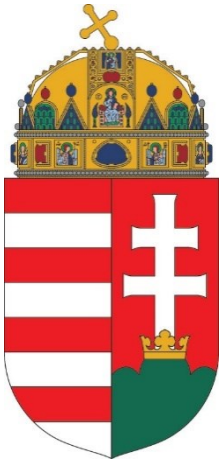
Hungary

Tenth National Report



in the Framework of the Convention on Nuclear Safety

2025

Acronyms, Abbreviations, and Definitions

ALARA – As Low As Reasonably Achievable

BCGO – Baranya County Government Office

CEMRP – Comprehensive Emergency Management and Response Plan

CFSI – Counterfeit, Fraudulent, and Suspect Items

CNFF – Central Nuclear Financial Fund

CNS or **Convention** – Convention on Nuclear Safety signed in Vienna on 20 September 1994 under the auspices of the International Atomic Energy Authority

DMCIC – Disaster Management Coordination Inter-Ministerial Committee

DMCIC NDWG – Disaster Management Coordination Inter-Ministerial Committee Nuclear Defense Working Group

EMR –Environmental Monitoring Rules

ENSREG – European Nuclear Safety Regulators Group

Euratom – European Atomic Energy Community

EURDEP –European Radiological Data Exchange Platform

FSAR – Final Safety Analysis Report

GRP – Geological Survey Programme

HAEA – Hungarian Atomic Energy Authority

HAEA SC - Hungarian Atomic Energy Authority Scientific Council

HNERP – Hungarian Nuclear Emergency Response Plan

HNERS – Hungarian Nuclear Emergency Response System

HUN-REN CER – HUN-REN Centre for Energy Research

IAEA – International Atomic Energy Agency

PSR – Periodic Safety Review

INES – International Nuclear and Radiological Event Scale

IPPAS – International Physical Protection Advisory Service

IRMIS – International Radiation Monitoring Information System

IRRS – Integrated Regulatory Review Service

MoE –Ministry of Energy

MoI NDGDM – Ministry of Interior National Directorate General for Disaster Management

MoI NDGDM NEIEC – Ministry of Interior National Directorate General for Disaster Management Nuclear Emergency Information and Evaluation Centre

MVM Paks NPP Ltd. – MVM Paks Nuclear Power Plant Ltd.

NECP – National Energy and Climate Plan

NERMS – National Environmental Radiological Monitoring System

NRMAS – National Radiological Monitoring and Alarming System

OECD – Organisation for Economic Co-operation and Development

OECD NEA – OECD Nuclear Energy Agency

OECD NEA CNRA – OECD Nuclear Energy Agency Committee on Nuclear Regulatory Activities

OLC – Operational Limits and Conditions

Paks NPP – Paks Nuclear Power Plant

Paks II Ltd. – Paks II Nuclear Power Plant Limited

PGA – Peak Ground Acceleration

PSA – Probabilistic Safety Assessment

PSAR – Preliminary Safety Analysis Report

PSIR – Preliminary Safety Information Report

PSOD – Production Subsystem Operation Development

PURAM – Public Limited Company for Radioactive Waste Management

RMR – Release Monitoring Rules

OOR – Organizational and Operational Rules

SAMGs – Severe Accident Management Guidelines

SAT – Systematic Approach to Training

SBEOP – Symptom-based Emergency Operating Procedures

SFISF – Spent Fuel Interim Storage Facility

SMR – Small Modular Reactor

SSLE – Subsequent Service Life Extension

TPR – Topical Peer Review

TS – Technical Specifications

TSR – Targeted Safety Reassessment

WANO – World Association of Nuclear Operators

WENRA – Western European Nuclear Regulators' Association

WRPR –Workplace Radiation Protection Rules

***

Atomic Act – Act CXVI of 1996 on Atomic Energy

Code of General Administrative Procedure – Act CL of 2016 on Code of General Administrative Procedure

HNERS decree – Government Decree 167/2010. (V. 11.) on the Hungarian Nuclear Emergency Response System

NSD directive – Directive 2009/71/EURATOM establishing a Community framework for the nuclear safety of nuclear installations and its amendment, Directive 2014/87/Euratom

nuclear safety decree – HAEA decree 1/2022. (IV. 29.) on the nuclear safety requirements of nuclear facilities and the related regulatory activities

nuclear security decree – Government Decree 190/2011. (IX. 19.) on the physical protection requirements for various applications of atomic energy and the corresponding system of licensing, reporting and inspection

radiation protection decree – HAEA decree 2/2022. (IV. 29.) on the protection against ionizing radiation and the corresponding licensing, reporting and inspection system

releases decree – Decree of the Minister of Environment 15/2001. (VI. 6.) on the radioactive releases into the air and water during the use of atomic energy, and on their control

Special Status Organs Act – Act CVII of 2019 on special status organs and the legal status of persons employed by them

training decree – HAEA decree 10/2022. (XII. 29.) on the special professional training and advanced training of workers employed in a nuclear facility, and on the scope of persons authorized to conduct activities in relation with the application of atomic energy

***

Table of Contents

***

1. Introduction

1.1. About This Report

The Tenth National Report (National Report) has been prepared to comply with the obligation according to Article 5 of the Convention on Nuclear Safety signed in Vienna on 20 September 1994 under the auspices of the International Atomic Energy Authority and promulgated in Hungary by the *ACT I OF 1997*, edited by the Hungarian Atomic Energy Authority (HAEA). The following organizations contributed to the development of the National Report coordinated and compiled by the HAEA:

- Baranya County Government Office (BCGO)
- Ministry of Energy (MoE)
- Ministry of Interior National Directorate General for Disaster Management (MoI NDGDM)
- MVM Paks Nuclear Power Plant Ltd. (MVM Paks NPP Ltd.)
- Paks II Nuclear Power Plant Limited (Paks II Ltd.)

Hungary is a Category 2 Contracting Party to the peer review process of the Convention[1], so the National Report has been prepared in full content based on Articles 7 to 19.

This Tenth National Report has been compiled in accordance with the requirements of the Convention and the "*Guidelines Regarding National Reports under the Convention on Nuclear Safety – INFCIRC/572/Rev.8*" together with the recommendations based on the conclusions of the Joint Eight and Ninth Review Meeting (2023) and the conclusions of the 3rd extraordinary meeting (2023) and taking into consideration the structure of the voluntary template.

In line with the letter of December 2018 of the President of the 8th Review Meeting, compliance with the principles of the Vienna Declaration in Hungary is separately indicated in the National Report.

1.2. Nuclear Programme in Hungary

1.2.1. Nuclear installations

» Paks Nuclear Power Plant

Hungary has one nuclear installation under the scope of the Convention. Paks Nuclear Power Plant (Paks NPP) is a base-load power plant, and the most important one as the largest electricity producer in the country, supplying approximately half of domestic electricity generation. Paks NPP comprises four VVER-440/213 type reactor units, in operation for over 40 years, providing safe, reliable, cost-effective and low-carbon electricity to residential and industrial consumers of Hungary. Upgrades have increased its total installed capacity to over 2,000 MW. Current operating licenses are valid until 2032 (Unit 1), 2034 (Unit 2), 2036 (Unit 3) and 2037 (Unit 4). In line with a

[1] According to Annex III of INFCIRC/571/Rev.9, Guidelines regarding the Review Process under the Convention on Nuclear Safety.

decision of the Parliament of Hungary, preparatory activities are ongoing for the subsequent service life extension (SSLE) of Paks NPP[2].

» Research Reactors

Hungary has two research reactors: the Budapest Research Reactor, with a thermal power of 10 MW, operated by the HUN-REN Centre for Energy Research (HUN-REN CER); and the Training Reactor, with a thermal power of 100 kW, operated by the Budapest University of Technology and Economics.

» Spent Fuel Interim Storage Facility

For the interim storage of spent fuel assemblies from Paks NPP a separate nuclear installation, the Interim Spent Fuel Storage Facility (ISFSF) serves, located in the immediate vicinity of the power plant. The ISFSF is operated by the Public Limited Company for Radioactive Waste Management (PURAM). The ISFSF is a modular, vault-type dry storage facility, in operation since 1997. The current operating license covers 24 vaults. The facility can be expanded modularly, so the facility can be continuously expanded in accordance with the amount of spent fuel generated at the Paks NPP.

1.2.2. National Energy and Climate Plan

Following extensive consultations, the MoE revised and updated Hungary's National Energy and Climate Plan (NECP) for the period up to 2030. The updated plan was adopted by the Government in 2024 and submitted to the European Commission. The main objectives of this policy document are to strengthen energy sovereignty and security of supply, preserve the results of utility cost reductions, successfully implement the green transition, and stimulate the green economy. By increasing the targets for emission reduction and renewable energy production, the revised plan also supports the achievement of climate neutrality and sustainability commitments.

According to the updated NECP, Hungary aims to reduce its gross greenhouse gas emissions by at least 50% by 2030 compared to 1990 levels, an increase from the previous target of 40%. The plan limits final domestic energy consumption to no more than 740 PJ by the early 2030s, compared to the earlier targeted upper limit of 785 PJ. The share of renewable energy in gross final energy consumption is targeted to reach 30%, up from the previous goal of 21%.

Key priorities include promoting electrification and reducing energy consumption in residential, public, industrial, and transport sectors. To enable the wider use of self-generated green energy, large-scale deployment of various energy storage solutions is required.

» The role of nuclear energy in the National Energy and Climate Plan

The revised NECP reaffirms the long-term use of nuclear technology as follows: Hungary's objective is for the majority of domestic electricity generation to come from two sources, nuclear energy and renewable energy, the latter primarily from solar power plants, in line with national opportunities. These technologies are not mutually exclusive but rather complementary solutions, and both are considered clean energy sources. Currently, nearly half of Hungary's electricity generation is provided by carbon-neutral nuclear power. With the implementation of the subsequent service life extension project of Paks NPP and the commissioning of the Paks II units in the years

[2] Resolution 56/2022 (XII. 8.) of the Hungarian Parliament on the subsequent extension of service life of the existing units of Paks NPP

following 2030, this share will remain sustainable in the long term. Given Hungary's circumstances, carbon-neutral electricity generation would be inconceivable and unattainable without nuclear energy. The use of nuclear power significantly contributes to energy security and to reducing dependence on fossil fuels by providing a clean solution to the challenges posed by growing electricity demand.

The NECP also addresses the dimensions of research, innovation, and competitiveness. In the nuclear field, a further objective is to support innovation that enhances the competitiveness of nuclear electricity generation and contributes to the preservation and expansion of Hungary's nuclear experience and knowledge base.

» Role of nuclear energy in the domestic energy mix and its share

MVM Paks NPP Ltd. operates Hungary's only nuclear power plant, the Paks Nuclear Power Plant. In 2022, the share of nuclear energy in total electricity generation was 46.7%, increasing to 48.8% in 2023, while in 2024, approximately half of the electricity produced in Hungary originated from nuclear energy. Paks NPP is therefore plays a vital role in Hungary's electricity system. Based on the current operating licenses, the four reactor units supply electricity for the consumers until 2037 (Unit 1: until 31 December 2032, Unit 2: until 31 December 2034, Unit 3: until 31 December 2036 and Unit 4: until 31 December 2037). Preparatory activities for a subsequent service life extension of Paks NPP are progressing in accordance with the planned schedule. The first phase of the environmental licensing procedure, namely the preliminary consultation process, was completed in 2024.

2. Relevant Nuclear Installations

2.1. Installations subject to the Convention

Main data of the nuclear installations under the scope of the Convention can be found in Table 1.

Table 1. Main data of the nuclear installations under the scope of the Convention

Site	Licensee	Unit	Type	First criticality	Power (electric)	State
Paks	MVM Paks NPP Ltd.	1	VVER-440/213	1982	508.6 MW	Operating
		2	VVER-440/213	1984	506 MW	Operating
		3	VVER-440/213	1986	506 MW	Operating
		4	VVER-440/213	1987	506 MW	Operating

Technical description of Paks NPP is detailed in Section 6.1.1.

3. Summary

Hungary is a Category 2 Contracting Party of the peer review process under the Convention. As such it has prepared its National Report for all Articles from 7 to 19 of the Convention. As noted in this report Hungary fulfils all these Articles.

3.1. Summary of Responses to Applicable Challenges and Suggestions

This section provides an update on the remaining challenges identified for Hungary during the Sixth Review Meeting of the Convention, as well as those established during the Joint Eight and Ninth Review Meetings.

Challenges and recommendations identified during the Sixth Review Meeting

With regard to the challenges and recommendations identified during the 6th Review Meeting, Hungary has achieved the following progress.

» Challenge 2: Implementation of the Hungarian National Action Plan

Following the Fukushima Daiichi accident, and in line with European Union expectations, MVM Paks NPP Ltd. implemented the Targeted Safety Reassessment (TSR) in 2011. Based on the review, the HAEA prescribed safety enhancement measures for Paks NPP. By the end of 2015, 24 out of the 46 tasks were completed, and an additional 16 tasks were completed between 2016 and 2018. Of the remaining five tasks, following their consolidation, four were completed during 2022–2024. At the time of closing the National Report, one task remained open: the seismic strengthening of the fire brigade building.

» Challenge 6: Knowledge management

The HAEA's training system was reviewed during the reporting period. Some elements of knowledge management are already in place, though not yet fully comprehensive. The training system is continuously operated; the methodology for competence assessment has been developed, and the assessment itself is expected in the next period. In addition, through regular technical meetings, the HAEA shares as widely as possible within the authority the experiences and lessons learned from its oversight tasks.

Challenges and recommendations identified during the Joint Eight and Ninth Review Meetings

With regard to the challenges and recommendations identified during the Joint Eight and Ninth Review Meetings, Hungary has achieved the following progress.

» Challenge 1: Paks II Ltd. should develop a human resource plan for the new build project, so as to assure that it has in each phase of the realization of the new build project the appropriate competences and resources for ensuring the safe implementation at both the regulator and the operator.

Paks II. Ltd. has aligned its staff management with the volume of tasks to be performed, thereby ensuring the necessary and sufficient human resources for work, and has developed a concept to ensure the availability of operating personnel. In scheduling

future recruitments, Paks II. Ltd. shall also pay particular attention to securing the required resources in line with project progress.

