate a pressure difference between the ventilated rooms due to which the air always flows from clean areas towards potentially contaminated areas. The pressure differences are provided if the doors are closed, however air absence and air excess, respectively of each room ensures an air flow with appropriate direction even in case of opened doors.

The third fundamental task is performed by the active exhaust system, in a way that it filters air exhausted from the potentially contaminated rooms via filters with very high efficiency and, with help of double (working – stand-by) fans, releases such air into the environment through a high chimney.

The fourth fundamental task is performed by the ventilating equipment as a whole, in a way that it creates an air flow, in order to remove internal heat developed, which ensures an appropriate temperature in the given room.

Condition of recirculation in case of fire:

In normal operation, the motor operated flap valves/fire dampers, located on the delivery side of the recirculation fan, let the air of the clean exhaust system to go into the air-handling unit and closes the leg going to outdoors. In case of fire, based on a signal from the smoke detector, the motor operated flap valves close the recirculation and open the leg going to outdoors, hereby preventing the smoke against mixing within the facility.

3.3.2.2 Performance and management requirements under fire conditions

3.3.2.2.1 Nuclear power plants (PAE)

National regulations define the boundary conditions in case of fire. In the event of fire, nuclear safety must not be compromised. This means that it must be possible to shut down the reactor and continuously ensure the residual heat removal from the reactor and the spent fuel pool and then keep it in a cold shut down state in the case of a fire. In practical terms, in the event of a fire, damage to one safety system at a time should be expected if the safety systems are properly separated and the possibility of a common fire case can be screened out. As there are three safety systems available for an operating unit, the failure of one safety system in the event of a fire still fulfils the conditions for the unit to be shut down even if an addition safety train is assumed unavailable (e.g.: due to maintenance) in line with the single failure criterion described in the national legislation. Besides, the constantly evolving technical fire protection measures, the fulfilment of the conditions for in-depth protection, can effectively prevent such a fire from occurring that would have a significant impact on nuclear safety.

3.3.2.2.2 Research reactors

BKR

In the absence of combustible material, the likelihood of fire starting and spreading in the technological rooms of the ventilation systems is minimal. In the event of a fire in the basement ventilation systems (N5, N6), the fire damper(s) at the boundary of the fire section are closed by automatic (thermal cut-off) operation to prevent further fire spread. Closing the fire damper may cause an imbalance in the intake/exhaust ventilation, resulting in the reactor having to be shut down in accordance with the malfunction regulations. In the event of a fire emergency, in addition to supervising the reactor once shut down, operational staff may also shut down additional ventilation systems to prevent further fire spread.

BME OR

The maintenance and checking of the ventilation system is carried out during the replacement of the air filters. These replacements happen on a case-by-case basis and not periodically, depending on the performance/degradation of the filters (the interval is between a half year and two years).

3.3.2.2.3 Dedicated spent fuel storage facilities (KKÁT)

The ventilating equipment of the KKÁT facility, located in the reception building, is designed to perform the four fundamental tasks described in section 3.3.2.1.3. One of them is to create an air flow, in order to remove the internal heat developed, which ensures the appropriate temperature in the room. All of the non-combustible air ducts participate in performance of this fundamental task.

It has to be specially noted that in case of fire, based on a signal from the smoke detector, the motor operated flap valves/fire dampers close the recirculation and open the leg going to outdoors, hereby preventing the smoke against mixing within the facility.

3.4 Licensee's experience of the implementation of the fire protection concept

3.4.1 Nuclear power plants (PAE)

The fire safety conditions for the operation of a nuclear power plant at the national regulatory level consist on the one hand of the fire safety conditions for nuclear safety, where the nuclear safety conditions are regulated and controlled by the national nuclear safety authority.
General fire safety conditions are controlled by the fire safety authority. Linked to this is the national regulation on fire safety in nuclear power plants, which is jointly supervised by the fire safety authority and the nuclear safety authority. The Hungarian Atomic Energy Act makes fire protection subject to the Fire Protection Act. The nuclear safety authority manages fire safety at the level of decrees, from an

approach that does not allow fires to negatively affect the operability of such systems that have an impact on nuclear safety.
Within the scope of establishment and use, a total of 16 "government decrees" and 16 ministerial decrees regulate the fire safety of industrial installations. Those regulations are accompanied by 14 recommended "Fire Protection Guidelines". The general fire safety requirements are supplemented by a specific ministerial decree on nuclear fire safety, with a "chapter" on fire safety in nuclear power plants.
Compliance with the legal requirements is regularly checked by the operator and the authority. Compliance with international standards is regularly monitored by WANO, OSART and international insurers. Fire risk analysis identifies measures in line with periodically evolving practices. The observations are built in the practices in a phased manner.

3.4.2 Research reactors

BKR
A fire safety analysis of the Budapest Research Reactor of the Centre for Energy Research was carried out in 2004. The analysis was prepared in fulfilment of the obligations of the PSR decisions at that time. Subsequently, the second PSR revised and amended the analysis document in 2014. The shortcomings identified by the review have been addressed in the recent period.
The fire safety analysis currently underway identifies recommendations for improvement to address the non-compliances, in a manner and with a timeline that is appropriate to BKR's evolving fire safety culture and its capabilities. The analysis did not reveal any deviations that would seriously affect fire safety.

There have been a significant number of recent changes to fire safety, which the licensee manages from time to time in accordance with its available resources and based on a graded approach. Decree 5/2015. (27. II.) of the Ministry of the Interior on the specific fire protection requirements for the use of nuclear energy introduced a fire load and its calculation method.

In practice, the requirement means that the fire load is calculated on the basis of the amount of cables and other minimum quantities of combustible technological materials installed in the area concerned. The vast majority of BKR's technological equipment has confirmedly been the same for 30 years, and where changes are made, smaller and fewer cables are installed, taking into account today's design principles. Even in a new construction, their assessment works with a conservative approach where the type of cables (since they are available, also their data), their length and the designer of the technology are known exactly. In the case of an existing facility, the design basis is adhered to and the load limit of e.g. 500 MJ/m^2 specified therein is not exceeded.

Due to the way in which small facilities operate (operational/abandoned state), there are periods when the operating staff performs remote on-call service, i.e. the person in charge of the on-call duty is available by telephone. There is a good experience with both the alerting process and on-call scheduling system in place.

Another positive experience is that in recent years the regionally competent Professional Firefighting Headquarter has again been participating in local knowledge exercises and trainings in the licensee's area. In the future, the investigation will cover the possibility of installing additional local automatic fire extinguishers due to the specificity of the use of the Research Reactor. This requires thorough analyses to produce reasonable decision preparatory documentation at the risk level of the research reactor.

BME OR
All systems installed and commissioned during the major reconstruction/refurbishment carried out in 2016, which involved the installing of the new fire detection system, are operational as expected and in compliance with their specifications.

3.4.3 Dedicated spent fuel storage facilities (KKÁT)

In the KKÁT facility, during its operating period of 25 years, there was no fire case, and missions related to fire safety have not been performed. The fire protection authority performed comprehensive fire protection inspections in the KKÁT facility with the cycle times (per 3, 5 years) prescribed in the national fire protection legislation, the deficiencies revealed by such inspections have been eliminated. Using the experience gained during such inspections, the Licensee has improved its fire protection concept. As a result of these inspections, deficiencies were eliminated and no further deficiency was identified during the last (year of 2022) comprehensive fire protection inspection.

The results of the safety reviews, as well as of the reconstruction of the built-in fire alarm equipment were presented towards the stakeholders and parties concerned within the frame of the annual fire protection trainings. No deficiency, deviation or non-compliance has been revealed during the fire risk analyses, which would have had a negative impact on fire safety and for which a corrective action should have been taken.

3.5 Regulator's assessment of the fire protection concept and conclusions

The HAEA generally does not examine the ensured level of fire protection in targeted on-site inspections, but relies on the results of inspections carried out by the BM OKF. In some cases however, a fire safety inspection is carried out during other walk-downs of the HAEA, during which the HAEA examines whether the activities/materials/etc. pose a risk of damaging nuclear safety related equipment. The HAEA reviews the results of the review carried out by the Licensee during the PSR and compares these results with its own experiences. As a result of this approach the evaluation of fire safety is an inter-authority effort carried out through the cooperation of the HAEA and BM OKF, which was also the approach followed during the formulation of the following regulatory conclusions.