To retain employees and facilitate future staff expansion, Paks II. Ltd. is committed to maintaining a remuneration policy that ensures competitive income compared to industry and market peers. To expand the specialist base, at the initiative of MVM Paks NPP Ltd. and Paks II. Ltd., a dual correspondence programme in electrical engineering will be launched in Paks from September 2025. The theoretical professional foundation for this will be provided by the University of Pécs, while the Energy Technical School and College will serve as the training venue. Both companies regard the Energy Technical School and College as a strategic partner and co-financier. The objective is that as many graduates as possible continue their studies at the University of Pécs and subsequently join one of the companies.

» Challenge 2: To develop a regulatory resources and competence plan so as to assure the required staff and competence are to be found in HAEA for the construction oversight of the new Paks II project.

Since 2022, as an independent regulatory organ, the HAEA has determined its human resource needs and organisational structure within its own competence. In 2024, its organisational structure was designed and changed to be aligned with the anticipated oversight tasks. The nuclear safety oversight of individual nuclear facilities is performed by separate departments with adequate resources of their own. A separate department was established for the oversight of the Paks II project, and a separate independent organisational unit carries out tasks related to general construction and pressure retaining equipment inspection. The competence and human resource needs required for the operation of the independent organisational units are determined by the head of the given unit. Taking into account the expected tasks, the organisational unit responsible for the oversight of the Paks II project assessed its resource and competence needs.

Through these steps, the HAEA has provided dedicated resources and takes into consideration additional resource and competence requirements in order to ensure the adequate level of oversight of the new units.

» Challenge 3: Setting up and ensuring the possible most effective work organisation for the implementation of the strategic objectives while maintaining a high level of nuclear safety.

One of the main objectives of the organisational restructuring carried out in May 2024 was to ensure that adequate resources are available for all oversight activities, and that resources are allocated in line with current and anticipated tasks as well as strategic objectives. The new organisational structure serving these objectives is presented in Section B.8.1.2.

» Challenge 4: Preparation for subsequent service life extension of Paks NPP

The preparatory work for subsequent service life extension of Paks NPP, initiated in 2019, entered a new phase following the Government decision in 2022. The objective of the priority SSLE project is to extend the operating licenses of Units 1–4, which are set to expire between 2032 and 2037. The fundamental legal framework for the implementation of the SSLE has been established, and the next step involves reviewing the detailed regulatory provisions and related regulatory guidelines. The licensee commenced preparations and completed the preliminary project scope in 2023. The necessary safety analyses and the review of aging management programmes have been initiated. The project implementation is also supported through international

cooperation with the International Atomic Energy Agency (IAEA). The pre-consultation phase of the environmental licensing process was completed in 2024. The project is progressing in accordance with the established schedule.

3.2. Summary of Other Significant Changes Since Previous Report

The HAEA, as the nuclear safety authority, has been operating as an independent regulatory organ with special legal status since 2022. Its President holds independent regulatory rulemaking authority. Following the change in HAEA's legal status, several organizational changes were implemented. A dedicated department was established to support rulemaking tasks and to provide more effective legal support for regulatory oversight activities. Additionally, a new organizational structure was developed to better align with the regulatory activities. Nuclear safety oversight of individual nuclear installations is now carried out by dedicated departments: one supervises the activities related to new nuclear power plants, another oversees operating nuclear power plants, and a third is responsible for research reactors and storage and disposal facilities.

Exercising its new regulatory rulemaking authority, the HAEA issued and subsequently amended the main nuclear safety-related regulations during the reporting period. Among the amendments to the Atomic Energy Act (↪ *Act CXVI of 1996 on atomic energy*) and the Nuclear Safety Decree (↪ *HAEA Decree 1/2022. (IV. 29.) on the nuclear safety requirements of nuclear facilities and the related regulatory activities*) in the recent years, the introduction of the so-called "new oversight concept" is of particular importance. With respect to new nuclear installations in the construction phase, this concept makes it possible to replace the licensing of manufacturing and procurement for systems and components classified in safety classes 2 and 3 with simplified notification-acknowledgement and deviation-notification-acknowledgement procedures, while keeping unchanged the licensing requirements for safety class 1 system, component and facility-level licenses. Another key development was the establishment of the legal framework for the subsequent service life extension of the nuclear power plant.

Paks NPP has completed additional tasks identified as the results of the Targeted Safety Reassessment (TSR). These include installation of severe accident diesel generators, implementation of containment overpressure protection, establishment of a Backup Command Centre equivalent to the Protected Command Centre, and deployment of a wireless communication system usable in all operational states. One remaining task is the seismic reinforcement of the fire station, which must be completed by the licensee by 31 December 2026.

In recent years, Paks NPP has implemented significant changes in the processes of its production subsystem, particularly in the area of work management. Preparations have also begun for the subsequent service life extension of its units beyond the current 50-year operational term.

Regarding the new nuclear power plant (Paks II), the HAEA issued the construction license in 2022, with conditions and hold points. The construction license is valid for 10 years and approves the complete technical concept and safety solutions of the power plant. The construction license on its own does not entitle the licensee to commence construction work; further specific structure, system, component and building-level permitting is required. During the reporting period, various site preparation, manufacturing, and construction activities were carried out.

3.3. Notable Achievements

Sections B.7.2.2 and B.7.2.3 report on legislative reviews, as a result of which the *ATOMIC ACT* and the *NUCLEAR SAFETY DECREE* were amended. For the construction phase, instead of requiring manufacturing and procurement licenses for systems and components classified in Safety Classes 2 and 3, notification-acknowledgement and deviation-notification-acknowledgement procedures were introduced, while regulatory inspections were reinforced. These changes support broader application of a graded approach in regulatory oversight activities.

3.4. Future Focus

The main nuclear energy–related tasks for the coming years are as follows:

» Preparation for subsequent service life extension of the operating units

The current operating licenses for Units 1–4 of Paks NPP are valid until the period between 2032 and 2037. The licensee intends to extend the service life of each unit by an additional 20 years. This will require the implementation of a comprehensive technical review and preparatory activity, which has already commenced. The licensee plans to submit the implementation programme required for service life extension to the HAEA by no later than 2028, followed by the application for the extension itself by no later than 2031. The legal basis for SSLE was established in 2024 through amendments to the *ATOMIC ACT.* The regulatory authority intends to review the detailed requirements for SSLE based on national and international experience.

» Construction of new units

Following the issuance of the construction license, the Paks II project has entered a new phase. In the coming years, site preparation and construction activities at the site are expected to further intensify, along with the corresponding increase in the intensity of regulatory oversight. In addition, a significant number of manufacturing and procurement activities will be undertaken, requiring the conduct of related regulatory procedures.

» Preparation for the deployment of small modular reactor technologies

The growing popularity of nuclear energy has brought small modular reactors (SMRs) into focus. However, SMRs present a number of challenges for both licensees and regulatory authorities. The practical implementation of SMRs will require the review of available experience, the development of the necessary competencies, and the revision of the legislative framework.

3.5. Planned Improvements

The HAEA plans to review its regulatory framework with regard to its applicability to SMRs.

3.6. Major Common Issues

The following sections provide an overview of activities carried out over the past three years and the current national status in relation to the major common issues identified at the Eight and Ninth Joint Review Meetings.

3.6.1. Managing extraordinary circumstances impacting the safe operation of nuclear installations

Through its integrated risk management system, the HAEA conducts annual assessments of risks, including those originating from external sources, that could adversely affect the performance of its regulatory functions. For identified risks, the HAEA implements measures and monitors their execution.

3.6.2. Strengthening national regulatory capabilities taking into account new and innovative technologies

The HAEA is committed to promoting the safe and efficient deployment of new and innovative nuclear technologies. To this end, it is an active member of several international organisations, participates in multiple working groups and other forums of international cooperation, and reviews its national regulatory framework accordingly.

The HAEA is a member of the Organisation for Economic Co-operation and Development (OECD) Nuclear Energy Agency (NEA) Committee on Nuclear Regulatory Activities (CNRA) *Working Group on New Technologies*, which provides a platform for nuclear safety authorities to discuss regulatory issues and share international experience on new technologies, such as SMRs, Generation IV reactors, artificial intelligence-based systems, robotics, and non-electricity-generating reactor applications (e.g., district heating).

At present, apart from the ongoing Paks II project, the HAEA is not conducting licensing or pre-licensing procedures for new nuclear power plants. The HAEA is developing its competencies and continuously expanding its knowledge in the licensing of SMRs, while closely monitoring developments in the field. In addition to tracking SMR-related information issued by international organisations and publicly available sources, the HAEA participates in international events to gain relevant experience. In 2024, the HAEA took part in two *Technical Safety Reviews* on SMRs conducted by the International Atomic Energy Agency (IAEA): the NuScale US460 in the United States and the SALUS-100 in the Republic of Korea. Furthermore, the HAEA expanded its knowledge on SMRs through site visits, including to the CAREM site in Argentina, the Rolls-Royce module development facility in Sheffield, and the NuScale site in Idaho.

Furthermore, the HAEA participates in the IAEA's *Nuclear Harmonization and Standardization Initiative* (*NHSI*) on SMRs, which aims to develop a jointly accepted pre-licensing framework for SMRs. This initiative plays a key role in promoting international regulatory harmonization and supporting the global deployment of SMRs. In addition, the HAEA plays an active role in the SMR Task Group of the Reactor Harmonization Working Group (RHWG) of the Western European Nuclear Regulators Association (WENRA), as well as in the EU SMR "pre-partnership" licensing working group.

3.6.3. Fostering international collaboration

The HAEA also seeks to establish relations with regulatory bodies that have greater experience in overseeing SMRs. In the framework of international cooperation, in 2024 the HAEA concluded a five-year bilateral agreement with the United Kingdom's *Office for Nuclear Regulation (ONR)*. This agreement focuses on jointly addressing regulatory challenges related to new technologies, particularly SMRs, and on sharing regulatory

experience, thereby contributing to the maintenance of a high level of nuclear safety at the international level.

In 2024, the HAEA conducted various consultations on SMR technologies with both industry and regulatory stakeholders. The HAEA plans to cooperate with the Czech and Polish nuclear regulatory authorities on the joint review of the BWRX-300 reactor design.

As part of its preparations for the future licensing of SMRs, the HAEA has also initiated a review of the regulatory framework. The establishment of a new regulatory framework for SMR licensing requires appropriate determination of procedures, safety requirements, and guidelines, taking into account the specific features of SMR technology, international recommendations, and modern regulatory approaches.

3.6.4. Foster international peer review missions and timely addressing of findings

Hungary, from both the regulatory and licensee sides, regularly subjects itself to independent assessments by international experts and peer review missions.

The IAEA conducted an *Integrated Regulatory Review Service (IRRS)* mission in 2015 to review the Hungarian regulatory system. The IRRS mission concluded that Hungarian experts were committed to the strict oversight of the country's nuclear programme and the various applications involving radioactive materials. The follow-up mission, which assessed the implementation of the recommendations and suggestions from the 2015 mission, took place in Hungary in September 2018. According to the IAEA expert delegation, Hungary had made significant improvements over the three-year period. The expert team concluded that Hungary had achieved commendable progress in implementing the recommendations and suggestions from the earlier review mission. Several good practices were identified, and further recommendations and suggestions were made for additional improvement. At the time of finalizing this report, Hungary is carrying out a self-assessment in preparation for the second mission, which is scheduled to take place in October 2025.

In accordance with the European Union's Nuclear Safety Directive (↪ *COUNCIL DIRECTIVE 2009/71/EURATOM OF 25 JUNE 2009 ESTABLISHING A COMMUNITY FRAMEWORK FOR THE NUCLEAR SAFETY OF NUCLEAR INSTALLATIONS*), every six years a thematic peer review (*Topical Peer Review – TPR*) focusing on a specific technical area must be carried out in each Member State operating nuclear installations. The first such review took place in 2017, focusing on ageing management, while the second review (TPR II), conducted in 2023, focused on fire protection. The self-assessment phase of the review in Hungary was coordinated by the HAEA. Using the individual self-assessment sub-reports and its own evaluation, the HAEA prepared the national report, which was submitted to the relevant EU bodies in October 2023. The report was evaluated by international experts invited by the European Nuclear Safety Regulators Group (ENSREG), as well as by regulatory and operator experts from EU Member States. The results of the evaluation were presented at two technical coordination meetings with the participating countries in Luxembourg in September and October 2024. Based on the self-assessment and earlier on-site visits by ENSREG experts, most of the identified non-compliances (primarily minor administrative deficiencies) had already been addressed before the coordination meetings, while the remaining tasks are covered by the related TPR II National Action Plan.

Hungary has also subjected itself, in relation to nuclear safety, to the following:

- the *Emergency Preparedness Review (EPREV) mission* in June 2016, and subsequently the follow-up mission in July 2022;
- the *International Physical Protection Advisory Service (IPPAS) mission* in June 2017;
- the review mission of the *Integrated Nuclear Security Support Plan (INSSP)* in April 2022;
- the *Integrated Review Service for Radioactive Waste and Spent Fuel Management, Decommissioning and Remediation (ARTEMIS) mission*, which reviewed the national system for managing spent fuel and radioactive waste, in March 2022.

The HAEA experts regularly participate in various IAEA missions, such as in IRRS, IPPAS, and Technical Safety Review missions, and have taken part in the review of the Akkuyu Nuclear Power Plant's stress test. Cooperation with the IAEA contributes to ensuring that Hungarian nuclear facilities operate in accordance with international standards.

Since the start of its operation, Paks NPP has consistently subjected itself to international safety reviews. A presentation of these international reviews is provided in Table 9 in Section 19.7.2. Paks NPP considers international peer reviews conducted by professional organisations to be an effective tool for the independent assessment of safe operation and for comparison with international good practices. The plant analyses the reports of international peer reviews, identifying the root causes and contributing factors in areas requiring improvements. It carries out a root cause analysis for the identified areas for development and, based on this, prepares an action plan. The progress of the tasks set out in the action plan is monitored quarterly by the Operations Review Committee.

3.6.5. Possible impact of global climate changes on the safe operation of nuclear installations

Due to global climate change, climate models project a gradual warming in the area around Paks, although the extent of this warming is uncertain. The most pronounced warming is expected to occur in summer, but warming is also projected in other seasons. As a result, in terms of safe operation of Paks NPP, a less favourable future is expected regarding extreme high temperatures, while extreme cold will likely become a less significant hazard. In connection with these changes, an increased occurrence of operational problems related to extremely high water temperatures in the River Danube, which serves as the plant's cooling source, can be expected. In order to reduce the number of power level changes resulting from such or energy supply security reasons, a ministerial decree[3], that came into force in 2024, allows for temporary exceedance of the 30 °C limit for the water temperature of the Danube, with the consent of the minister responsible for energy. The minister responsible for energy had not used the opportunity to grant any ad hoc exemptions until the time this report was compiled. However, the hazards posed by extreme snowfall and icing of the Danube are expected to decrease.

[3] *Decree of the Minister of Energy 12/2024. (VIII. 15.) amending Decree of the Minister of Environment 15/2001. (VI. 6.) on the radioactive releases into the air and water during the use of atomic energy, and on their control*

As a result of global climate change, climate models do not provide a clear trend for changes in annual precipitation amounts in the area around Paks; however, an increase in the frequency of sudden, heavy rainfalls within short periods cannot be ruled out. From the perspective of plant safety, drought occurring at the site itself is irrelevant, and only the assessment of large, sudden precipitation events is necessary. In the wider area (the Danube catchment area), however, prolonged drought can affect the water level of the Danube, which in turn may threaten the plant's cooling water supply. It should be noted that changes in the Danube riverbed morphology can also significantly alter the river's water level, although this is not a factor related to climate change.

According to climate models, the direction of change in average wind speed around Paks is unclear and the change is not expected to be significant, but an increase in the maximum wind gust speeds is expected. Since only extreme wind gusts are capable of damaging buildings and outdoor equipment, the change in maximum wind gusts is relevant from a plant safety perspective.

Paks NPP's adequate protection against meteorological hazards has been demonstrated for the design basis frequency of 10^{-4}/year. In addition, the risk values of certain meteorological events have been determined, with risk calculations performed up to extremes with a much lower frequency of occurrence than the design basis, i.e. 10^{-7}/year. Considering the quantified risks of meteorological events together, the total risk per unit does not exceed the legal criterion of 10^{-4}/year. Even taking global climate change into account, it is unlikely that meteorological extremes beyond the values defined in the plant's design basis will occur during the remaining operational lifetime.

To monitor global climate change, Paks NPP continuously collects data from the Paks meteorological station operated by the HungaroMet Hungarian Meteorological Service Nonprofit Ltd. At regular intervals, the hazard curves used for the risk assessment of meteorological hazards are updated with the latest data. Following the first *Probabilistic Safety Assessment (PSA)* of external hazards in 2012, the hazard curves were last updated in 2018. In the 2012 analysis, a Gumbel distribution was fitted to extreme values for the period 1980–2010, while in the 2018 update, the data from 1980–2018 were used. This not only incorporated the then most recent data (intended to reflect the extent of climate change) but also provided a broader dataset for extrapolation, which influenced and refined the obtained extreme values. Following the 2018 update, extreme values decreased for maximum wind gusts, precipitation amounts, and snow thicknesses; increased for extremely high temperatures; and, for extremely low temperatures, some extremes decreased slightly, while others increased slightly – meaning that no clear trend was identifiable.

3.6.6. Securing reliable supply chains

Licensees may involve contractors in nuclear safety-related activities in accordance with legal requirements. The management system established and operated by licensees shall include regulatory processes for the nuclear qualification and supervision of contractors, as well as for the prevention, detection, handling, and control of *Counterfeit, Fraudulent, and Suspect Items (CFSI)* as special cases of nonconformances. The oversight of products and contractors is the primary responsibility of the licensee. While the HAEA has not conducted inspections specifically in this area, it is entitled to carry out inspections related to counterfeit and fraudulent items, including at contractors if necessary.

To gain broader experience in this field, the HAEA is a member of the newly established (in 2023) Working Group on Supply Chain (WGSUP) under the OECD NEA CNRA. One

of the main areas of activity of this working group is sharing the experiences of inspections related to counterfeit, fraudulent, and suspect items carried out by member authorities, as well as those from international inspections organized by the working group.

Over the past three years, supply chains have faced numerous challenges and changes. The COVID-19 pandemic had a significant impact on both global and local supply chains, causing disruptions in many sectors, while the Russia–Ukraine conflict also made the procurement of products difficult from the region. Paks NPP responded flexibly to these challenges and successfully managed the problems that arose. Proactive risk management strategies helped minimize the impacts of disruptions, ensuring uninterrupted provision of the tools and services required for plant operation.

Ensuring the continuous procurement of nuclear fuel is of particular importance for the operation of Paks NPP. Although the plant has a long-term contract for fuel supplied by the Russian company TVEL, it recognized in time the need to take steps toward diversifying its fuel supply. As a result of these efforts, in autumn 2024 Paks NPP signed a contract with Framatome for the European production of the currently licensed fuel at the Framatome's European factory. Licensing of production and preparation of manufacturing capacity will allow for deliveries no earlier than 2027. As a longer-term solution, Paks NPP, together with other European VVER-440 reactor operators, is negotiating with Framatome for the development of an independent European VVER-440 nuclear fuel. Paks NPP has reaffirmed its commitment to Framatome and its partners to develop an independent fuel supply.

Paks II Ltd. operates a continuous and strict inspection system for the qualification and supervision of contractors, with special attention to quality and nuclear safety aspects. In the event of any problems, the company takes immediate action to implement the necessary corrections. It keeps detailed records of all participants in the supply chain, documenting identified deficiencies, and, where justified, suspends the further involvement of the affected subcontractor in the project.

3.6.7. Strategies for ageing management in support of the operation of nuclear installations

The topic is described in Annex II.

3.6.8. Strengthening emergency preparedness and response arrangements and fostering cross border collaboration

The subsection „International exercises" of Section 16.1.5. describes this topic.

3.7. Vienna Declaration on Nuclear Safety

The National Report describes the compliance with the principles of the *Vienna Declaration* in the following sections:

Principles of Vienna Declaration	Section
Principle 1	17.1.3 18.1.2
Principle 2	6.1.3 14.1.2 18.1.2 19.4.2 Annex II
Principle 3	7.2.1

A. GENERAL PROVISIONS

Part A consists of the following Articles:

Article 6: Existing Nuclear Installations

6. Existing Nuclear Installations

Convention on Nuclear Safety, Article 6

> *"Each Contracting Party shall take the appropriate steps to ensure that the safety of nuclear installations existing at the time the Convention enters into force for that Contracting Party is reviewed as soon as possible. When necessary in the context of this Convention, the Contracting Party shall ensure that all reasonably practicable improvements are made as a matter of urgency to upgrade the safety of the nuclear installation. If such upgrading cannot be achieved, plans should be implemented to shut down the nuclear installation as soon as practically possible. The timing of the shut-down may take into account the whole energy context and possible alternatives as well as the social, environmental and economic impact."*

Summary Statement for Article

Upon the entry into force of the Convention in Hungary, the fulfilment of the obligations under Article 6 regarding existing nuclear installations was presented in the national reports prepared earlier. During the current review period, Hungary took further steps to maintain and/or enhance the safety of nuclear facilities. Safety improvement measures at Paks NPP, which falls under the scope of the Convention, are continuously ongoing, and preparations have begun for the subsequent service life extension of the plant.

6.1. Paks Nuclear Power Plant

6.1.1. Technical description of Paks NPP

The scope of the Convention covers the four units of Paks NPP operated by MVM Paks NPP Ltd. The units were commissioned between 1982 and 1987. The originally 30-year design lifetime of the units was extended by an additional 20 years. The units of the NPP are in good technical condition. In September 2022, Paks NPP launched a subsequent service life extension project, aiming to extend the operation of Units 1–4 by a further 20 years beyond the currently licensed 50-year service life, until 2052–2057.

The main technical data of the individual units of Paks NPP are summarised in Table 2.

Table 2. Main technical parameters of the reactor units of Paks NPP

Reactor type	Pressurized-water, water-cooled, water-moderated power reactor, type: VVER-440/V-213
Thermal power of the reactor	1485 MW
Electric power output of the units	508.6 MW; 504.2 MW; 500 MW; 500 MW
Number of primary loops per unit	6
Volume of the primary circuit	237 m^3
Pressure in the primary circuit	123 bar
Average temperature of the primary coolant	284 ± 2 °C

Height/diameter of the pressure vessel	11.8 m and 4.27 m
Average enrichment of the fuel	3.82-4.7%
Fuel quantity per unit	44 tons of uranium in 349 fuel assemblies
Number of turbo-machine groups per unit	2
Pressure of secondary circuit main steam line	43.15 bar

The moderator and the coolant of the reactors is light water. In terms of safety philosophy, Paks NPP belongs to the group of second-generation VVER-440 nuclear power plants. According to the original design, the nominal thermal output of the units was 1375 MW per unit, and the electrical output was 440 MW per unit. As a result of the power-uprate programme implemented between 2006 and 2009, the thermal output of each unit increased to 1485 MW, and the electrical output to 500 MW. By the end of 2021, the modernisation of the high-pressure casing of the turbines had been completed on all units, resulting in a further slight increase in their electrical output.

6.1.2. Significant safety related events

In the nuclear power plant, safety-related events meeting the specified criteria are reported by Paks NPP to the HAEA in accordance with the relevant regulations, and these events are assessed in investigations.

During the reporting period, no events indicating a serious deterioration in safety or radiation protection occurred at Paks NPP. All events reported to the HAEA were rated as INES 0 on the *International Nuclear and Radiological Event Scale (INES)*. Below is a brief description of the events that occurred between 2022 and 2024, during which a safety barrier was impaired, or a first-level automatic protection operation was triggered.

» Automatic reactor protection actuation due to high-pressure feedwater heater reaching limit water level

On 25 December 2023, at Unit 4 operating at nominal power, the operational staff performed a scheduled power reduction at the request of the electric network operator. Following the power restoration, the condensate switching interlock of the high-pressure feedwater pre-heaters associated with Turbine 7 was activated; however, the interlock action was not fully carried out, as one slide valve did not receive the open command. The partially executed interlock action blocked the condensate drainage path, and the water level in the high-pressure feedwater pre-heater No. 2 began to rise. The level deviation triggered unit protection, which led to the shutdown of unit 4 upon an automatic protection operation signal. The protection operated properly, the staff stabilized the parameters, and measures were taken to correct the fault. During inspection, the staff identified a faulty relay, which was repaired. After the repair, the unit was brought back to nominal power.

» Automatic reactor protection actuation due to “Last operating turbine tripped” signal from simultaneous differential protection on generators

On 25 March 2024, during normal operation of Unit 1, level one automatic protection was triggered due to simultaneous differential protection activation on the unit generators. The differential protections operated in response to a transient caused by the closing of the 400 kV network breaker at Unit 4. The protection functioned properly. After checking and stabilizing the parameters, the staff restored the unit to nominal power.

» Primary circuit compensable leakage due to autonomous loop temperature measurement weld leak

On 19 October 2024, during in-service inspections at Unit 3, intense blow-by and leakage were observed around the No. 1 main circulating pump. Further inspections determined that a weld on one of the temperature measurement points had lost leaktightness. To eliminate the leak, the unit was shut down and cooled down. The repair was performed by replacing the affected pipe section. No other faults were found during subsequent inspections, and the unit was returned to nominal power.

6.1.3. Planned programmes and measures for the continued safety upgrading

» Targeted Safety Reassessment

Following the accident at the Fukushima Daiichi Nuclear Power Plant, the European Union stress test (officially referred to in Hungary as Targeted Safety Reassessment, TSR) resulted in the HAEA ordering for the implementation of 46 measures in 2012. The majority of the ordered safety improvement measures (40 tasks) were completed by 2018. The remaining six tasks were rescheduled and partially consolidated by the HAEA in the resolution concluding the Periodic Safety Review, thereby requiring the licensee to implement the following five tasks:

- Seismic reinforcement of the fire brigade barrack (2026);
- Installation of severe accident diesel generators (2024, completed);
- Implementation of containment overpressure protection (2025, completed);
- Establishment of a Backup Command Centre equivalent to the Protected Command Centre (2024, completed);
- Implementation of wireless communication usable in all operating states (2022, completed).

By 2025, all tasks have been completed with one exception. The licensee shall complete the seismic reinforcement of the fire brigade barrack by 31 December 2026.

Details of the TSR process and the tasks implemented on the basis of its results are reported in Annex III.

» Further ongoing and implemented safety improvement measures

Additional ongoing safety improvement measures and modifications outside the frames of the TSR:

- Fire risk reduction reconstruction package;
- Improvement of spent fuel pool leak-tightness;
- Restoration of fire barriers' functionality;
- Refurbishment of cable supports in the water intake structure cable tunnels;
- Structural reinforcement of the essential cooling water system pipeline tunnel to prevent damage in case of a design basis earthquake;
- Seismic strengthening of the environmental and release control system (sampling stations) of radiation protection monitoring system;
- Replacement of containment sealing valves to ensure leak-tight closure;
- Development of alternative fuel;
- Safety modifications of refuelling machines;
- Reconstruction of turbine power control and secondary protections;

— Seismic reinforcement of the component cooling water and fire water pump houses;
— Refurbishment of electrical and I&C supply cabinets and their power supply in the main control room;
— Establishment and fixation of primary circuit storage racks, protection of technological systems against earthquakes;
— Reinforcement of the main operational building against tornados;
— Reinforcement of the relay room walls in the main control room.

Safety improvement measures and modifications already implemented outside the TSR frames:

— Establishment of a backup cooling system for the spent fuel pool;
— Expansion of radiation portal monitors to enable detection of gamma-emitting isotopes.

The modifications related to severe accident management implemented at the Paks NPP units between 2011 and 2014 are described in Section 18.1.2.

The operating nuclear power plant conducts regular safety reviews in accordance with Principle 2 of the Vienna Declaration, resulting in the implementation of further safety improvement measures.

6.1.4. Continued operation of the nuclear installation

» Service life extension of Paks Nuclear Power Plant

Within the framework of the service life extension process, the HAEA issued the service life extension license for Unit 1 on 17 December 2012, for Unit 2 on 24 November 2014, for Unit 3 on 19 December 2016, and for Unit 4 on 19 December 2017.

The operating licenses issued in relation to service life extension were modified in 2019 due to the introduction of the fifteen-month operating cycle.