PAE

In relation to the fire protection concept of PAE, it can be stated that compliance with the relevant technical requirements and legislation is ensured by the operation of the built-in fire protection equipment and devices, the facility fire department and the well-structured fire protection organization and qualified fire protection engineers employed by the Licensee. The fire protection organization regularly carries out the tasks arising from the inspections and maintenance of devices and sensors related to the large number of built-in fire alarm devices operated in the area of the PAE, paying particular attention to the investigations of false fire alarms and to reducing their number.

BKR

In the NAR the Licensee provided sufficient and satisfactory information to validate the compliance with the relevant national regulations and the WENRA RLs specified by the TPR II Technical Specifications even while it can be concluded that a significant part of the BKR systems rely on rather old equipment (e.g.: 30 year old cables). The Licensee allocated significant resources to improve fire safety and as a result several long existing issues have been solved or proper corrective actions were formulated. As a result of these activities the Licensee identified two areas of improvement:

1. Comprehensive update of the local Fire Protection Regulation based on the results of the recent fire risk analysis
2. The decommissioning and elimination of the old diesel fuel tanks, and their replacement with 160 l fuel tanks (fuel tanks of the diesel engines under the engines themselves).

Based both on the results of the review and the site visit it can be concluded that the staff of the operator organization has a sufficient number of fire safety experts. The systems and equipment provided to fulfil relevant fire safety requirements are sufficient both in quality and quantity and its operation is periodically tested and taught for the operator organization.

The major issue identified during the on-site inspection was the inconsistencies in authority between the operator organization and area supervisors (e.g.: for the different measurements and experiments carried out in the measurement hall. These inconsistencies/unclear responsibilities and authority resulted in the accumulation of various unnecessary flammable/combustible materials (e.g.: packaging materials, paper waste, unknown liquids, etc.). In order to resolve these issues the Licensee formulated corrective actions with reasonable short deadlines. The details of these corrective actions are presented in the chapters and annexes below.

BME OR
In the NAR the Licensee provided sufficient and satisfactory information to validate the compliance with the relevant national regulations and the WENRA RLs specified by the TPR II Technical Specifications. Since the reconstruction of the facility fire safety greatly improved through the installation of the new fire detection and alarm systems and the removal of unnecessary flammable/combustible materials from the facility combined with the limitation of transport of such materials into the facility. The only exception to this was some materials left in the basement (mostly packaging materials, paint, etc. from the reconstruction) which were found during the on-site investigation carried out by the co-authorities and for which corresponding corrective actions were formulated with reasonably short deadlines.

Based both on the results of the information presented by the Licensee in the NAR and the site visit it can be concluded that the staff of the operator organization is sufficient in number and qualification.

KKÁT
In relation to the fire protection concept of KKÁT, it can be stated that compliance with the relevant technical regulations and provisions of legislation is ensured by the operation of the built-in fire protection equipment and devices, as well as a well-structured fire protection organization and qualified fire protection engineers employed by the Licensee.

3.6 Conclusions on the adequacy of the fire protection concept and its implementation

Based on the results of the regulatory review it was concluded that the fire protection concept and its implementation is mostly satisfactory in all facilities. Minor issues however were identified in the case of all facilities (both by the Licensees and the co-authorities) for which corresponding corrective actions were formulated. The detailed description of these findings, corrective actions and identified good practices are presented in the chapters bellow and in a summarized and tabular form in the V and VI annexes of the NAR.

4 OVERALL ASSESSMENT AND GENERAL CONCLUSIONS

This chapter aims to present and summarize the conclusions made both by the licensees and the co-authorities during the assessment. The chapter is separated into two main sections:

- Self and regulatory assessment of the facilities based on the comparison between the administrative framework and existing fire safety infrastructure at the facilities and the WENRA RLs.
- Conclusions on the assessment/gap analysis of the legal and regulatory framework in Hungary based on the comparison with the WENRA RLs.

In line with the expectations and goals of the TPR, for every finding made during the regulatory and self-assessment corresponding corrective actions have been formulated. According to the Hungarian national practice these corrective actions (depending on the severity of the issues) were set by the parties for themselves (mostly in the inspection reports), however if the licensees fail to implement them until the agreed deadline regulatory action will follow.

4.1 Results and conclusions regarding the facilities within the scope

4.1.1 Nuclear power plants (PAE)

4.1.1.1 Conclusion of the Licensee

At the nuclear power plant, the fire risk analysis identified that transverse corridor A008/2-2 and transverse corridor A008/4-4 next to the wall of the turbine hall contain an oil manipulation tank where spent oil is temporarily stored. Supplementary flame sensor is going to be installed to protect the area. The project is ongoing.

4.1.1.2 Conclusion of the regulators

The Licensee provided sufficient and satisfactory information to validate the compliance with the relevant national regulations and the WENRA RLs specified by the TPR Technical Specifications.
Further corrective actions regarding the oil manipulation tank at A008/2-2 and A008/4-4 are not needed. The implementation of the modification (additional flame detectors in the transverse corridor A008/4-4 and A008/2-2) is already ongoing.

During the site visit the co-authorities inspected the relevant premises and rooms as well as the related active and passive fire protection systems and equipment. Based on the visual inspection it was concluded that these systems are in satisfactory conditions and operable as intended. The site visit escort personal provided by the Licensee was highly competent and able to provide detailed professional response to the questions of the co-authority representatives, hence provided an in-depth view on the applied technical solutions especially on conditions of the automatic and manual initiating signal generation. The Licensee has the official permits related to the construction or modification of the individual fire protection systems, and the competent disaster management branch office has the fire protection competence to conduct these procedures. Similarly to that the on-site outpost of the HAEA continuously carries out on-site inspections in line with the 5 year inspection plans of the authority. Based on the observed conditions and discussed subjects it was concluded that modifications or corrective actions regarding the fire protection systems and equipment is not necessary.

Non-compliances identified during the on-site inspection:

1. Periodic reviews are carried out but the highlighting/marking of this task in accordance with the NFSC (Decree 5/2015. (II.27.) of the Ministry of the Interior, Annex I, 10.11; 11.6) does not appear in the local Fire Protection Regulation.
2. In the local Fire Protection Regulation and the FIB403 procedure, the reference to the repealed Government Decree 118/2011. appears instead of the currently valid HAEA Decree 1/2022.

4.1.1.3 Corrective actions

1. Adding a reference to the periodic review of the fire safety analysis in Chapter 2.1.1 of the local Fire Protection Regulation

2. In the case of the local Fire Protection Regulation and FIB403 procedure, the incorrect references will be corrected during the next review cycle

4.1.1.4 Identified good practices

In the case of the PAE the increased interest in participation in international programs, getting to know the professional experiences of foreign nuclear facilities, getting to know the regulations of other countries and international organizations was considered as a good practice since it has a positive effect on the evaluation of the professional practice of one's own country.

Another identified good practice of the PAE is that the PSA models and documentation of the PAE is updated at least on a yearly basis, taking into consideration any and all modification to the design as well as the operator experience and both the models and the documentation is submitted in its full content to the HAEA. This practice ensures that the regulatory body has up-to-date information on the various risks of the facility (fire risk included) and supports the HAEA in various PSA based regulatory applications.

From the regulatory point of view the recent co-authority inspection practice, that is carried out at the PAE can be considered as a regulatory good practice that ensures the comprehensive nature of the inspection activity through involving experts specialized both nuclear and in fire safety.

4.1.2 Research reactors

In the case of research reactors it was identified both by the Licensees and the regulators that there is a persisting issue regarding the staffing of these facilities which pose a continuous obstacle on carrying out scheduled tasks on time. The issue arises from the size of the nuclear expert community and strict requirements on the qualifications of these experts, which significantly limits the number of available experts.

An additional general issue of these facilities is the complex nature of the roles and responsibilities of the different organizations involved in the operation of the research reactors. The site of both of these facilities are owned and operated by organizations different from the reactor operator organization and in both cases the Licensee is also different from the operator organization. This creates an environment which may cause situations with cross-duties and rather complex approval processes for even simple modifications or corrective actions.

BKR

4.1.2.1 Conclusion of the Licensee (BKR)

Based on the recent fire risk analysis and the self-assessment carried out within the framework of the TPR II the following conclusions can be drawn:

- The replacement of the more than 30-year-old fire protection systems (doors, dampers) installed at the fire section boundaries of the Research Plant building must be planned and scheduled according to their condition.
- It is recommended to remove the oil storage (auxiliary engine room, diesel gas oil tank: 6,72 m^3). By removing the 'empty' fuel storage tank, an unused hazard source is removed from the site.
- It is recommended to operate, maintain and inspect the 'Safety Power Supply' of the RD in all senses - nuclear technological, fire protection, etc. - according to its specifications (diesel generators, battery plants and their associated uninterruptible power distributors).
- Following the development of the Fire Safety Analysis it is necessary to develop a new local (Reactor department) Fire Protection Regulations based on the legislation in force.

During the analysis it was revealed and concluded that the manufacturer of fire deterrent doors, Fémtechnika Ltd., guaranteed a 10-year supply of parts in 1989 and in accordance with the National Fire Protection Regulation and the relevant Fire Protection Technical Guideline (FPTG) 12.5:2022.06.13, the Directive on Control, Inspection and Maintenance:

'Fire retardant doors and windows wear out during use. Wear and tear may occur at the end of the intended period of use and/or at the end of the intended and proven long-term cycle of use.
With regular maintenance, the duration of use of the doors and windows can be increased to a certain extent, and the manufacturer can provide information on this. Unless otherwise specified by the manufacturer regarding the durability period of use of the product, the expected period of use of the doors and windows from the date of manufacture is generally 25 years.'

'If the door has reached or exceeded the period of use specified by the manufacturer or specified above and no other means of demonstrating the original fire resistance performance of the product can be used, it shall be replaced. Replacement of the doors and windows shall be carried out as far as possible within the durability period of use or, at the latest, within 6 months thereafter.'

4.1.2.2 Conclusion of the regulators (BKR)

The Licensee provided sufficient and satisfactory information to validate the compliance with the relevant national regulations and the WENRA RLs specified by the TPR II Technical Specifications. The Licensee allocated significant resources to improve fire safety and as a result several long existing issues have been solved or proper corrective actions were formulated. As a result of these activities the Licensee identified two area of improvement:

1. Comprehensive up-date of the local Fire Protection Regulation based on the results of the recent fire risk analysis
2. The decommissioning and elimination of the old diesel fuel tanks, and their replacement with 160 l fuel tanks (fuel tanks of the diesel engines under the engines themselves).

During the on-site inspection of the reactor hall, the co-authorities found that there are combustible materials at the individual workstations and their surroundings, the presence of which is not justified (typically plastic and paper waste and packaging). The authorities had similar experiences when visiting the measurement hall, where a large amount of seemingly unnecessary combustible material on site was found. In connection with the on-site visit, the authorities viewed the report of the 2022 Fire Safety walk-down, in connection with which the experience was that a significant part of the corrective actions and measures with a November 2022 deadline had not been carried out (e.g.: metal waste and metal parts still left behind are found unsecured on the top of electrical distribution boards, there are wood scraps left in the hall, etc.). Other findings: the fire extinguishers randomly inspected during the inspection had a valid inspection, the automatic closing of the fire doors and windows used during the inspection was ensured, the built-in fire alarm system's local center (control room) shows a ready state, and no errors were indicated.

In summary the following during the on-site inspection, the co-authorities identified the following further discrepancies to be addressed by corrective action:

3. The Licensee failed to submit fire safety related documentation previously requested by the BM OKF due to miscommunication, but after the site inspection it was submitted to the authorities
4. During the site visit by the co-authorities a significant amount of unnecessary combustible materials were spotted in the reactor hall, which is in violation of the regulations strictly requiring the minimization of such materials.
5. During the site visit by the co-authorities a significant amount of unnecessary combustible materials were spotted in the measurement hall, which is in violation of the regulations strictly requiring the minimization of such materials. During the inspection of the related internal walk down reports it was concluded that the operator organization already identified this issue during a 2022 walk-down and proposed corrective actions, but these were only carried out partly.
6. In the Sz-1.18 internal procedures (The use of the experimental equipment of the Budapest Research Reactor) there is no requirement to take into consideration fire safety in the planning of modifications.
7. The internal Fire Protection Regulation of the licensee does not set responsibilities in a coherent and clear manner regarding identified non-compliances and activities that may increase fire risk

in cases when the issue is outside of the authorial zone of the Operator organization. Because of this hazardous situations may occur and persist for a long time within the facility, such as the case of the significant amount of unnecessary combustible materials without anyone responsible of its removal.

8. There is no requirement set in the internal Fire Protection Regulation of the Licensee that the document should be reviewed and updated at least on a yearly bases by the fire protection officer. Furthermore while there are requirements for the internal fire protection officer that the changes in the domestic legal and regulatory framework shall be taken into consideration during these updates it was discovered during the on-site inspection that are references to legal requirements that were repealed 9 years ago indicating that the task of monitoring the changes in the legal and regulatory framework is not carried out properly. Last but not least the current wording on the validity of the current version of the internal Fire Protection Regulation states that the document is valid until repeal, which is not in line with the practice of continuous update and amendment.

4.1.2.3 Corrective actions (BKR)

1. The development of a new internal Fire Protection Regulation based on the regulations in force and the results of the most recent fire risk analysis.
2. The decommissioning and elimination of the old diesel fuel tanks (6,72 m^3) and their replacement with the new fuel tanks.
3. The requested documentation shall be submitted as soon as possible to the BM OKF and the HAEA.
4. The correction of the non-compliances with the regulations and the removal of unnecessary combustible materials from the reactor hall.
5. The correction of the non-compliances with the regulations and the removal of unnecessary combustible materials measurement hall in line with the proposal of the 2022 walk-down report.
6. The Sz-1.18 internal procedure shall include the aspects of fire safety to be taken into consideration during the planning of modifications.
7. The internal Fire Protection Regulation should be complemented/amended in a manner that sets clear responsibilities when a source of fire hazard is identified outside of the authorial zone of the Operator organization.
8. The internal Fire Protection Regulation of the Licensee should be complemented by additional requirements stating that the document shall be updated at least on an annual basis and that the changes in the legal and regulatory framework should be considered as a priority during these revisions. Furthermore the local FPR statement on validity shall be modified in a manner to be in line with the related statements in the document.

4.1.2.4 Identified good practices (BKR)

BKR

During the on-site inspection carried out within the framework of the TPR II self-assessment it was identified as a good practice that a high amount of the reactor operator personnel have fire safety engineer certification and that the operator personnel goes through on a fire safety training on a yearly basis in order to be able to identify potentially hazardous situations and events during the daily scheduled walk-downs.

BME OR

4.1.2.5 Conclusion of the Licensee (BME OR)

The Training Reactor of the BME University operates in compliance with the regulations in force. Since the reconstruction work carried out in 2016 it is a priority of the Licensee to limit the amount of unnecessary materials and equipment in the reactor building that may pose a fire risk. The procedures regulating fire safety are followed by the operator personnel. The facility has a valid internal Fire

Protection Regulation, however it will have to be reviewed once the new fire risk assessment is finalized and approved by the authorities.

4.1.2.6 Conclusion of the regulators (BME OR)

The facility for the most part is in compliance with the relevant regulations and requirements, the operator personnel are trained and qualified adequately in the subject of fire safety, the responsibilities are clear and defined. The ensured level of fire protection of the facility is generally adequate, the basic regulatory tools are developed. Based on the experience of the on-site inspection, the safety culture related to fire protection is of a high standard and implemented with sufficient responsibility. The content elements of the fire protection regulations mainly meet the special requirements arising from the facility. The operating conditions of active fire protection systems are also adequate.

A major issue that the facility faces is the lack of/small amount of available certified nuclear fire safety experts in Hungary, which poses a continuous obstacle for the BME OR to carry out certain tasks, such as the completion of the fire risk assessment. Due to this reason the Licensee was unable to comply with previous regulatory obligations and requested deadline extension from the HAEA.