In the operating licenses, a total of 63 tasks were ordered. Since then, Paks NPP has completed 36 tasks within the deadline and 5 tasks beyond the deadline. At the time of closing the National Report, 22 tasks remained open. Out of these, 17 tasks represent regular examination and reporting obligations to be carried out until the end of service life, which are fulfilled by Paks NPP with the required regularity.

The remaining 5 tasks concern specific examinations or corrective measures.

» Subsequent service life extension of the Paks Nuclear Power Plant

MVM Paks NPP Ltd. launched the examination of the subsequent service life extension (SSLE) of Paks NPP in 2019. The resulting feasibility study, completed in 2020, concluded that, for the examined 10-year SSLE period, there were no technical or other exclusionary factors for the extension. In 2022, the Government decided to prepare for the subsequent service life extension of Paks NPP. On 26 September 2022, the CEO of MVM Paks NPP Ltd. established the Subsequent Service Life Extension Priority Project. The Parliament approved the confirmatory resolution of the SSLE in 2022.

The project is progressing according to schedule, with the aim of extending the licenses of Units 1-4, expiring in 2032–2037, by an additional 20 years each.

The legal basis for the SSLE was created by the amendment of the *ATOMIC ACT* in 2024[4]. In 2023, the licensee developed the programme (task list and schedule) in accordance with IAEA SSG-48 and submitted the notification to European Atomic Energy Community (EURATOM) under Article 41 of the EURATOM Treaty. The preliminary scope of the reconstruction programme was completed in the first half of 2023. The preparation of nearly 250 projects is ongoing, as is the definition of the SSLE scope (according to IAEA SRS-106), the preparation of time limited ageing analyses (based on IAEA SRS-82 IGALL), and the review of ageing management programmes (in line with IAEA SSG-51).

In January 2024, MVM Paks NPP Ltd. signed a cooperation agreement (extrabudgetary programme) with the IAEA, under which the IAEA supports the project with preparatory workshops, advisory activities, and Safety Aspects of Long Term Operation (SALTO) missions. The Pre-SALTO mission to Hungary is coming in 2027.

The preliminary consultation phase of the environmental licensing procedure was closed on 24 October 2024. The environmental impact assessment, covering 13 impact assessment programmes, was under preparation in 2024. The start of the environmental licensing procedure, including the international phase under the Espoo Convention, is expected in the second half of 2026.

The submission of the SSLE implementation programme, serving as a prerequisite for the authorisation of SSLE, to the HAEA is expected in the second half of 2028. The SSLE license applications for Units 1-4 are planned to be submitted to the HAEA in the second half of 2031, 2033, 2035 and 2036, respectively.

Summary of Responses to Applicable Challenges and Suggestions

6th Review Meeting - Challenge 2: Implementation of the Hungarian National Action Plan

Following the Fukushima Daiichi accident, and in line with European Union expectations, MVM Paks NPP Ltd. implemented the TSR in 2011. Based on the review, the HAEA prescribed safety enhancement measures for Paks NPP. By the end of 2015, 24 out of the 46 tasks were completed, and an additional 16 tasks were completed between 2016 and 2018. Of the remaining five tasks, following their consolidation, four were completed during 2022–2024. At the time of closing the National Report, one task remained open: the seismic strengthening of the fire brigade building.

9th Review Meeting - Challenge 4: Preparation for the subsequent service life extension of Paks NPP

The preparatory work for subsequent service life extension of Paks NPP, initiated in 2019, entered a new phase following the Government decision in 2022. The objective of the priority SSLE project is to extend the operating licenses of Units 1–4, which are set to expire between 2032 and 2037. The fundamental legal framework for the implementation of the SSLE has been established, and the next step involves reviewing the detailed regulatory provisions and related regulatory guidelines. The licensee commenced preparations and completed the preliminary project scope in 2023. The necessary safety analyses and the review of aging management programmes have been initiated. The project implementation is also supported through international

[4] The amendment of the *ATOMIC ACT*, which establishes the legal basis for subsequent service lifetime extension, entered into force on 7 January 2025, while the amendment of the *NUCLEAR SAFETY DECREE* entered into force in May 2025.

cooperation with the IAEA. The pre-consultation phase of the environmental licensing process was completed in 2024. The project is progressing in accordance with the established schedule.

Summary of Significant Changes Since Previous Report

Following the targeted safety reassessment conducted at Paks NPP, four additional tasks out of the 46 identified have been completed, leaving only one unclosed item.

Rulemaking activities related to the subsequent service life extension of Paks NPP have commenced, and the licensee is preparing to define the scope required for the licensing process. The environmental licensing process was initiated in 2024.

B. LEGISLATION AND REGULATION

Part B consists of the following articles:

Article 7: Legislative and Regulatory Framework

Article 8: Regulatory Body

Article 9: Responsibility of the Licence Holder

7. Legislative and Regulatory Framework

Convention on Nuclear Safety, Article 7

> *„1. Each Contracting Party shall establish and maintain a legislative and regulatory framework to govern the safety of nuclear installations.*
> *2. The legislative and regulatory framework shall provide for:*
> *(i) the establishment of applicable national safety requirements and regulations;*
> *(ii) a system of licensing with regard to nuclear installations and the prohibition of the operation of a nuclear installation without a license;*
> *(iii) a system of regulatory inspection and assessment of nuclear installations to ascertain compliance with applicable regulations and the terms of licenses;*
> *(iv) the enforcement of applicable regulations and of the terms of licenses, including suspension, modification or revocation."*

Summary Statement for Article

Hungary fulfils its obligations under Article 7 of the Convention. The national legislative and regulatory framework is aligned with international expectations and ensures a graded system of safety requirements necessary for maintaining nuclear safety, as well as the possibility of flexible regulation through the independent regulatory status of the HAEA. The regulatory framework clearly defines the requirements for licensing procedures, including the content requirements of license applications, licensing timelines, and the conditions for license issuance.

The national legislation clearly assigns the tasks and competences of HAEA in the area of regulatory oversight. The HAEA conducts regular on-site and documentation-based inspections and assessments to ensure the continuous oversight of the safety of nuclear installations. The regulatory framework also includes enforcement mechanisms to ensure compliance with legal and regulatory requirements, such as the possibility to impose sanctions (e.g. prohibition of activities, fines), prescribe conditions or obligations, or, as a last resort, revoke licenses.

Hungary thus operates a comprehensive and coherent regulatory system that enables effective assurance of nuclear safety while fully meeting the obligations set out in the Convention.

7.1. Establishing and Maintaining a Legislative and Regulatory Framework

7.1.1. Sources of law

In Hungary, the levels of legal sources are differentiated and exist in a hierarchical relationship. A legal source at a lower level in the hierarchy may not contradict the content of a higher-level legal source.

At the top of the legal hierarchy is the Fundamental Law of Hungary (↪ *FUNDAMENTAL LAW OF HUNGARY*), followed by acts of Parliament. These are succeeded, in hierarchical order, by government decrees, prime ministerial decrees, ministerial decrees, decrees of the Governor of the Hungarian National Bank, decrees issued by the heads of

independent regulatory organs (e.g. the President of the HAEA), and local government decrees.

In Hungary, the regulatory framework for nuclear installations is provided by the *ATOMIC ACT* adopted by the Parliament. Detailed implementing provisions are set out in government decrees, ministerial decrees, and decrees issued by the President of HAEA.

7.1.2. Ratification of international conventions and legal instruments related to nuclear safety

Hungary is a party to the following inter-governmental and inter-state agreements related to the safe use of nuclear energy:

- Convention on Early Notification of a Nuclear Accident (promulgated by *GOVERNMENT DECREE NO. 28/1987. (VIII. 9.) MT ON THE PROMULGATION OF THE CONVENTION SIGNED IN VIENNA ON 26 SEPTEMBER 1986*)
- Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (promulgated by *GOVERNMENT DECREE NO. 29/1987. (VIII. 9.) MT ON THE PROMULGATION OF THE CONVENTION SIGNED IN VIENNA ON 26 SEPTEMBER 1986*)
- Vienna Convention on Civil Liability for Nuclear Damage (promulgated by *GOVERNMENT DECREE NO. 24/1990. (II. 7.) MT ON THE PROMULGATION OF THE CONVENTION SIGNED IN VIENNA ON 21 MAY 1963*)
- Joint Protocol Relating to the Application of the Vienna Convention on Civil Liability for Nuclear Damage and the Paris Convention on Third Party Liability in the Field of Nuclear Energy (promulgated by *GOVERNMENT DECREE NO. 130/1992. (IX. 3.) ON THE PROMULGATION OF THE JOINT PROTOCOL RELATING TO THE APPLICATION OF THE VIENNA CONVENTION ON CIVIL LIABILITY FOR NUCLEAR DAMAGE AND THE PARIS CONVENTION ON THIRD PARTY LIABILITY IN THE FIELD OF NUCLEAR ENERGY SIGNED ON 20 SEPTEMBER 1989*)
- Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention) (promulgated by *GOVERNMENT DECREE NO. 148/1999. (X. 13.) ON THE PROMULGATION OF THE CONVENTION SIGNED IN ESPOO, FINLAND, ON 26 FEBRUARY 1991*)
- Convention on Nuclear Safety (promulgated by *ACT I OF 1997 ON THE PROMULGATION OF THE CONVENTION CONCLUDED UNDER THE AUSPICES OF THE INTERNATIONAL ATOMIC ENERGY AGENCY IN VIENNA ON 20 SEPTEMBER 1994*)
- Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (promulgated by *ACT LXXVI OF 2001 ON THE PROMULGATION OF THE JOINT CONVENTION ON THE SAFETY OF SPENT FUEL MANAGEMENT AND ON THE SAFETY OF RADIOACTIVE WASTE MANAGEMENT CONCLUDED UNDER THE AUSPICES OF THE INTERNATIONAL ATOMIC ENERGY AGENCY*)
- Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters (Aarhus Convention), (promulgated by *ACT LXXXI OF 2001 ON THE PROMULGATION OF THE CONVENTION ADOPTED IN AARHUS ON 25 JUNE 1998 CONCERNING ACCESS TO INFORMATION IN ENVIRONMENTAL MATTERS, PUBLIC PARTICIPATION IN DECISION-MAKING, AND ACCESS TO JUSTICE*).
- Treaty establishing the European Atomic Energy Community (EURATOM), to which Hungary acceded in 2004 (promulgated by *ACT XXX OF 2004 ON THE PROMULGATION OF THE TREATY BETWEEN THE KINGDOM OF BELGIUM, THE KINGDOM OF DENMARK, THE FEDERAL REPUBLIC OF GERMANY, THE HELLENIC REPUBLIC, THE KINGDOM OF SPAIN, THE FRENCH REPUBLIC, IRELAND, THE ITALIAN REPUBLIC, THE GRAND DUCHY OF LUXEMBOURG, THE KINGDOM OF THE NETHERLANDS, THE REPUBLIC OF AUSTRIA, THE*

Portuguese Republic, the Republic of Finland, the Kingdom of Sweden, the United Kingdom of Great Britain and Northern Ireland (Member States of the European Union), and the Czech Republic, the Republic of Estonia, the Republic of Cyprus, the Republic of Latvia, the Republic of Lithuania, the Republic of Hungary, the Republic of Malta, the Republic of Poland, the Republic of Slovenia and the Slovak Republic, concerning the accession of the Czech Republic, the Republic of Estonia, the Republic of Cyprus, the Republic of Latvia, the Republic of Lithuania, the Republic of Hungary, the Republic of Malta, the Republic of Poland, the Republic of Slovenia and the Slovak Republic to the European Union.)

7.2. Provisions of the Legislative and Regulatory Framework

7.2.1. Atomic Act

The *Atomic Act* was adopted by the Parliament of Hungary in December 1996 and entered into force on 1 June 1997. The *Atomic Act*, which has been amended several times (most recently in 2024), takes into account regulatory and operational experience gained during the construction and operation of the nuclear power plant, technological developments, international obligations, and the requirements of the Convention on Nuclear Safety. The *Atomic Act* is in compliance with relevant European Union legislation, as well as the recommendations of the IAEA and the OECD NEA.

The scope of the *Atomic Act* covers the peaceful use of nuclear energy, the related rights and obligations, and the protection of people and the living and non-living environment against the harmful effects of natural and artificial sources of ionizing radiation.

The implementation of the tasks set out in the *Atomic Act* is primarily ensured by the HAEA as the atomic energy oversight body, as well as by certain ministers and administrative bodies within the scope of responsibilities and competences defined by the *Atomic Act*. The continuous regulatory oversight of nuclear installations under the *Atomic Act* is carried out through the following means:

- individual regulatory procedures involving licensing, notification-acknowledgement, deviation-notification-acknowledgement[5], and approval decisions (see Chapter 7.2.3 of this report);
- regular analysis and assessment of licensee operations and the safety, security, and peaceful use of nuclear energy (see Chapter 7.2.4 of this report);
- continuous and case-specific inspections, including the implementation of inspection programmes related to modifications (see Chapter 7.2.4 of this report);
- enforcement procedures to ensure the practical implementation of legal requirements and regulatory provisions based on them (see Chapter 7.2.5 of this report).

» Implementation of the Atomic Act

The detailed implementing provisions of the *Atomic Act* are defined by decrees issued by the President of the HAEA, as well as by certain government and ministerial decrees.

[5] The acknowledgement procedures for notifications and for deviation notifications may be carried out exclusively in relation to the new nuclear power plant units.

The implementing regulations related to the use of nuclear energy shall not contradict the provisions of either the *FUNDAMENTAL LAW* or the *ATOMIC ACT*.

As a result of the change in HAEA's legal status in 2022, the President of HAEA, as the head of an independent regulatory organ, has the authority to issue decrees based on the mandate provided in the *ATOMIC ACT*. The process of reissuing regulations previously adopted at the level of government decrees as HAEA presidential decrees began in 2022, and several legal instruments related to nuclear safety were published as presidential decrees during the reporting period.

In establishing the regulatory framework and safety requirements, Hungary takes into account the IAEA publications and the WENRA reference levels, in accordance with Principle 3 of the Vienna Declaration. During the regulatory review process, HAEA also considers international best practices and the outcomes of international peer reviews.