In terms of fire safety design it was concluded both from the report and the site visit that the facility is adequately (and even conservatively) equipped to perform fire suppression in the cases of small fires, and has the proper channels to inform official fire brigades in cases of large/extensive fires.

During the on-site visit the co-authorities reviewed the compliance with specific requirements arising from the nature of the facility (nuclear facility with educational and training purposes). The co-authorities reviewed and assessed the internal Fire Protection Regulation regarding its content, maturity and the means through which the regulation ensures compliance with and enforceability of the specific regulations set in the NFSC.
During the on-site visit it was concluded that the elaboration of the conditions for occasional fire-hazardous activity is in compliance with the fire safety regulations, the building has an adequate fire alarm system, the operation log of which was checked in order to verify that the operation and inspection tasks are carried out properly. Fire extinguishers have a valid review and are in compliance with the regulations in force.

As a significant deficiency, the co-authorities identified the lack of an updated fire risk analysis, which has been in place since 2015, and the fire protection regulation does not cover the effective control rules for the transport, storage and use of combustible materials. Another weakness can be identified as the fact that unused packaging materials and other combustible waste are stored in the utility room on the ground floor and the circular corridor in the basement of the facility, which are no longer needed for operation or work related to the reconstructions.

Based on the observations made during the site visit the following issues were identified:

1. The Licensee has not finished the development of the fire risk analyses and the internal Fire Protection Regulation of the facility on time set by the HAEA resolution OR-HA0008.
2. The internal Fire Protection Regulation of the facility refers to expired and withdrawn regulations instead of the currently valid regulations set by the HAEA Decree 1/2022.
3. There are no requirements or procedures set in the internal process control system of the Licensee to monitor changes in the domestic and international regulations and methodologies and update the Fire Protection Regulation accordingly.
4. In certain areas within the facility a large amount of unnecessary flammable materials were detected in close proximity to cables relevant from the point of nuclear safety.
5. The Licensee does not keep an inventory/log on the flammable materials transported into the facility (e.g.: packaging materials, paints, etc.).

4.1.2.7 Corrective actions (BME OR)

1. The fire risk analysis has to be finished.

2. The validity of the referred legal documents in the local Fire Protection Regulation of the facility has to be checked and updated.
3. The internal process control system of the Licensee has to be amended in a way to cover the requirements and responsibilities regarding the monitoring of changes in the domestic and international regulations.
4. The unnecessary flammable materials has to be removed from the facility.
5. The procedural framework to track and monitor flammable material transport into the facility has to be developed.

4.1.2.8 Identified good practices (BME OR)

1. During the 2016 reconstruction of the reactor building the Licensee made it one of its priorities to remove all unnecessary and potentially combustible materials (paper, wooden furniture, etc.) from the building. This resulted in a clean and safe working area, while ensuring fire prevention through the lack of combustible materials.
2. Even in the absence of some relevant regulations, the safety culture related to fire protection is of a high standard and implemented with sufficient responsibility. The content elements of the fire protection regulations mainly meet the special requirements arising from the facility. Based on the on-site inspection, the responsibilities for all professional issues are clear, and the persons responsible for the given task are aware of their obligations.

4.1.3 Dedicated spent fuel storage facilities (KKÁT)

4.1.3.1 Conclusion of the Licensee

In the National Report, based on the pre-defined chapters, the actual situation of fire protection in the KKÁT facility has been reviewed and presented in the NAR. It can be stated that a number of enhancements and fire safety related improvements have been implemented in the facility during its operating period of 25 years. Both enhancements and improvements have been performed on the basis of the national and international general and nuclear fire protection design requirements. The principles of defence in depth are complied with, the fire protection of operation has been established with consideration of such principles. The fire safety analyses of the facility have been made on more occasions based on the relevant national requirements, as a result of such analyses the fire risk of the facility is low, and it is due to, among others, arrangement and technology of the facility which involve insignificant fire risk. The fire protection conception of the facility is based on the principle of so called „combustion triangle”, during the realization of which there is an effort to minimize the quantity of both the built-in combustible materials and the temporary combustible materials, hereby to minimize the fire load. It can be emphasized as a good practice that the way of controlling the combustible materials has been further developed in the fire protection regulation, which measure was taken as a response to a deficiency, experienced based on internal inspections, non-endangering the nuclear safety. Supervision of potential ignition sources are provided, the oxygen concentration of the facility shows a natural, environmental value. The active fire protection of the facility is a state-of-the-art one due to the reconstruction implemented 5 years ago, it can be mentioned as a good practice that the fire extinguishers facilitating the manual fire extinguishing were replaced with a cycle time shorter than one prescribed by the national regulation (5 years instead of 20 years), by means of which a modern fire extinguishing opportunity is available.

As part of execution of its fundamental tasks prescribed by the relevant national legislation, the Licensee, elaborated an internal fire protection regulation in which the fire protection, fire safety requirements, as well as the method of complying with them are determined taking into account the national fire protection legislation and the national standards, and if such requirements are fulfilled then it is possible to reduce the fire risks, consequently the fire cases can be prevented. In order to enforce the requirements of the internal fire protection regulation, the Licensee created and operates a fire protection organization and regularly performs internal inspections to check operation of such organization.

In the KKÁT facility, during its operating period of 25 years, there was no fire case, a mission related to fire safety has not been performed, however the regular inspections performed by the national fire protection authority ensured that it was possible to continuously update the facility's fire protection situation, as a result of which the fire protection situation of the facility can be qualified as appropriate.

4.1.3.2 Conclusion of the regulators

The Licensee provided sufficient and satisfactory information to validate the compliance with the relevant national regulations and the WENRA RLs specified by the TPR Technical Specifications.

During the visit, representatives of the authorities (HAEA and BM OKF) inspected the premises of the storage facility, in particular the environment of the electrical switch room "KT003", identified as the most critical from the fire risk point of view, and the passive and active fire protection systems used in the facility.

Based on a visual inspection the systems are ready for operation, with no indications of faults (e.g. fire alarm centre). The escorts provided for the site visit gave appropriate professional answers to the general and specific professional questions raised in all cases.

The Licensee has the official permits related to the construction or modification of the individual fire protection systems, and the competent disaster management branch office has the fire protection competence to conduct these procedures.

In the same way, the aforementioned branch carries out authority inspections on an ongoing basis, in accordance with five-year cycle control plans. No corrective action was taken or recommended during the inspection of the systems and system components inspected.

During the on-site inspection, the co-authorities identified one minor discrepancy to be addressed by a corrective action:

1. In the process control system of RHK Ltd., the internal Fire Protection Regulation do not specify who should be notified by the operational staff in case of a fire safety relevant detection.

4.1.3.3 Corrective actions

1. The internal Fire Protection Regulation shall state that in the event of a fire safety relevant detection, the operational staff shall notify a member of the fire safety organisation.

4.1.3.4 Identified good practices

1. Identified good practice is considered to be the Licensee's practice of providing continuous feedback of fire safety experience through dedicated training sessions, in addition to the minimum requirements set out in the internal Fire Protection Regulation.
2. Licensee's practice of providing a dedicated form (Ny 1940-01) prior to the planning of the modifications can be considered as an identified good practice, which helps the designer to identify and take into account the fire safety aspects.

4.2 Results and conclusions regarding the Hungarian legal and regulatory framework

During the self-assessment the co-authorities extended the scope of the TPR to include the gap analysis of the legal and regulatory framework, through the comparison of the existing regulations with the WENRA RLs for the different facilities. In general it was concluded that in the case of nuclear power plants the Hungarian regulations are practically fully in line with the WENRA RLs (although in some cases in a different structure). In the case of research reactors and interim spent fuel storages however several gaps were identified in the Hungarian regulations during and even prior the TPR II as part of a regulatory self-assessment.

It should be noted that the Hungarian NSC is updated on a 5 year basis, which is a continuous mandatory task for the HAEA, therefore the identified gaps can be corrected within the framework provided by this periodic update. During such periodic updates both national and international rules, regulations and standards as well as the advance of science and technology are taken into consideration. In the case of the NFSC a different approach is followed, in which the periodicity of the updates is not set, but the updates are carried out based on necessity. During the updates of the NSFC a comprehensive evaluation of the national and international rules, regulations and standards is carried out, and the new regulations are prepared via taking these into consideration. Consultation with the stakeholders and the public on the proposed new regulations are an essential part of both update approaches.