7.2.2. National Safety Requirements and Regulations

» Nuclear Safety Code

The nuclear safety requirements for nuclear installations (including nuclear power plants) related to the use of nuclear energy are defined in the *NUCLEAR SAFETY DECREE*, and in the *NUCLEAR SAFETY CODE* issued as annexes to the decree. The decree and the annexes take into account the *EUROPEAN UNION NUCLEAR SAFETY DIRECTIVE*, the *IAEA SAFETY STANDARDS*, and the *WENRA REFERENCE LEVELS*. The decree of the President of the HAEA replaced the previously issued *GOVERNMENT DECREE NO. 118/2011. (VII. 11.) ON THE NUCLEAR SAFETY REQUIREMENTS FOR NUCLEAR INSTALLATIONS AND THE RELATED REGULATORY ACTIVITIES*.

The scope of the *NUCLEAR SAFETY DECREE* extends to nuclear installations intended to be established or already operating in Hungary, their systems and components, activities related to nuclear installations and the persons performing such activities, including radiation protection, systems and components ensuring the transport of radioactive materials within nuclear installations and the interim storage of radioactive waste, safety classified pressure-retaining components and pipelines within nuclear installations, and fire protection, insofar as they affect nuclear safety, and exclusively from the perspective of such impact.

In addition to general provisions, the annexes to the regulation contain nuclear safety requirements for regulatory procedures related to nuclear installations, for the management systems of nuclear installations, and for the implementation and oversight of activities according to the lifecycle of nuclear installations:

- Annex 1. Nuclear safety regulatory procedures of nuclear facilities;
- Annex 2. Management systems of nuclear facilities,
- Annex 3. Design requirements for operating nuclear power plants;
- Annex 3a. Design requirements for new nuclear power plants;
- Annex 4. Operation of nuclear power plants;
- Annex 5. Design and operation of research reactors;
- Annex 6. Interim storage of spent nuclear fuel;
- Annex 7. Site survey and assessment of nuclear facilities;
- Annex 8. Decommissioning of nuclear facilities;
- Annex 9. Requirements for the design and construction period of a new nuclear facility
- Annex 10. Nuclear Safety Code definitions

Compliance with the nuclear safety requirements and provisions is mandatory for all those who carry out, participate in, or submit an application or notification for activities subject to regulatory licensing or acknowledgement under the *ATOMIC ACT* and the *NUCLEAR SAFETY DECREE*.

» Guidelines issued by the HAEA

To support the implementation of the mandatory provisions set out in the *NUCLEAR SAFETY DECREE*, the HAEA also formulates recommendations, which are issued in the form of guidelines and published on its website. These guidelines do not have legally binding force; however, if licensees apply a method different from that described in the guidelines to meet regulatory requirements, HAEA will examine the correctness, adequacy, and completeness of the alternative method in detail.

» Review

According to the *ATOMIC ACT*, the nuclear safety requirements for the use of nuclear energy shall be regularly reviewed and updated, taking into account scientific developments and international experience. The *NUCLEAR SAFETY CODE* shall be reviewed every five years and updated as necessary, while the guidelines may be reviewed periodically as determined by the nuclear safety authority or, exceptionally, upon proposal by licensees.

Since the previous National Report, the HAEA has amended the *NUCLEAR SAFETY DECREE* on two occasions and, in connection with these amendments, initiated changes to the *ATOMIC ACT* as well.

The primary objective of the first amendment was the introduction of a "new regulatory oversight concept". The revised regulation continues to ensure a high level of nuclear safety while enhancing the efficiency of regulatory oversight, optimizing system-level licensing, and strengthening facility-level licensing. It places particular emphasis on the inspection of the licensee's management system, internal processes, safety culture, and the enforcement of licensee responsibility. It also enables broad involvement of an independent third party (inspection organization) authorized on the basis of legislation in the execution of inspections. A key element of the "new regulatory oversight concept" was the introduction of the notification-acknowledgement and deviation-notification-acknowledgement procedures during the construction phase of new nuclear power plants for the procurement and manufacturing of systems and components classified in safety classes 2 and 3.

The main purpose of the second amendment was to establish provisions at the level of law and decree for the SSLE of Paks NPP. Furthermore, the amendment introduces the licensing of deviations from design for nuclear power plant structures, systems and components, in cases where their physical condition or technical parameters differ unintentionally from the design documents forming the basis of the valid commissioning or operating license, in order to allow their continued operation, provided that such operation does not result in a decrease of nuclear safety.

7.2.3. System of Licensing

The general rules of administrative licensing procedures are laid down in the Code of General Public Administration (↪ *ACT CL OF 2016 ON GENERAL PUBLIC ADMINISTRATION PROCEDURES*), while the fundamental principles of licensing procedures for nuclear facilities, the rules differing from the *CODE OF GENERAL PUBLIC ADMINISTRATION*, and the scope of authorities participating in the licensing procedures are regulated by the *ATOMIC ACT* (Chapter III and Annex 2).

For the commencement of preparatory activities for the establishment of a new nuclear facility or for the extension of an existing NPP with a new unit containing an additional nuclear reactor, the prior approval in principle of the Parliament is required, and for the acquisition of ownership of an existing nuclear facility and the transfer of its use under any legal title, the prior approval in principle of the Government is required.

According to the applicable legislation, an authorisation is required for each phase of the lifetime of the facilities (site survey, site evaluation and site suitability assessment, construction, extension, commissioning, operation, final shutdown, decommissioning), and any facility-level or safety-related system or component level modification may only be carried out under license.

In the licensing procedures of the HAEA, the opinions of the specialised authorities designated by law in specific technical matters are binding on the HAEA.

According to the *NUCLEAR SAFETY DECREE*, every nuclear facility and activity related to nuclear safety shall have a license/permit, approval, acknowledgement or exemption.

The *NUCLEAR SAFETY DECREE* stipulates which regulatory licenses are required for certain activities in different life cycle phases of nuclear facilities. There are separate license types for facility-level and for system and component-level activities. The general regulatory requirements related to the various licensing procedures are set out in the main text of the *NUCLEAR SAFETY DECREE* and in chapters 1.2 and 1.3 of Annex 1 thereto; depending on the nuclear safety risk, different requirements apply to licensing procedures related to different activities.

The documentation underlying the application or, in the case of the notification-acknowledgement procedure, the notification (see below) shall be prepared by the licensee in line with the extent and nature of the nuclear safety risk of the activity subject to the application or notification, in such detail and depth that, on its basis, the HAEA can perform the independent review and assessment of the fulfilment of the requirements and prescriptions, as well as the adequacy of the technical and administrative activities necessary for such fulfilment.

The license of HAEA may be granted for a fixed or indefinite period and subject to certain conditions. A fixed-term license may be extended upon request.

The *CODE OF GENERAL PUBLIC ADMINISTRATION* allows the correction, supplementation, modification and withdrawal of a decision.

The HAEA may withdraw the license or limit its time validity if the safety conditions on which the license was based have changed and the resulting risk has increased.

In the case of activities carried out without a license or in deviation from the license, or in the case of a violation of legislation, the HAEA initiates an enforcement procedure (see Chapter 7.2.5 of this report).

Pursuant to the *ATOMIC ACT* and the *CODE OF GENERAL PUBLIC ADMINISTRATION*, the decisions of the HAEA (conclusive decisions and procedural decisions) may only be challenged through the courts.

During the reporting period, the current regulatory oversight system was reviewed and optimised in order to enable HAEA to carry out its activities more effectively and in line with international requirements. As a result of this review of the regulatory system, the "new oversight concept" was developed, aiming to strengthen the effectiveness of regulatory oversight, ensure the continuous improvement of the level of nuclear safety,

systematically enforce the principle of a graded approach in regulatory oversight, optimise component-level licensing by strengthening facility-level licensing, place special emphasis on the inspection of the licensee's management system, internal processes, safety culture and application of licensee responsibility, as well as create the possibility of involving third parties in the execution of inspections (see Section 7.2.4).

From 2024, the scope of procedures of the HAEA has been expanded. The amendments to the *ATOMIC ACT* and the *NUCLEAR SAFETY DECREE* contain the implementing rules of the "new oversight concept" for the construction of new NPP units, and enable a more efficient application of regulatory oversight, more consistent with the principle of a graded approach and adapted to the respective facility life cycle. The amended regulation defines the detailed rules of the notification-acknowledgement procedure and the deviation-notification-acknowledgement procedure for the manufacturing and procurement of systems and components classified in safety classes 2 and 3, which are considered to be of lower nuclear safety risk, as well as the scope of the documentation required for the notifications and the manner of their handling.

7.2.4. System of Regulatory Inspection and Assessment

Based on the *ATOMIC ACT*, the use of atomic energy may take place exclusively in the manner defined by legislation, and nuclear facilities are under continuous regulatory oversight. One important part of regulatory oversight is inspection. The authority is obliged to verify compliance with the requirements set forth in the legislation and licenses, as well as the safety of the use of atomic energy.

The HAEA is entitled to carry out inspections that are announced in advance and, if necessary for the achievement of the purpose of the inspection, inspections that are not announced in advance, as well as to perform comprehensive inspections in predetermined subject areas. HAEA prepares an annual inspection plan, in which the planned inspections are specified on a quarterly basis. For the purpose of the continuous oversight of the safety of facilities falling under the scope of the *ATOMIC ACT*, the HAEA operates a multi-level inspection system.

Regulatory inspections are carried out on the basis of written and approved plans.

With respect to corrective measures related to findings of regulatory inspections, the HAEA expects their determination and implementation from the licensee. In the case of omission or inadequacy of such measures, the HAEA orders the corrective measures in an individual resolution, applying sanctions, if necessary.

For the controlled use of atomic energy and for the assessment of the activities of the licensee(s), the HAEA operates a reporting system. Reports shall be sufficiently detailed to enable the independent judgement, review and assessment of the operator's activities and of the events that have occurred. The investigation of safety-related events occurring during operation, the determination of their causes and the implementation of measures necessary to prevent their recurrence are primarily the responsibility of the licensee. Safety-related events shall be reported by the licensee to HAEA in accordance with the applicable legal requirements. Based on the notification and the report on the investigation carried out by the licensee (or, depending on the significance of the event, independently of the licensee), the HAEA analyses and evaluates the event and, if necessary, initiates further measures.

The main elements of the assessment system are the Periodic Safety Review (PSR) every ten years in line with Principle 2 of the Vienna Declaration, the annual comprehensive inspection, and the evaluation of safety indicators.

In the case of Paks NPP, in addition to conventional assessment techniques, since 2001 the HAEA has also applied the system of safety indicators developed on the basis of the IAEA methodology. Safety indicators represent a set of measurable parameters, which, among others, measure organisational and human performance.

The safety indicators can be grouped into three main categories:

— characteristics of smooth operation,
— characteristics of operational safety, and
— characteristics of commitment to safety.

The collected statistical set of indicators enables both multifaceted assessment and the raising of questions. The HAEA currently prepares an annual comprehensive assessment of the licensee's safety performance, the evaluation results of which are used, for example, in the preparation of the annual inspection plan.

Monitoring and analysing the safety characteristics of operation, in addition to facilitating the early identification of potential safety issues, provides data for the planning of the HAEA's oversight activities and for regulatory measures.

From 2024 onwards, in the cases defined in the *Nuclear Safety Decree*, the licensee of a nuclear facility shall, or may, employ an independent inspection organisation authorised on the basis of legislation, registered in accordance with the Atomic Act. The register of such organisations is maintained by the HAEA in line with *HAEA Decree 1/2024. (IV. 8.) on the Register of Independent Inspection Organisations Authorised on the Basis of Legislation and on the Requirements to be Applied during Accreditation*. The rules of the new decree cover the register of independent inspection organisations that may be involved in inspections and the requirements to be applied during accreditation.

7.2.5. Enforcement

» Legal basis

The HAEA regularly verifies compliance with the provisions set forth in its decisions and in legislation, as well as the safety of the use of atomic energy, and takes or initiates immediate measures to eliminate any observed irregularities.

The HAEA conducts enforcement procedures on the basis of the relevant provisions of the *Atomic Act*, taking into account the *Code of General Public Administration* and the provisions of *Act CXXV of 2017 on Sanctions for Administrative Violations*.

» Enforcement and enforcement measures

The primary purpose of enforcement is that users of atomic energy and all contributors within their responsibility (employees, contractors) should recognise, voluntarily disclose, and correct any deviations from the requirements prescribed in the relevant legislation and regulatory decisions as soon as possible. To encourage and support this, the HAEA adopts appropriate enforcement measures and, if necessary, compels compliance and corrective actions through the application of administrative sanctions.

Enforcement is based on the objective identification of the given non-compliance or deviation and the assessment of the risk. In the course of an enforcement procedure, the HAEA always acts by examining all the circumstances of the case, also taking into account the nature and severity of the violation of legislation or regulatory decision.

As a result of an enforcement procedure, the HAEA may impose the following measures and administrative sanctions:

- issuance of a warning,
- imposition of obligations,
- imposition of an administrative fine,
- restriction of the licensed activity,
- suspension of the licensed activity,
- limitation of the time validity of the license,
- withdrawal of the license (as the most severe enforcement measure).

At every stage of the enforcement procedure, including the determination of the enforcement measure to be applied and the determination of the amount of any fine imposed, the HAEA applies the principle of a graded approach.

The basis of the graded approach is that measures proportionate to the risk, probability and possible consequences of losing control over systems, processes and methods shall be applied.

In applying the graded approach, the HAEA takes the following aspects into account:

- whether an extraordinary event, nuclear emergency or nuclear damage has occurred;
- whether unauthorized removal or successful sabotage has occurred;
- the seriousness of the violation of requirements and prescriptions;
- whether the violation is repeated;
- whether the conduct causing the violation or omission is attributable;
- whether the violator or defaulter has demonstrated mitigating conduct to assist in eliminating the condition caused;
- the detriment caused by the violation, including the costs of preventing, mitigating or remedying the detriment, as well as the extent of any advantage gained through the violation;
- the reversibility of the detriment caused by the violation;
- the size of the group affected by the violation;
- the duration of the unlawful condition;
- the recurrence and frequency of the unlawful conduct;
- the cooperative conduct of the violator during the procedure; and
- the economic weight of the violator.

In matters falling within its tasks and competence, the HAEA, having regard to the graded approach, may impose as one of the most severe sanctions an administrative fine, the amount of which, in the case of the licensee of a nuclear power plant, shall be at least fifty thousand forints and at most fifty million forints. (In the case of the licensee of another nuclear facility, the amount of the fine in nuclear safety regulatory matters shall be at least fifty thousand forints and at most five million forints.)

» Regulatory experience related to enforcement

During the reporting period, five enforcement procedures were initiated with respect to facilities falling under the scope of the Convention. In one case, the most severe sanction, i.e. the imposition of an administrative fine, was applied against Paks NPP. It can be concluded that compared to the previous National Report, the number of fines imposed during enforcement procedures has not increased; the enforcement procedure (and the measures and sanctions applicable as a result thereof) effectively

encourages users of atomic energy to comply with the law and with safety requirements.

Summary of Significant Changes Since Previous Report

Since the previous report, the Atomic Act has remained the principal element of the legislative framework related to the use of atomic energy in Hungary. Due to the change in the legal status of the HAEA, the former governmental decree on nuclear safety lost its effect and was replaced by the Nuclear Safety Decree issued by the President of the HAEA, which at that time did not contain any substantive amendments.

During the three-year reporting period, the Atomic Act and the Nuclear Safety Decree were amended twice, while maintaining the high level of nuclear safety requirements, primarily in relation to the "new oversight concept" and the planned subsequent service life extension of Paks NPP.

From 2024 onwards, the licensee of a nuclear facility must, or may, employ an independent inspection organisation authorised on the basis of legislation.

8. Regulatory Body

Convention on Nuclear Safety, Article 8

> *"1. Each Contracting Party shall establish or designate a regulatory body entrusted with the implementation of the legislative and regulatory framework referred to in Article 7, and provided with adequate authority, competence and financial and human resources to fulfil its assigned responsibilities.*
> *2. Each Contracting Party shall take the appropriate steps to ensure an effective separation between the functions of the regulatory body and those of any other body or organization concerned with the promotion or utilization of nuclear energy."*

Summary Statement for Article

Hungary fulfils its obligations under Article 8 of the Convention. The national legislative framework clearly defines the tasks and competence, as well as the operational and procedural rules, of the authority responsible for nuclear safety regulation, the HAEA. The HAEA operates as an independent regulatory organ, making its decisions free from influence, thereby ensuring the objectivity and professional soundness of regulatory oversight.

The President of the HAEA has regulatory rulemaking authority, which enables the independent development and updating of regulatory requirements related to nuclear safety. The financial independence of the HAEA's operation is also guaranteed, as its budget is determined directly by the Parliament, thereby ensuring the necessary resources for the performance of its tasks.

In terms of organisational and personnel competences, the President is responsible for establishing the organisational structure that ensures the effective operation of the authority, for providing the necessary human and technical resources, and for the continuous development of the professional expertise of its staff.

The HAEA is fully independent from any other body or organisation involved in, or with an interest in, the use of atomic energy, including electricity generation, the use of radioisotopes, and the management of spent fuel and radioactive waste, and takes its decisions solely on a professional basis, in accordance with legislative requirements.

8.1. Establishment of the Regulatory Body

8.1.1. Mandate, scope of tasks and competences

Since 1 January 2022, the HAEA has been carrying out the continuous regulatory oversight of nuclear facilities as a special-status, independent regulatory organ led by its President.

According to the *Atomic Act*, the HAEA's tasks cover the performance of regulatory functions related to the exclusively peaceful use of atomic energy, to the safety and radiation protection of nuclear facilities and radioactive waste repositories, as well as of containers used for the transport of nuclear and other radioactive materials, and to their physical protection. The HAEA also has general construction authority and building supervision competence concerning structures located within the safety zone of nuclear facilities. In the case of a new nuclear facility, the HAEA oversees the entire

construction process, from the methodology of the site investigation through commissioning and into operation.

One of the most important international requirements concerning the safe and secure use of atomic energy is that the regulatory authority shall be independent from generating, ownership and service provider interests, as well as from governmental bodies with an interest in the use of atomic energy. In Hungary, several provisions of the *ATOMIC ACT* and its implementing decrees guarantee compliance with the international requirements on independence.

In the course of carrying out its tasks, the HAEA is subordinated only to legislation; within its competences it may not be instructed, and it performs its functions separately from other organisations and free from influence.

8.1.2. Organisational structure of the authority

Following the change in its legal status, the HAEA adopted a new Organisational and Operational Rules (OOR), which has since been amended several times.

Initially, in 2022, the new organisational structure resulting from the change in legal status introduced the characteristics deriving from the special status into the organisational framework. Accordingly, the work of the President is supported by two Vice Presidents. The departments dealing with regulatory tasks came under the supervision of the Regulatory Vice President, while the organisational units responsible for the operation of the HAEA perform their duties under the supervision of the General Vice President.

In view of the high number of procedures conducted annually by the HAEA and of the new rulemaking tasks, in 2023 the *Legal and Codification Department for Requlatory Affairs* was established under the direct supervision of the President. Its task is the legal review of regulatory decisions. This separated the tasks related to the operation of the HAEA from those related to the legal oversight of regulatory procedures.

As of 1 May 2024, the tasks of the organisational units under the supervision of the Regulatory Vice President were reorganised in order to ensure more efficient resource management.

The independent organisational units under the direct supervision of the Regulatory Vice President are:

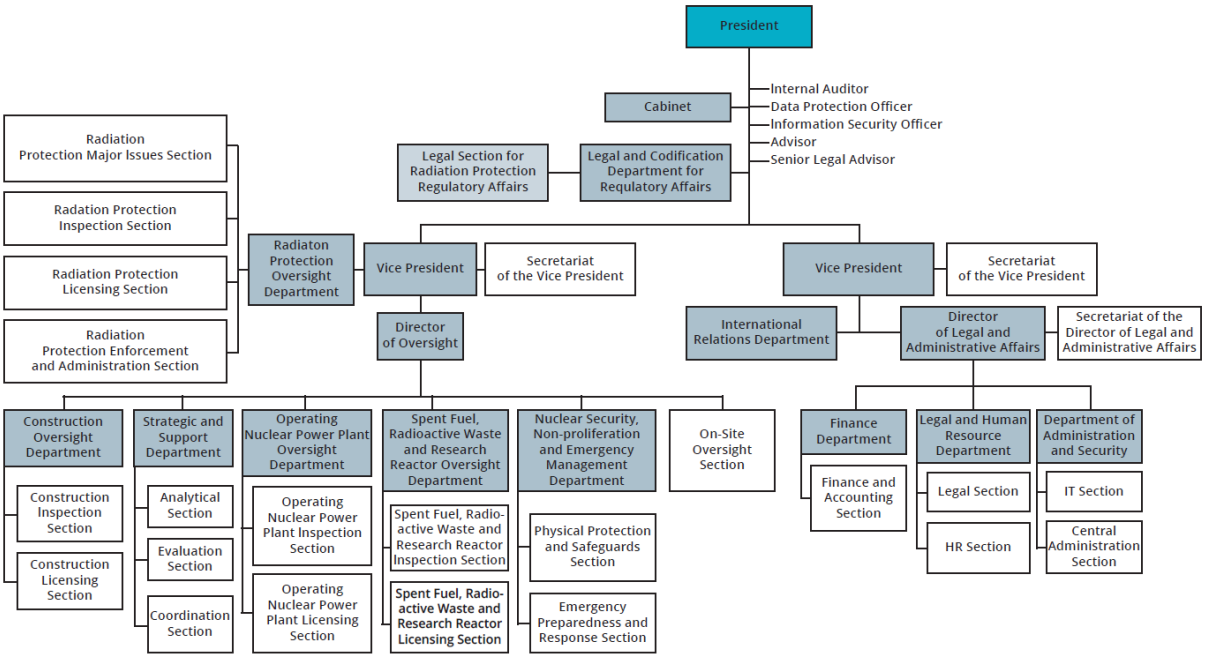
— *Radiaton Protection Oversight Department*, responsible for the regulatory oversight of the use of nuclear and radioactive materials, of the placing on the market and operation of devices generating ionising radiation without containing radioactive materials, as well as for performing general radiation protection regulatory oversight activities.

The independent organisational units under the direct supervision of the Director of Oversight are:

— *Construction Oversight Department*, responsible for regulatory oversight activities related to the new nuclear power plant.
— *Strategic and Support Department*, responsible for the coordination and support of activities related to the regulatory tasks of the organisational units under the supervision of the Regulatory Vice President and the Director of Oversight.

— *Operating Nuclear Power Plant Oversight Department*, responsible for regulatory oversight activities related to the operating nuclear power plant.
— *Spent Fuel, Radioactive Waste and Research Reactor Oversight Department*, responsible for regulatory oversight activities related to spent fuel interim storage facilities, radioactive waste repositories, as well as research and training reactors.
— *Nuclear Security, Non-Proliferation and Emergency Management Department*, responsible for the regulatory oversight of nuclear safeguards and nuclear security in the domestic use of atomic energy, and for regulatory oversight activities related to nuclear emergency response.
— *On-site Oversight Section*, responsible for carrying out operational regulatory oversight activities on-site, and for inspection tasks related to general construction matters and pressure equipment.

Figure 1. Organisational chart of the HAEA from 1 May 2024



The establishment of the Construction Oversight Department achieved the objective of ensuring that the oversight of the construction of new nuclear power plant units is given appropriate weight and that adequate resources are available in this area. The creation of a separate department for the oversight of new unit construction was also justified by the fact that new nuclear power plants are subject to requirements different from, and stricter than, those applicable to operating nuclear power plants.

8.1.3. Human resources

94% of the HAEA's staff are professionals with higher education degrees; 41% of them hold two or three diplomas, and 14% have a scientific degree or a PhD title from a university. 79% of all staff members possess a state-recognised language examination certificate in one or more foreign languages.

Table 3 summarises the changes in the staffing of the HAEA, including the number of employees working in the nuclear professional field, between 2022 and 2024:

Table 3. Number of employees of the HAEA, 2022-2024

Year	2022	2023	2024
Total staff number of the HAEA	211	218	220
- number of employees in professional area	150	153	149

Employees of the HAEA may perform independent regulatory oversight activities, licensing, inspection and assessment only after successfully passing the inspector's examination, which takes place at the end of the full training process.

Part of the inspector training is the completion of facility-specific training courses, which in the case of the nuclear power plant are provided within its training system (through courses).

The HAEA has developed a systematic training plan for the training and further training of its inspectors. The HAEA strives to apply the Systematic Approach to Training (SAT) recommended by the IAEA, i.e. to plan short- and long-term training objectives and programmes, to develop its training system, to implement and evaluate the training programmes carried out, and, where necessary, to define corrective actions.

The training plan includes three basic types of training: introductory training, refresher training and advanced training. During their introductory training, newly recruited staff members follow an individual training plan tailored by the head of their independent organisational unit.

The managers and staff of the regulatory areas present the most significant or noteworthy oversight tasks of the past period at regular monthly technical meetings, thereby contributing not only to the dissemination of knowledge but also to the sharing of important safety issues and lessons learned.

As a result of the change in legal status in 2022, the determination of the staff number of the HAEA fell within the competence of its President. In view of the oversight of the construction of new units, the subsequent service life extension of operating units, and the newly emerging rulemaking tasks (see Section 7.1.1.), the staff number of the HAEA increased during the reporting period. At the end of the reporting period, the number of staff employed in regulatory professional fields at the HAEA was about 150.

During the construction of the new nuclear power plant units, the HAEA shall also fully perform the regulatory oversight of the existing four operating nuclear power plant units, the other three nuclear facilities, and the storage/disposal facilities. Due to the ageing of the facilities' equipment and the resulting equipment replacements and modernisation projects, the number of procedures is increasing, leading to growing oversight burdens. These aspects must also be taken into account in the training of personnel. In order to develop staff competences, the HAEA, in line with the new organisational structure, has defined the qualification requirements for the various functions and, in addition to qualifications, the necessary competences. The methodology for competence assessment has been developed, and the assessment is currently in progress.

8.1.4. Financial resources

According to the *EUROPEAN UNION NUCLEAR SAFETY DIRECTIVE*, the competent regulatory authority shall, among others, have targeted and adequate budgetary resources to enable it to carry out its regulatory functions as defined in the national system, shall be accountable for the implementation of the budget allocated to it, and shall employ an

appropriate number of staff with the qualifications, experience and expertise necessary to fulfil its obligations.

Since 1 January 2022, the HAEA has been a central budgetary body with special status and chapter-leading authority, whose budget forms a separate title within the budget chapter of the Parliament. The expenditure and revenue totals of its budget may only be reduced by the Parliament. Its personnel are subject to the provisions of the Special Status Organs Act (↪ *ACT CVII OF 2019 ON SPECIAL STATUS ORGANS AND THE LEGAL STATUS OF PERSONS EMPLOYED BY THEM*) and of the *ATOMIC ACT*.

The uninterrupted operation of the HAEA is ensured, on the one hand, by the budgetary support defined in the annual budget act, and on the other hand by the oversight fee revenues specified in the *ATOMIC ACT*.

Each year, a determined amount must be allocated from the central budget for:

— the costs of technical support activities serving regulatory work;
— the development costs of nuclear emergency response; and
— the costs arising from international obligations.

The licensees of nuclear facilities and radioactive waste repositories are obliged to pay an oversight fee to the authority in the manner and to the extent defined in the *ATOMIC ACT*.

Accordingly, the HAEA is financially independent from nuclear facilities, and its budget is sufficient to ensure effective operation. It uses its revenues from oversight fees, administrative service fees payable for individual procedures, and potential fines to cover its operations, and these revenues may not be diverted for other purposes.

The financial management of the HAEA is balanced.

8.1.5. Management system

Among government administrative bodies, the HAEA was one of the first to introduce and have certified a management system in accordance with the ISO 9001 standard. Certification under the standard must be renewed every three years, and annual surveillance audits are carried out.

As a result of the successful recertification audit conducted in 2024, the certification is valid for another three years, until March 2027.

8.1.6. Communication and transparency

One important element of the HAEA's information activities is the preparation of the annual report to the Parliament on the safe use of atomic energy. The HAEA informs the public on the most important issues related to the safe domestic use of atomic energy through its continuously updated Hungarian- and English-language website (*www.oah.hu*), and by issuing news and press releases.

The HAEA continuously strives to provide increasingly comprehensive information to both professional and general audiences interested in nuclear safety issues. As part of this process, the HAEA also publishes short, plain-language summaries of regulatory resolutions of greater importance or wider interest. A list of the resolutions issued by the HAEA is available on its website. The HAEA considers it a priority task to inform the public about nuclear safety-related events of public interest. For this purpose, it

publishes on its website the results of regulatory investigations of events rated level 1 or higher on the INES scale, as well as of other reportable events attracting media interest.