4.2.1 Overview of strength and weaknesses

It was concluded that the Hungarian legal and regulatory framework is adequately robust and prescriptive. Due to the requirements for the authorities to continuously monitor national and international trends and the new results of science and technology and amend the legal framework accordingly the Hungarian framework is generally in compliance with international good practices. The implementation of the continuous amendment of the legal framework as well as its implementation can be considered as a strength.

Another strength of the legal framework can be considered the separation of the nuclear fire safety regulations from the generic nuclear safety codes. In this approach detailed and necessarily prescriptive requirements are set for fire safety by the fire safety authority, while the nuclear safety authority focuses on how an arising fire case may jeopardize nuclear safety. A possible weakness of this approach is the duplication of requirements and the need for coordination between the co-authorities to avoid setting contradicting requirements, however it should be noted that due to the prescriptive nature of the Hungarian legal framework such coordination is part of the national legislative practice in most areas, hence there are good and frequently applied practices to ensure the avoidance of duplications or contradictions.

A general area of weakness was identified regarding the research reactors, namely the issue of their sites which are not "facility specific". Both research reactors were constructed on sites of major research and education institutes and their site is the site of these institutes which include various other facilities and activities as well. While in the case of interim spent fuel storage facilities and nuclear power plants the authorities and responsibilities within the site is clear, in the case of the research reactors this is an inter-facility issue where various stakeholders and organizations need to coordinate. This could lead to situations where the Licensee identifies issue at the site but it is not within direct authority to implement the necessary corrective actions or at least not without the permission of the site operator. Unfortunately it is unclear if this could be solved through changing the Hungarian NSC or the NSFC, although it should be stated that this condition has not jeopardized nuclear safety or the activity of the authorities.

4.2.2 Facility specific results of the gap analysis

Nuclear power plants

Regarding the regulations of the nuclear power plants in Hungary the legal and regulatory framework was found to be adequate and in line with the requirements set by the WENRA RLs.

Research reactors

1. Fire prevention: Gap identified on the minimization of combustible materials

The current regulation requires the effective control of combustible materials, but does not specifically requires the minimization of them. In practice of course effective control is interpreted as minimization as well, but the amendment of the regulation to include this term can increase the quality of the regulation.

2. Fire suppression provisions: Gaps identified on necessary areal coverage of fire suppression systems

The current regulation does not specify the necessary areal coverage for the fire suppression systems. Although the current regulation clearly states that the extinguishing system should be designed based on the results of the fire risk analyses which inherently means that the SSCs important for safety should be covered by it, yet further specification on areal coverage may increase the quality of the regulation.

3. Fire detection: Gap identified on the necessity of non-interruptible emergency power supply for the fire detection system.

The current regulation for research reactors does not specify that the fire detection system shall be provided with non-interruptible emergency power supply.

4. Passive fire protection (ventilation): Gaps identified on the specifics of the necessary properties of the ventilation system.

While neither the NSC nor the NSFC has corresponding regulations to the WENRA RL S 4.5 the subject is covered by the National Fire Protection Regulation 4. § item (2):
"Protection against the spread of fire: a set of solutions that can be used continuously to prevent the spread of fire to the protected structure, part of the structure, outdoor storage unit. Methods: fire distance, fire prevention building structure, built-in fire prevention equipment, and other design ensuring the fire spread limit value or fire resistance performance."
Since the National Fire Protection Regulation covers all facilities in Hungary (nuclear facilities included), therefore no further modification or amendment of the legal framework was deemed necessary.

Spent fuel storage Facilities

1. Fire suppression provisions: Gaps identified on necessary areal coverage of fire suppression systems

The current regulation does not specify the necessary areal coverage for the fire suppression systems. Although the current regulation clearly states that the extinguishing system should be designed based on the results of the fire risk analyses which inherently means that the SSCs important for safety should be covered by it, yet further specification on areal coverage may increase the quality of the regulation.

2. Fire detection: Gap identified on the necessity of non-interruptible emergency power supply for the fire detection system.

The current regulation for research reactors does not specify that the fire detection system shall be provided with non-interruptible emergency power supply.

4.2.3 Corrective actions

In the Hungarian national practice the continuous amendment of the legal and regulatory framework to ensure that it is up to date and in line with the current level of science, technology and international trends and standards is required from the HAEA by law. In order to fulfil this requirement the HAEA regularly amends the regulations and carries out a comprehensive re-evaluation and amendment of the 1/2022. HAEA decree and the NSC on a 5 year basis. In order to ensure compliance with the international best practices the corrective modifications will be added to the NSC review plan and the new regulations will be issued.

4.2.4 Identified good practices

During the TPR II self-assessment a good practice that was identified in the regulatory practice of the co-authorities is the continuous monitoring of relevant international guides, standards and practices. This practice ensures that the Hungarian legal and regulatory framework is in line with the international best practice to the extent reasonably achievable. Although it should be noted that this practice previously, in line with the graded approach and international trends, primarily focused on nuclear power plants and the frameworks for research reactors fell somewhat behind of international expectations.

On the regulatory side it was identified as a good practice that the HAEA obligated the PAE to submit the most up-to-date version of the PSA models annually because:

- It ensures that all regulatory reviews, professional discussions, etc. are based on the same models and documents that the Licensee uses.
- It gave a chance to the HAEA to develop its own PSA applications, such as PSA based event analysis.
- It created the possibility for the HAEA to check the adequacy of the PSA calculations done by the Licensee via cross-checking it with its own results.

5 REFERENCES

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[A5] Act XXXI of 1996 on the protection against fire, technical rescue and the Fire Department.

[A6] Decree 35/1996. (XII. 29.) of the Ministry of the Interior on the publication of the National Fire Protection Regulations.

[A7] Act LXXIV of 1999 on the management and organization of disaster prevention and prevention of serious accidents involving dangerous substances.

[A8] Decree 9/2008. (II. 22.) of the Ministry of Municipal and Regional Development on the publication of the National Fire Protection Regulations.

[A9] Decree 28/2011. (IX. 6.) of the Ministry of the Interior on the National Fire Protection Regulations.

[A10] Act CXXVIII of 2011 on disaster prevention and amendment of related certain acts

[A11] Government Decree 259/2011. (XII. 7.) on the organizations performing fire protection authority tasks, on the fire protection fine and on mandatory life and accident insurance for participants in fire protection.

[A12] Decree 54/2014. (XII. 5.) of the Ministry of the Interior on the National Fire Protection Regulations.

[A13] https://www.katasztrofavedelem.hu/213/tuzvedelmi-muszaki-iranyelvek

[A14] Government Decree 108/1997. (VI. 25.) on the procedures of the Hungarian Atomic Energy Authority in official matters related to nuclear safety.

[A15] Government Decree 89/2005. (V. 5.) on the nuclear safety requirements of nuclear facilities and on related regulatory activities

[A16] Government Decree 118/2011. (VII. 11.) on the nuclear safety requirements of nuclear facilities and on related regulatory activities

[A17] Decree 5/2015. (II. 27.) of the Ministry of the Interior on specific fire protection requirements related to the use of nuclear energy and the manner of their enforcement in the course of the activities by the authorities

[A18] Government Decree 489/2017. (XII. 29.) on the general and special rules of fire protection official procedures

[A19] HAEA Decree 1/2022. (IV. 29.) on the nuclear safety requirements of nuclear facilities and on related regulatory activities

[A20] Decree 15/2022. (IV. 29.) of the Ministry of the Interior on amendment of Decree 5/2015. (II. 27.) of the Ministry of the Interior on specific fire protection requirements related to the use of nuclear energy and the manner of their enforcement in the course of the activities by the authorities

[A21] Decree 19/2007. (VIII. 29.) of the Ministry of Municipal and Regional Development on specific fire protection requirements related to the use of nuclear energy and the manner of enforcing the requirements during the activities of the authorities.