The *ATOMIC ACT* regulates in which procedures the HAEA must hold a public hearing. A public hearing provides an opportunity for the population and various organisations to become familiar with the details of the case concerned and to express their views. During the COVID-19 pandemic, electronic public hearings became possible in Hungary from 2020. From 2024, an amendment to the *ATOMIC ACT* also allows for public hearings to be held via electronic communications tools or by publishing on a website. During the reporting period, the HAEA held one public hearing electronically.

Following the easing of the pandemic situation, between 2022 and 2024 the HAEA, in cooperation with TIT Studio Association, organised five times its public outreach conference entitled "On Atomic Energy – for Everyone", where in addition to presentations, the mainly student audience could become acquainted with the peaceful use of atomic energy through an interactive exhibition.

The HAEA also strives to present its work as broadly as possible. It prepares an annual report to the Parliament on its activities and, twice a year, publishes a summary of current professional news (Bulletin) in both Hungarian and English, which is also available on the HAEA website. In addition to other information materials, the national reports are available in both Hungarian and English on the website. Furthermore, by issuing press releases, the HAEA informs the public about the most important issues and information related to the safe use of atomic energy.

The HAEA continuously evaluates and monitors the effectiveness of its communication tools and the possibilities for improving its information activities. In 2024, based on previous experience, the HAEA implemented several developments related to communication, which primarily strengthened target group-specific communication. In addition to its website and *Facebook* page, it launched a *LinkedIn* page in Hungarian and English for the professional audience, created an educational profile on Instagram for younger generations, and introduced an intranet platform to improve the flow of information to its own staff.

8.1.7. External experts

The HAEA is responsible for coordinating research and development activities related to the safety of the peaceful use of atomic energy in Hungary, and for financing technical support activities serving regulatory oversight.

The strategic directions of technical support activities for regulatory oversight of the safe use of atomic energy are defined by the HAEA's policy on technical support activities, while the current tasks are set out in a four-year programme. For the 2021–2024 period, the HAEA defined the priorities of technical support activities as follows:

- development of the regulatory system;
- support and modernisation of regulatory work;
- nuclear facilities and radioactive waste repositories;
- decommissioning and radioactive waste management;
- development and harmonisation of operational safety and security;
- analysis of events belonging to design extension conditions;
- nuclear emergency response;
- nuclear material safeguards oversight;
- bringing radioactive materials outside regulatory control under supervision;

— physical protection;
— radiation protection.

Through regular technical support programmes in recent years, the network of technical support organisations assisting the HAEA's regulatory activities has been further expanded. The number of participating organisations exceeds 40, and the HAEA continuously seeks to broaden this network depending on new organisations and the volume of regulatory tasks.

In recent years, in line with its licensing responsibilities, the HAEA has primarily required expert support in relation to licensing procedures for the new nuclear power plant, particularly in the fields of mechanical engineering (reactor pressure vessel), architecture (reactor building, buildings of the nuclear island, geotechnics), and operational safety.

8.1.8. Advisory bodies

For the evaluation and analysis of principal issues related to the development of science and technology, and thereby of the nuclear industry, which influence regulatory procedures and processes, the work of the HAEA is supported, in accordance with the provisions of the *Atomic Act,* by a 12-member Scientific Council (HAEA SC) composed of nationally recognised experts. The experts invited to participate in the work of the HAEA SC carry out their mandate independently of their workplaces and positions, and in line with their professional convictions. Taking into account the latest scientific results, the HAEA SC provides opinions on the most important principal and research and development issues related to nuclear safety, nuclear non-proliferation, radiation protection and nuclear emergency response.

8.2. Status of the Regulatory Body

8.2.1. Independence within Government Structure

According to the amendments adopted in 2021 to the *Atomic Act* and certain status laws, the legal status of the HAEA changed; from 1 January 2022 it has been a special-status body, accountable solely to the Parliament. In the course of performing its functions, the HAEA may not be instructed, it carries out its tasks separately from other organisations and free from influence, and is subordinated only to legislation. No appeal lies against decisions of the HAEA; its decisions may be challenged solely through judicial review.

The HAEA is an independent regulatory organ, which, under the authorisation of the *Fundamental Law* and the *Atomic Act*, also has independent regulatory rulemaking authority.

The financial independence of the HAEA is ensured by the fact that, as a special-status independent regulatory organ, its budget forms a separate title within the budget chapter of the Parliament, and therefore its expenditure and revenue totals may only be modified by the Parliament. The President of the HAEA performs those functions which the *Act CXCV of 2011 on Public Finances* assigns to the head of a chapter-leading body.

8.2.2. Reporting obligations

The President of the HAEA is obliged to report annually to the Parliament on the regulatory activities of the previous year.

8.2.3. Conflict of interest requirements

The conflict of interest rules applicable to manager and non-manager public officers of the HAEA are defined by the *Special Status Organs Act* and the *Atomic Act*. For one year after the termination of the mandate of the President or Vice Presidents – with the exception of majority state-owned companies – they may not establish an employment relationship with, nor acquire shares in, a business company whose right or legitimate interest was affected by a decision of the HAEA during the three years preceding the termination of their mandate.

Public officials of the HAEA may not establish or maintain membership, employment, or any other work-related legal relationship, nor hold an executive officer or supervisory board position in an organisation falling within the supervisory competence of the HAEA. With the exception of inheritance, HAEA public officials may not acquire ownership shares in an organisation subject to the supervisory competence of the HAEA.

Summary of Responses to Applicable Challenges and Suggestions

6th Review Meeting – Challenge 6: Knowledge Management

The HAEA's training system was reviewed during the reporting period. Some elements of knowledge management are already in place, though not yet fully comprehensive. The training system is continuously operated; the methodology for competence assessment has been developed, and the assessment itself is expected in the next period. In addition, through regular technical meetings, the HAEA shares as widely as possible within the authority the experiences and lessons learned from its oversight tasks.

9th Review Meeting – Challenge 2: To develop a regulatory resources and competence plan so as to assure the required staff and competence are to be found in HAEA for the construction oversight of the new Paks II project.

Since 2022, as an independent regulatory organ, the HAEA has determined its human resource needs and organisational structure within its own competence. In 2024, its organisational structure was designed and changed to be aligned with the anticipated oversight tasks. The nuclear safety oversight of individual nuclear facilities is performed by separate departments with adequate resources of their own. A separate department was established for the oversight of the Paks II project, and a separate independent organisational unit carries out tasks related to general construction and pressure retaining equipment inspection. The competence and human resource needs required for the operation of the independent organisational units are determined by the head of the given unit. Taking into account the expected tasks, the organisational unit responsible for the oversight of the Paks II project assessed its resource and competence needs.

Through these steps, the HAEA has provided dedicated resources and takes into consideration additional resource and competence requirements in order to ensure the adequate level of oversight of the new units.

9th Review Meeting – Challenge 3: Setting up and ensuring the possible most effective work organisation for the implementation of the strategic objectives while maintaining a high level of nuclear safety.

One of the main objectives of the organisational restructuring carried out in May 2024 was to ensure that adequate resources are available for all oversight activities, and that resources are allocated in line with current and anticipated tasks as well as strategic objectives. The new organisational structure serving these objectives is presented in Section 8.1.2.

Summary of Significant Changes Since Previous Report

During the reporting period, the HAEA established a new organisational structure in which the organisational units are aligned with tasks related to current and anticipated oversight activities.

Notable Achievement

With the introduction of the "new oversight concept" described in Sections 7.2.2 and 7.2.3, the principle of graded approach is applied more effectively, and regulatory resources are focused more strongly on safety-significant activities.

Future Focus

The most important future tasks of the HAEA include preparing for the oversight of subsequent service life extension as described in Section 3.4, overseeing the construction phase of the Paks II project, and reviewing the regulatory framework related to SMRs.

9. Responsibility of the Licence Holder

Convention on Nuclear Safety, Article 9

> *"Each Contracting Party shall ensure that prime responsibility for the safety of a nuclear installation rests with the holder of the relevant license and shall take the appropriate steps to ensure that each such license holder meets its responsibility."*

Summary Statement for Article

Hungary fulfils its obligations under Article 9 of the Convention, which establishes the prime responsibility of the licensee for ensuring nuclear safety. This principle is clearly and explicitly stated in the highest-level sectoral legislation, the Atomic Act. According to the Act, the safe operation of nuclear facilities, and the protection of human health and the environment, are primarily the responsibility of the licensee.

This responsibility extends to the entire life cycle of the facility, as well as to all activities that may affect nuclear safety. The licensee is obliged to provide the necessary technical, organisational and human resources, to continuously develop safety culture, and to comply with legislation and with the requirements of the Authority.

The HAEA exercises continuous oversight of the activities falling under the responsibility of the licensee through its licensing, inspection and assessment activities. In addition, the HAEA may prescribe the necessary measures if the licensee does not comply with safety requirements.

9.1. Main Requirements and Administrative Arrangements

The *Atomic Act* places primary responsibility for the safe use of atomic energy and for compliance with safety requirements on the licensee. The *Atomic Act* also stipulates that atomic energy may only be used in such a way that it does not endanger human life, the health and living conditions of present and future generations, the environment, or property beyond the socially acceptable risk level, the level of risk necessarily accepted in the course of other economic activities, and that the prime responsibility for safety rests with the person or organisation that holds the license for a facility or activity resulting in an increased risk from radiation.

The main obligations of the licensee are to:

- ensure the reasonable protection of humans and the environment from radiation;
- provide the technical-technological, financial and human conditions necessary for the safe use of atomic energy, and for maintaining and improving safety;
- prevent the development of an uncontrolled nuclear chain reaction;
- keep the annual radiation exposure of workers and the public as low as reasonably achievable;
- ensure that the risk of injury to any individual does not exceed an acceptable level;
- continuously monitor radiation conditions in line with the latest verified scientific results, international expectations and experience, and regularly, at least monthly, inform the public thereof;

— minimise the generation of radioactive waste, both in terms of activity and quantity, to the lowest level reasonably achievable;
— carry out continuous activities to enhance safety and finance the associated research and development;
— take into account human capabilities and limitations for the entire lifetime of nuclear facilities;
— ensure that employees meet the prescribed requirements regarding education, qualifications and health status;
— employ suppliers that have a quality management system regulated as part of nuclear safety requirements;
— provide financial coverage (insurance) for the amount of nuclear damage liability;
— take all possible measures to prevent nuclear or radiological accidents and to mitigate their consequences;
— manage extraordinary events and ensure that the risk of such events is reduced, their occurrence is prevented, their consequences are systematically eliminated, and any potential harmful effects of released radioactive material and ionising radiation are reduced to the lowest level reasonably achievable;
— compensate for damage arising from the use of atomic energy up to a specified amount and within a specified time limit;
— ensure the guarding of the facility by an armed security service and maintain effective physical protection;
— make regular payments into the Central Nuclear Financial Fund (CNFF) to cover the costs of final disposal of radioactive waste, interim storage of spent fuel, closure of the nuclear fuel cycle, and – in the case of nuclear power plants – decommissioning of the facility.

The *NUCLEAR SAFETY DECREE* also establishes that responsibility for the safety of a nuclear facility, for compliance with and enforcement of nuclear safety requirements, and for all activities related to the nuclear facility throughout its entire life cycle rests with the licensee, and that the licensee shall demonstrate to the nuclear safety authority the full compliance with the requirements set out in the *NUCLEAR SAFETY DECREE*.

The decree further prescribes that the level of safety culture of organisations participating in the operation of a nuclear facility shall be continuously improved throughout the entire lifetime of the facility, and that a management system must be established whose fundamental objective is the achievement and enhancement of safety.

9.2. Implementation by licence holder

Paks NPP

The management of the Paks NPP is committed to establishing and operating the plant's safety configuration, as well as the regulation of operational and safety-significant activities, in line with the principle of defense in depth. Each level of defense in depth has been designed so that the systems to be used provide the expected level of protection, taking into account the interactions of human, technological and organisational factors. The management has committed itself to maintaining and improving the necessary level of safety of plant operation throughout the entire operational lifetime of the plant, through systematic monitoring and verification.

The staff of the nuclear power plant carries out its activities in accordance with its OOR. To ensure long-term efficient operation and the achievement of strategic objectives, the licensee operates an integrated management system based on a company-wide process structure built on uniform principles. The management system, based on clear accountability, supports and enhances the dissemination and improvement of safety culture and the achievement of the highest possible safety level.

To ensure the reliable and predictable availability of the resources necessary for the safe and sustainable operation of the nuclear power plant, the management applies both medium-term and annual planning systems, operating concurrently and building on each other.

In the course of operation, the objective of keeping radiation exposure to workers and the public as low as reasonably achievable is enforced in daily practice through the requirements laid down in the Workplace Radiation Protection Rules (WRPR), the Emissions Control Rules (ECC), and the Environmental Monitoring Rules (EMR).

The personal, material and organisational conditions for healthy and safe work as well as regular occupational safety and fire protection training, and the commitment to improving workplace and fire safety, are guaranteed in daily practice by the requirements set out in the Fire Protection Rules and the Occupational Safety Rules.

Only qualified employees holding the necessary skills and competences for the given activity are allowed to perform work at the nuclear power plant. The same requirements apply to the employees of contractors as to those of the licensee. The required qualification level is determined by the type of activity and its conditions (location, equipment, level of independence, level of supervision, etc.). To verify the suitability of contractors to be engaged, the nuclear power plant has developed and operates a qualification and assessment system in accordance with Annexes 2–4 of the *Nuclear Safety Decree*.

As part of its risk management activities, Paks NPP identifies potential risks related to its strategic objectives, operational processes and projects in a preventive manner, evaluates the risks, selects critical risks based on the evaluation results, manages them, monitors the implementation of measures to mitigate or eliminate identified risks, controls managed risks, and measures the effectiveness of risk management activities.

To manage potential emergency situations affecting the plant, and to ensure the continuous availability of the personal and material conditions for high-level emergency preparedness, the nuclear power plant maintains annual and long-term training, exercise and maintenance programmes and plans, ensuring the continuous and high-level readiness of both personnel and technical equipment.