[A22] Decree 2/2002. (I. 23.) of the Ministry of the Interior on establishing the technical requirements of fire protection and civil protection

[A23] EPRI/NRC-RES; Fire PRA Methodology for Nuclear Power Facilities, Final Report (NUREG/CR-6850, EPRI 1011989); September 2005

[A24] International Atomic Energy Agency; Protection Against Internal and External Hazards in the Operation of Nuclear Power Plants; IAEA SSG-77; March 2022

[A25] International Atomic Energy Authority; Development and Application of Level 1 Probabilistic Safety Assessment for Nuclear Power Plants; IAEA SSG-3; April 2010

[A26] EN 54 Fire Detection and Fire Alarm Systems

[A27] Fire Protection Technical Guideline – Protection against fire spread

[A28] Fire Protection Technical Guideline – Evacuation

[A29] Fire Protection Technical Guideline – Protection against heat and smoke spread

[A30] Fire Protection Technical Guideline – Ensuring the intervention conditions of firefighting units

[A31] Fire Protection Technical Guideline – Planning, design and installation of fire alarm systems

[A32] Fire Protection Technical Guideline – Planning, design and installation of fixed fire fighting systems

[A33] Fire Protection Technical Guideline – Electrical installations, lightning protection and protection against electrostatic discharge

[A34] Fire Protection Technical Guideline – Fire–, smokespread and evacuation modelling

[A35] Fire Protection Technical Guideline – Fire Protection Technical Conformity Manual

[A36] Fire Protection Technical Guideline – Open air events

[A37] Fire Protection Technical Guideline – Fire protection properties for building constructions

[A38] Fire Protection Technical Guideline – Control, inspection and maintenance

[A39] Fire Protection Technical Guideline – Explosion protection

[A40] Fire Protection Technical Guideline – Risk classification

6 LIST OF ANNEXES

ID	Title	Description
Annex I	EXTRACT OF THE ON-SITE INVESTIGATION REPORT – PAKS NPP (EJ-098-001/2023)	Extract of the Inspection report on the on-site inspection carried out by the HAEA and BM OKF at the PAE site.
Annex II	EXTRACT OF THE ON-SITE INVESTIGATION REPORT – KKÁT (EJ-098-002/2023)	Extract of the Inspection report on the on-site inspection carried out by the HAEA and BM OKF at the KKÁT site.
Annex III	EXTRACT OF THE ON-SITE INVESTIGATION REPORT – BKR (EJ-098-003/2023)	Extract of the Inspection report on the on-site inspection carried out by the HAEA and BM OKF at the BKR site.
Annex IV	EXTRACT OF THE ON-SITE INVESTIGATION REPORT – BME OR (EJ-098-004/2023)	Extract of the Inspection report on the on-site inspection carried out by the HAEA and BM OKF at the BME OR site.
Annex V	Corrective Actions	The table describes and summarizes the good practices, issues and corresponding corrective actions that were identified during the regulatory review of the answers provided by the Licensees for the NAR and the results of the on-site inspection carried out as part of the NAR development process.
Annex VI	Identified Good Practices	The table describes and summarizes the identified good practices both at the nuclear facilities and the co-authorities responsible for fire safety in nuclear facilities.

ANNEX I

EXTRACT OF THE ON-SITE INVESTIGATION REPORT – PAKS NPP (EJ-098-001/2023)

Documents reviewed on-site

- Fire Protection Regulation of the facility
- TKO-303 Preparation, design, implementation and completion of technical modifications
- Tv-09-TL-2023
- PAE - Permit for the Occasional Conduct of Flammable Activities
- Fire Safety Operational Logs - Inspection of fire doors during the month of May 2023
- Consolidated list - inspection of fire doors in the first semester of 2023
- KVV-09 - Demolition of fire stops on cable lines Their temporary and permanent restoration
- FIB402_ELJ Provision of fire protection conditions
- FIB403_ELJ_V03 Provision of fire protection systems and devices
- TKO303_VU02 Technical design
- Refresher training lecture ÜVIG (Operational Directorate)
- MUT07619817/04 Inspection of gas extinguishing equipment

Experience of the site visit

During the site visit the co-authorities inspected the relevant premises and rooms as well as the related active and passive fire protection systems and equipment. Based on the visual inspection it was concluded that these systems are in satisfactory conditions and operable as intended. The site visit escort personnel provided by the Licensee was highly competent and able to provide detailed professional response to the questions of the co-authority representatives, hence provided an in-depth view on the applied technical solutions especially on conditions of the automatic and manual initiating signal generation. The Licensee has the official permits related to the construction or modification of the individual fire protection systems, and the competent disaster management branch office has the fire protection competence to conduct these procedures. Similarly to that the on-site outpost of the HAEA continuously carries out on-site inspections in line with the 5 year inspection plans of the authority. Based on the observed conditions and discussed subjects it was concluded that modifications or corrective actions regarding the fire protection systems and equipment is not necessary.

Non-compliances identified

1. Periodic reviews are carried out but the highlighting/marking of this task in accordance with the NFSC (Decree 5/2015. (II.27.) of the Ministry of the Interior, Annex I, 10.11; 11.6) does not appear in the local Fire Protection Regulation of the facility.
2. In the Fire Protection Regulation of the facility and FIB403, the reference to the repealed Government Decree 118/2011. appears instead of the current HAEA Decree 1/2022.

Licensee's statement in response to comments

The Licensee agreed with the comments.

Corrective actions for the Licensee

1. Add a reference to the periodic review of the fire safety analysis in Chapter 2.1.1 of the internal Fire Protection Regulation.
2. In the case of the internal Fire Protection Regulation and FIB403, the incorrect references will be corrected during the next review cycle.

ANNEX II

EXTRACT OF THE ON-SITE INVESTIGATION REPORT – KKÁT (EJ-098-002/2023)

Documents reviewed on-site

- Sz 1940 – Internal Fire Protection Regulation of the facility
- UT7501-11 – Modification procedures of KKÁT
- UT7509-03 – Organisation of trainings
- PA/1853-002/2023 – Inspection report
- Ny 1940-01 - Declaration on the need to carry out a fire safety analysis
- Ny 1940-06 - Permit to carry out occasional flammable activities
- PA/1853-002/2023 – Inspection report

Experience of the site visit

During the visit, representatives of the authorities (HAEA and BM OKF) inspected the premises of the storage facility, in particular the environment of the electrical switch room "KT003", identified as the most critical from the fire risk point of view, and the passive and active fire protection systems used in the facility.
Based on a visual inspection the systems are ready for operation, with no indications of faults (e.g. fire alarm centre). The escorts provided gave appropriate professional answers to the general and specific professional questions raised in all cases.

The Licensee has the official permits related to the construction or modification of the individual fire protection systems, and the competent disaster management branch office has the fire protection competence to conduct these procedures.
In the same way, the aforementioned branch carries out authority inspections on an ongoing basis, in accordance with five-year cycle control plans. No corrective action was taken or recommended during the inspection of the systems and system components inspected.

Non-compliances identified

1. In the process control system of RHK Ltd., the local Fire Protection Regulation do not specify who should be notified by the operational staff in case of a fire protection relevant detection.

Licensee's statement in response to comments

The Licensee agreed with the comments.

Corrective actions for the Licensee

1. The local Fire Protection Regulation shall state that in the event of a fire safety relevant detection, the operational staff shall notify a member of the fire safety organisation.

ANNEX III

EXTRACT OF THE ON-SITE INVESTIGATION REPORT – BKR (EJ-098-003/2023)

Documents reviewed on-site

- Sz-1.11: Internal Fire Protection Regulation of the facility
- Fire Risk Assessment
- Sz. 1.18 Internal Procedure
- Annual walk-down report of the Licensee (2022.06.22)
- Operation of the Fire Protection Systems of the BKR
- Fire Protection Operation Log;
- Inspection reports for review and maintenance of fire doors

Experience of the site visit

During the on-site inspection, the Licensee did not send the documentation related to the provision of fire protection in advance to the site visit, so these documents were reviewed in a preliminary manner on site. After the on-site visit however, the Licensee sent the necessary documentation to the authorities, so that their substantive review could begin. During the on-site inspection of the reactor hall, the co-authorities found that there are combustible materials at the individual workstations and their surroundings, the presence of which is not justified (typically plastic and paper waste and packaging). The authorities had similar experiences when visiting the measurement hall, where a large amount of seemingly unnecessary combustible material on site was found. In connection with the on-site visit, the authorities viewed the report of the 2022 Fire Safety walk-down, in connection with which the experience was that a significant part of the corrective actions and measures with a November 2022 deadline had not been carried out (e.g.: metal waste and metal parts still left behind are found unsecured on the top of electrical distribution boards, there are wood scraps left in the hall, etc.) Other findings: the fire extinguishers randomly inspected during the inspection had a valid inspection, the automatic closing of the fire doors and windows used during the inspection was ensured, the built-in fire alarm system its local centre (control room) shows a ready state, and no errors were indicated.

Non-compliances identified

1. The Licensee failed to submit fire safety related documentation previously requested by the BM OKF due to miscommunication, but after the site inspection it was submitted to the authorities.
2. During the site visit by the co-authorities a significant amount of unnecessary combustible materials were spotted in the reactor hall, which is in violation of the regulations strictly requiring the minimization of such materials.
3. During the site visit by the co-authorities a significant amount of unnecessary combustible materials were spotted in the measurement hall, which is in violation of the regulations strictly requiring the minimization of such materials. During the inspection of the related internal walk down reports it was concluded that the operator organization already identified this issue during a 2022 walk-down and proposed corrective actions, but these were only carried out partly.
4. In the Sz-1.18 internal procedures (The use of the experimental equipment of the Budapest Research Reactor) there is no requirement to take into consideration fire safety in the planning of modifications.
5. The internal Fire Protection Regulation of the licensee does not set responsibilities in a coherent and clear manner regarding identified non-compliances and activities that may increase fire risk in cases when the issue is outside of the authorial zone of the Operator organization. Because of this hazardous situations may occur and persist for a long time within the facility, such as the case of the significant amount of unnecessary combustible materials without anyone responsible of its removal.
6. There is no requirement set in the internal Fire Protection Regulation of the Licensee that the document should be reviewed and updated at least on a yearly bases by the "fire protection officer". Furthermore while there are requirements for the fire protection officer that the

changes in the domestic legal and regulatory framework shall be taken into consideration during these updates it was discovered during the on-site inspection that are references to legal requirements that were repealed 9 years ago indicating that the task of monitoring the changes in the legal and regulatory framework is not carried out properly. Last but not least the current wording on the validity of the current version of the internal Fire Protection Regulation states that the document is valid until repeal, which is not in line with the practice of continuous update and amendment.

Licensee's statement in response to comments

The Licensee agreed with the comments.

Corrective actions for the Licensee

1. The requested documentation shall be submitted as soon as possible to the BM OKF and the HAEA.
2. The correction of the non-compliances with the regulations and the removal of unnecessary combustible materials from the reactor hall.
3. The correction of the non-compliances with the regulations and the removal of unnecessary combustible materials measurement hall in line with the proposal of the 2022 walk-down report.
4. The Sz-1.18 internal procedure shall include the aspects of fire safety to be taken into consideration during the designing of modifications.
5. The internal Fire Protection Regulation should be complemented/amended in a manner that sets clear responsibilities when a source of fire hazard is identified outside of the authorial zone of the Operator organization.
6. The internal Fire Protection Regulation of the Licensee should be complemented by addition requirements stating that the document shall be updated at least on an annual basis and that the changes in the legal and regulatory framework should be considered as a priority during these revisions. Furthermore the Fire Protection Regulation statement on validity shall be modified in a manner to be in line with the related statements in the document.

ANNEX IV

EXTRACT OF THE ON-SITE INVESTIGATION REPORT – BME OR (EJ-098-004/2023)

Documents reviewed on the spot

- Internal Fire Protection Regulation of the BME NTI (NTI-SZ-15/2015 V.2.0 – 2015.05.25)
- Operational log of the installed fire detection and alarm system
- Manual of the fire detection and alarm system (CT/CI 1142, CI1145)

Experience of the site visit

During the on-site visit the co-authorities reviewed the compliance with specific requirements arising from the nature of the facility (nuclear facility with educational and training purposes). The co-authorities reviewed and assessed the internal Fire Protection Regulation regarding its content maturity and the means through which the regulation ensures compliance with and enforceability of the specific regulations set in the Decree 5/2015. (II. 27.) of the Ministry of the Interior .

During the on-site visit it was concluded that the elaboration of the conditions for occasional fire-hazardous activity is in compliance with the fire safety regulations, the building has an adequate fire alarm system, the operation log of which was checked in order to verify that the operation and inspection tasks are carried out properly. Fire extinguishers have a valid review and are in compliance with the regulations in force.

Non-compliances identified

1. The Licensee has not finished the development of the fire risk analyses and the internal Fire Protection Regulation of the facility on time set by the HAEA resolution OR-HA0008.
2. The internal Fire Protection Regulation of the facility refers to expired and withdrawn regulations instead of the currently valid regulations set by the HAEA Decree 1/2022.
3. There are no requirements or procedures set in the internal process control system of the Licensee to monitor changes in the domestic and international regulations and methodologies and update the Fire Protection Regulation accordingly.
4. In certain areas within the facility a large amount of unnecessary flammable materials were detected in close proximity to cables relevant from the point of nuclear safety.
5. The Licensee does not keep an inventory/log on the flammable materials transported into the facility (e.g.: packaging materials, paints, etc.)

Licensee’s statement in response to comments

The Licensee agreed with the comments.

Corrective actions for the Licensee

1. The fire risk analysis has to be finished.
2. The validity of the referred legal documents in the internal Fire Protection Regulation of the facility has to be checked and updated.
3. The internal process control system of the Licensee has to be amended in a way to cover the requirements and responsibilities regarding the monitoring of changes in the domestic and international regulations.
4. The unnecessary flammable materials has to be removed from the facility.
5. The procedural framework to track and monitor flammable material transport into the facility has to be developed.

ANNEX V

Corrective actions

ID	Organization	Issue	Corrective action	Deadline	Status
1	PAE	Periodic reviews are carried out but the highlighting/marking of this task in accordance with the NFSC (Decree 5/2015. (II.27.) of the Ministry of the Interior, Annex I, 10.11; 11.6) does not appear in the local Fire Protection Regulation.	Add a reference to the periodic review of the fire safety analysis in Chapter 2.1.1 of the local Fire Protection Regulation.	2023 December	In progress
2	PAE	In the local Fire Protection Regulation and the FIB403 procedure, the reference to the repealed Government Decree 118/2011. appears instead of the currently valid HAEA Decree 1/2022.	In the case of the local Fire Protection Regulation and FIB403 procedure, the incorrect references will be corrected during the next review cycle.	2023 December	In progress
1	BKR	A comprehensive up-dated version of the local Fire Protection Regulation based on the results of the recent fire risk analysis was not finalized and submitted for regulatory approval.	The development of a new local Fire Protection Regulation based on the regulations in force and the results of the most recent fire risk analysis.	2023 December	In progress
2	BKR	The old diesel fuel tanks were identified as unnecessary.	The decommissioning and elimination of the old diesel fuel tanks (6,72 m^3) and their replacement with the 160 l fuel tanks.	2024 December	In progress
3	BKR	The Licensee failed to submit fire safety related documentation previously requested by the BM OKF due to miscommunication.	The requested documentation shall be submitted as soon as possible to the BM OKF and the HAEA.	2023 September	Finished
4	BKR	During the site visit by the co-authorities a significant amount of unnecessary combustible materials were spotted in the reactor hall, which is in violation of the regulations strictly requiring the minimization of such materials.	The correction of the non-compliances with the regulations and the removal of unnecessary combustible materials from the reactor hall.	2023 September	Finished
5	BKR	During the site visit by the co-authorities a significant amount of unnecessary combustible materials were spotted in the measurement hall, which is in violation of the regulations strictly requiring the minimization of such materials. During the inspection of the related internal walk down reports it was concluded that the operator organization already identified this issue during a 2022 walk-down and proposed corrective actions, but these were only carried out partly.	The correction of the non-compliances with the regulations and the removal of unnecessary combustible materials measurement hall in line with the proposal of the 2022 walk-down report.	2023 September	Finished

6	BKR	In the Sz-1.18 internal procedures (The use of the experimental equipment of the Budapest Research Reactor) there is no requirement to take into consideration fire safety in the planning of modifications.	The Sz-1.18 internal procedure shall include the aspects of fire safety to be taken into consideration during the designing of modifications.	2023 September	Finished
7	BKR	The local Fire Protection Regulation of the licensee does not set responsibilities in a coherent and clear manner regarding identified non-compliances and activities that may increase fire risk in cases when the issue is outside of the authorial zone of the Operator organization. Because of this hazardous situations may occur and persist for a long time within the facility, such as the case of the significant amount of unnecessary combustible materials without anyone responsible of its removal.	The local Fire Protection Regulation should be complemented/amended in a manner that sets clear responsibilities when a source of fire hazard is identified outside of the authorial zone of the Operator organization.	2023 December	In progress
8	BKR	There is no requirement set in the local Fire Protection Regulation of the Licensee that the document should be reviewed and updated at least on a yearly bases by the fire protection officer. Furthermore while there are requirements for the fire protection officer that the changes in the domestic legal and regulatory framework shall be taken into consideration during these updates it was discovered during the on-site inspection that are references to legal requirements that were repealed 9 years ago indicating that the task of monitoring the changes in the legal and regulatory framework is not carried out properly. Last but not least the current wording on the validity of the current version of the local FPR states that the document is valid until repeal, which is not in line with the practice of continuous update and amendment.	The local Fire Protection Regulation of the Licensee should be complemented by addition requirements stating that the document shall be updated at least on an annual basis and that the changes in the legal and regulatory framework should be considered as a priority during these revisions. Furthermore the FPR statement on validity shall be modified in a manner to be in line with the related statements in the document.	2023 December	In progress
1	BME OR	The Licensee has not finished the development of the fire risk analyses and the internal Fire Protection Regulation of the facility on time set by the HAEA resolution OR-HA0008.	The fire risk analysis has to be finished.	2023 December	In progress
2	BME OR	The local Fire Protection Regulation of the facility refers to expired and withdrawn regulations instead of the currently valid regulations set by the HAEA Decree 1/2022.	The validity of the referred legal documents in the local Fire Protection Regulation of the facility has to be checked and updated.	2023 September	Finished
3	BME OR	There are no requirements or procedures set in the internal process control system of the Licensee to	The internal process control system of the Licensee has to be amended in a way to cover the requirements and	2023 October	In progress

		monitor changes in the domestic and international regulations and methodologies and update the Fire Protection Regulation accordingly.	responsibilities regarding the monitoring of changes in the domestic and international regulations.		
4	BME OR	In certain areas within the facility a large amount of unnecessary flammable materials were detected in close proximity to cables relevant from the point of nuclear safety.	The unnecessary flammable materials has to be removed from the facility.	2023 September	Finished
5	BME OR	The Licensee does not keep an inventory/log on the flammable materials transported into the facility (e.g.: packaging materials, paints, etc.).	The procedural framework to track and monitor flammable material transport into the facility has to be developed.	2023 December	In progress
1	KKÁT	In the process control system of RHK Ltd., the local Fire Protection Regulation do not specify who should be notified by the operational staff in case of a fire protection relevant detection.	The local Fire Protection Regulation shall state that in the event of a fire safety relevant detection, the operational staff shall notify a member of the fire safety organisation.	2023 October	Finished
1	HAEA	The current regulation for research reactors does not specify the necessary areal coverage for the fire suppression systems. Although the current regulation clearly states that the extinguishing system should be designed based on the results of the fire risk analyses which inherently means that the SSCs important for safety should be covered by it, yet further specification on areal coverage may increase the quality of the regulation.	In order to ensure compliance with the international best practices the corrective modifications will be added to the NSC review plan and the new regulations will be issued not later than during the next 5 year review.	2025 December	In preparation
2	HAEA	The current regulation for research reactors does not specify the necessary areal coverage for the fire suppression systems. Although the current regulation clearly states that the extinguishing system should be designed based on the results of the fire risk analyses which inherently means that the SSCs important for safety should be covered by it, yet further specification on areal coverage may increase the quality of the regulation.	In order to ensure compliance with the international best practices the corrective modifications will be added to the NSC review plan and the new regulations will be issued not later than during the next 5 year review.	2025 December	In preparation
3	HAEA	The current regulation for research reactors does not specify that the fire detection system shall be provided with non-interruptible emergency power supply for research reactors.	In order to ensure compliance with the international best practices the corrective modifications will be added to the NSC review plan and the new regulations will be issued not later than during the next 5 year review.	2025 December	In preparation
4	HAEA	The current regulation for spent fuel storage facilities does not specify the necessary areal coverage for the fire suppression systems. Although the current regulation clearly states that the extinguishing system should be designed based on the results of the fire risk	In order to ensure compliance with the international best practices the corrective modifications will be added to the NSC review plan and the new regulations will be issued not later than during the next 5 year review.	2025 December	In preparation

		analyses which inherently means that the SSCs important for safety should be covered by it, yet further specification on areal coverage may increase the quality of the regulation.			
5	HAEA	The current regulation for research reactors does not specify that the fire detection system shall be provided with non-interruptible emergency power supply for spent fuel storage facilities.	In order to ensure compliance with the international best practices the corrective modifications will be added to the NSC review plan and the new regulations will be issued not later than during the next 5 year review.	2025 December	In preparation

ANNEX VI

Identified good practices

ID	Organization	Identified good practice
1	PAE	Participation in international programs, getting to know the professional experiences of foreign nuclear facilities, getting to know the regulations of other countries and international organizations have a positive effect on the evaluation of the professional practice of one's own country, the evaluation of practice and regulation. Participation, collecting WANO event reports.
2	PAE	The PSA models and documentation of the PAE is updated at least on a yearly basis, taking into consideration any and all modification to the design as well as operator experience and both the models and the documentation is submitted in its full content to the HAEA. This practice ensures that the regulatory body has up-so-date information on the various risks of the facility (fire risk included) and supports the HAEA in various PSA based regulatory applications.
1	BKR	A high amount of the reactor operator personal goes through a fire safety training at least on a yearly basis in order to be able to identify potentially hazardous situations and events during the daily scheduled walk-downs.
1	BME OR	During the 2016 reconstruction of the reactor building the Licensee made it one of its priorities to remove all unnecessary and potentially combustible materials (paper, wooden furniture, etc.) from the building. This resulted in a clean and safe working area, while ensuring fire prevention through the lack of combustible materials.
2	BME OR	Even in the absence of some relevant regulations, the safety culture related to fire protection is of a high standard and implemented with sufficient responsibility. The content elements of the fire protection regulations mainly meet the special requirements arising from the facility. Based on the on-site inspection, the responsibilities for all professional issues are clear, and the persons responsible for the given task are aware of their obligations.
1	KKÁT	Identified good practice is considered to be the Licensee's practice of providing continuous feedback of fire safety experience through dedicated training sessions, in addition to the minimum requirements set out in the local Fire Protection Regulation.
2	KKÁT	Licensee's practice of providing a dedicated form (Ny 1940-01) prior to the planning of the conversions can be considered as an identified good practice, which helps the designer to identify and take into account the fire safety aspects.
1	HAEA/BM OKF	The recent co-authority inspection practice, that is carried out at the nuclear facilities can be considered as a regulatory good practice that ensures the comprehensive nature of the inspection activity through involving experts specialized both nuclear and in fire safety.
2	HAEA/BM OKF	The continuous monitoring of relevant international guides, standards and practices by the co-authorities can be considered as a good regulatory practice, which ensures that the Hungarian legal and regulatory framework is in line with the international best practice.
3	HAEA	On the regulatory side it was identified as a good practice that the HAEA obligated the PAE to submit the most up-to-date version of the PSA models annually because: • It ensures that all regulatory reviews, professional discussions, etc. are based on the same models and documents that the Licensee uses • It gave a chance to the HAEA to develop its own PSA applications, such as PSA based event analysis • It created the possibility for the HAEA to check the adequacy of the PSA calculations done by the Licensee via cross-checking it with its own results.