The management of the nuclear power plant treats the establishment, operation and development of reliable physical protection as a priority area. In line with the design basis threat determined by the regulatory authority and with the nuclear security decree (↪ *Government Decree 190/2011. (IX. 19.) on the physical protection requirements for various applications of atomic energy and the corresponding system of licensing, reporting and inspection*) the development of physical protection technical systems is carried out on a continuous basis.

Paks NPP is committed to the peaceful use of nuclear technology. To demonstrate this, it operates a written safeguards system in accordance with *Council Regulation (Euratom) No. 302/2005 on the application of Euratom safeguards* and the *HAEA Decree 4/2022. (IV. 29.) on the rules for the accounting and control of nuclear materials*.

Paks II. Ltd.

The management of Paks II. Ltd. is committed to fulfilling the obligations arising from its responsibility in assuming and exercising the role of licensee. In all areas of safety, and in particular in nuclear safety, safety is always the primary consideration in all decision-making and activities. The management of Paks II. Ltd. ensures the necessary resources for this purpose.

The safety policy and the regulatory documents derived from it define the fundamental principles on the basis on which Paks II. Ltd. establishes, ensures and continuously maintains the conditions and operational practices necessary to enforce nuclear and general safety.

In the selection and employment of managers and employees, the primary considerations are professional preparedness and competence, commitment to the task and its associated responsibility, and the health status of the employees, taking into account the relevant legal and regulatory requirements. The responsibilities of managers and their staff, as well as the rules of communication and reporting, are defined and documented.

In carrying out its technical tasks, Paks II. Ltd. operates a multi-level process of control and approval, the basic principle of which is the identification of requirements and expectations related to nuclear safety, their acceptance, and their incorporation into the technical, design, construction, commissioning and operational processes of the facility to be realised. An important element of this control system is independent expert review, which is carried out on the basis of strict legal requirements.

For all design and licensing documentation related to the investment, whether falling within the scope of the ownership responsibilities or those of the main contractor, the licensee pays particular attention to verifying compliance with all requirements arising from the applicable legislation and other regulatory documents. The approval of such documentation may only take place after the unconditional and complete acceptance of compliance with the requirements.

Paks II. Ltd. involves in the project implementation those contractual partners who are highly qualified, possess extensive expertise and professional experience, are recognised within the industry, whose commitment to safety is beyond doubt, and whose professional competence is unquestionable. The selection of contractual partners is based on a prior assessment of their capabilities and on the evaluation of their performance during their activities, conducted in accordance with a qualification and evaluation system based on nuclear safety requirements.

As a licensee, Paks II. Ltd. defines hold points and control points through approved and licensed quality control and sampling plans during manufacturing and construction, applying a graded approach. On this basis, it supervises activities and inspections, including the verification of compliance with the requirements defined at the design stage. The planning and implementation of supervisory activities, the management of deviations and non-conformities from the requirements, manufacturing, construction and licensing documentation, as well as the documentation and archiving of inspections, are carried out in accordance with its own regulatory system. This system is periodically reviewed and updated, incorporating both internal and international experience. The licensee ensures the provision of an adequate number of qualified personnel, as well as the material and organisational conditions necessary for supervisory and inspection activities.

The management of Paks II. Ltd. is committed to the development of a strong nuclear safety culture. The management expects that everyone working on the project will demonstrate behaviour accountable for safety, will maintain and strengthen safety through their activities, actions and decisions, and will be prepared to challenge prevailing practices if they compromise safety.

Paks II. Ltd. pays attention to the identification and management of risks related to construction, as well as to the evaluation and utilisation of both external and internal experience related to construction.

Paks II. Ltd. treats the obligations arising from licensee responsibility as a matter of priority. Accordingly, during the design, construction and operational phases of the facility, it fully enforces nuclear safety, nuclear security and nuclear safeguards requirements and continuously strives to ensure their full compliance.

9.3. Regulatory Review and Control

The HAEA ensures the primary responsibility of the licensees for safety through continuous oversight and initiates enforcement procedures in case of violation of legal requirements.

In 2024 the HAEA carried out a comprehensive inspection at Paks NPP, where a dedicated group of inspectors examined the licensee's primary responsibility for safety, including the accountability in decision making and the communication towards the owner.

At Paks II. Ltd. the HAEA carried out a comprehensive inspection in 2023, where a dedicated inspection reviewed the management's primary commitment to nuclear safety, and the communication within the company and with subcontractors.

Summary of Significant Changes Since Previous Report

In respect of this Article, no significant changes occurred in Hungary during the reporting period.

C. GENERAL SAFETY CONSIDERATIONS

Part C consists of the following articles:

Article 10: Priority to Safety

Article 11: Financial and Human Resources

Article 12: Human factors

Article 13: Quality assurance

Article 14: Assessment and verification of safety

Article 15: Radiation Protection

Article 16: Emergency Preparedness

10. Priority to Safety

Convention on Nuclear Safety, Article 10

> *"Each Contracting Party shall take the appropriate steps to ensure that all organizations engaged in activities directly related to nuclear installations shall establish policies that give due priority to nuclear safety."*

Summary Statement for Article

Hungary fulfils the obligations under Article 10 of the Convention, which establishes the principle of primacy of nuclear safety. This principle is clearly stated in the Atomic Act. According to the Act, nuclear safety takes priority over all other aspects.

The licensee is obliged to establish and operate its safety policy and management system in accordance with this principle. The licensee shall ensure that this safety-oriented approach also extends to the activities of its suppliers.

The HAEA verifies the commitment to safety of both the licensee and the suppliers.

10.1. Main Requirements and Administrative Arrangements

The *Atomic Act* clearly states that "in the use of atomic energy, safety shall take priority over all other considerations".

The *Nuclear Safety Decree* obliges the licensee to develop a safety policy that ensures that safety is of overriding importance in all activities related to the nuclear facility, and the safety policy shall stipulate that the licensee, taking into account internal and external design, construction, commissioning and operational experience, as well as new knowledge related to nuclear safety, shall continuously improve the level of nuclear safety.

The decree further requires that safety shall be the overriding priority within the management system, and that the management of both the licensee and its suppliers, at all levels, shall consistently and firmly demand and promote the attitudes necessary for a strong safety culture. It is the responsibility of the licensee to ensure that suppliers also meet the requirements relating to safety culture.

10.2. Implementation by regulatory body

The HAEA carries out safety culture assessments within its own organisation, thereby ensuring internal feedback and continuous improvement in relation to safety culture.

The HAEA dedicated 2024 as the "Year of Safety Culture", during which, at its monthly internal technical meetings, it repeatedly conveyed short safety culture messages to its inspectors in order to raise safety awareness.

10.3. Implementation by licence holder

The licensees of the HAEA, in particular MVM Paks NPP Ltd. and Paks II. Ltd., implement internal safety culture programmes aimed at ensuring that employees perform their tasks with the highest possible level of safety awareness.

Paks NPP

» Safety policy

MVM Paks NPP Ltd.'s safety policy summarises the main expectations related to nuclear power plant safety and sets out the principle of the primacy of safety. The specific modes of practical implementation are only indirectly addressed; these are realized through internal regulations, procedures and instructions.

The safety policy applies uniformly and comprehensively to all organisational units and employees of the nuclear power plant, as well as to suppliers. It highlights the general responsibility of the Chief Executive Officer and the specific responsibility of the Safety Director for ensuring safety. The policy emphasises the importance of commitment to safety, its manifestations in striving for safety, identifying factors that may weaken safety, and improving safety culture. It also stresses the significance of training, information and feedback mechanisms.

The nuclear power plant operates its safety configuration, as well as the regulation of activities important to safety and operation, in accordance with the principle of defense in depth. Each level of defense in depth is designed to take into account the interactions of human, technological and organisational factors and interactions with their components.

MVM Paks NPP Ltd. regularly reviews its safety policy, thereby ensuring its timeliness and validity.

The management supports the dissemination and understanding of the expectations set out in the safety policy to the implementing staff through conscious communication. The expectations laid down in the policies are regularly included on the agenda of both internal and external forums, including in the forms of cooperation maintained with suppliers (e.g. Supplier Day). For the fulfilment of the expectations defined for the operational areas and functions designated in the safety policy, MVM Paks NPP Ltd. has the necessary management, supervisory and operational elements and tools.

The measures serving the priority of safety support the application of good practices and the strengthening of safety culture.

» Management responsibility

The CEO of the nuclear power plant is responsible for the planned and safe operation of the plant and for quality. In its work the CEO is assisted by, and exercises delegated authority through, the Safety Director.

The managers are responsible, within the framework of the organisations they lead, for the compliance and enforcement of safety requirements and for the implementation of the safety policy.

In order to delineate tasks, responsibilities, powers and rights, the CEO established the internal regulation hierarchy set out in the Management System Manual. Rights and responsibilities are also defined in the job descriptions.

» The role of personnel in operational safety

Every member of the operating staff holds the qualification and certification necessary for the performance of their work. Depending on the safety impact of the position to be filled, certification is obtained through company, special company or regulatory authorisation examinations. The authorization examination must be repeated at regular intervals.

The training and qualification requirements for the operating staff providing shift service in the operating organisations are laid down in the Training Decree (↪ *HAEA DECREE 10/2022. (XII. 29.) ON THE SPECIAL PROFESSIONAL TRAINING AND ADVANCED TRAINING OF WORKERS EMPLOYED IN A NUCLEAR FACILITY, AND ON THE SCOPE OF PERSONS AUTHORIZED TO CONDUCT ACTIVITIES IN RELATION WITH THE APPLICATION OF ATOMIC ENERGY*), as well as in the procedures describing the training activities.

Operating personnel on shift may transfer their responsibility to other persons only in a regulated manner and under regulated conditions, both in normal operation and in abnormal situations.

As part of its Final Safety Analysis Report (FSAR), the Paks NPP has defined, in accordance with nuclear safety requirements, the so-called safety-related positions, together with the expectations and the training and qualification requirements for those positions.

The activities of non-shift managers in the main control room are also regulated. Only persons with the appropriate qualifications set out in their job description, and who have entered shift operating service in accordance with the applicable rules, may intervene directly in the operation. No direct intervention by other persons is permitted.

The responsibility of maintaining the plant equipment in a reliable and operable condition lies with the maintenance personnel. The maintenance process of the nuclear power plant is carried out in the form of structured work instructions. An administrative instruction ensures that only properly considered and prepared work, with the necessary permits, may be carried out. A procedure describes the verification and review functions required in the workflow. The nuclear power plant manages in a regulated manner the emergency stockpiles of key system components, as well as the supply chain providing materials and services necessary for maintenance.

The preparation of maintenance personnel is carried out within the same training system as that of the operating personnel. Their preparation is greatly supported by the plant's well-equipped Maintenance Training Centre.

The maintenance organisations are responsible for the maintenance and refurbishment of the installations, the elimination of equipment failures, preparation for regulatory inspections, the execution of all welding and technological assembly work, repair and manufacturing tasks arising at the nuclear power plant, as well as for the planning and provision of the safety, personnel and material conditions necessary for the work, the preparation of the work instructions required for execution, and the documentation and archiving of the work performed.

The tasks of the technical support organisation are the following:

— development of safety analyses;
— performance of reactor physics calculations;
— preparation and coordination of nuclear fuel supply;

- definition of the scope, schedule and cycle length of technological tests;
- preparation, coordination, review and modification of operating procedures, operating schemes, test scenarios and their schedules;
- keeping detailed records of the technological tests and operating programmes performed, from which reliability and trend analyses can be made, and on this basis, conclusions can be drawn on the suitability of equipment and systems;
- preparation, review and periodic updating of production regulations, ensuring their registration;
- technical preparation of outages, unplanned and online maintenance, and maintenance and repair works during operation;
- definition of the company's long-term, medium-term and annual maintenance programme;
- maintenance and updating of the cyclic maintenance plan of equipment;
- technical justification, preparation, planning, licensing and documentation of maintenance and repair works, preparation of new maintenance, repair, assembly and welding technologies and programmes, licensing of these, approval of technologies prepared by external contractors;
- definition of the principles for emergency stockpiles;
- development of service life management and ageing management programmes, and ensuring the environmental qualification of equipment;
- system analysis, condition monitoring and formulation and implementation of technical tasks based on the follow-up of operating and maintenance events, in order to ensure the safe, economic and environmentally conscious operation of the nuclear power plant;
- ensuring the availability of technical and licensing documentation of appropriate quality necessary for the work;
- performance of energy management tasks.

The activities performed by the auxiliary staff do not directly affect safety.

» Responsibility and safety issues in the use of suppliers

Work on safety-classified systems and equipment within the site of the nuclear power plant may only be performed by suppliers accepted by MVM Paks NPP Ltd. and holding a valid nuclear qualification. Suppliers are requalified at regular intervals. Qualification is carried out on the basis of the requirements of the *Nuclear Safety Code* and the internal regulations of the nuclear power plant, under regular regulatory supervision. MVM Paks NPP Ltd. is responsible for the lawful conduct of the qualification procedure and for the continuous enforcement of the conditions of qualification.

Compliance with the Integrated Management System Manual, and the internal regulations derived from it, is mandatory for all external organisations and workers performing work at the site of the nuclear power plant. The contracting organisation supervises the full scope of the supplier's work and, for this purpose, appoints a technical inspector for each task.

In the field of engineering services, analyses, calculations and investigations requiring theoretical engineering and professional knowledge are carried out by research institutes, universities and engineering offices. The coordination and supervision of external works is performed by the contracting organisational unit.

At Paks NPP, the SMS (Supplier Management System) coordinator performs the system-level coordination tasks related to suppliers.

Paks II. Ltd.

» Safety policy

In line with the legal requirements, the licence holder shall develop its safety policy, in which it declares the overriding priority of safety in all activities related to the nuclear installation. Safety objectives must be enforced throughout all stages of the installation's lifetime (including site selection, design, manufacturing, construction, commissioning, operation, as well as decommissioning, shutdown and closure, and also the transport of radioactive materials related to these activities and radioactive waste management). In line with this, after obtaining the site investigation and evaluation license (14 November 2014), Paks II. Ltd. prepared its current safety policy.

To ensure the continuous implementation of the measures necessary for the fulfilment of the objectives declared in the safety policy, Paks II. Ltd. has introduced, operates and continuously develops an effective management system. The fundamental objective of the management system is to achieve and enhance safety, and to ensure the priority of safety over all other demands.

» Management responsibility

The management has identified the key factors and characteristics that support a strong safety culture and ensures that these are shared with and understood by the employees. To this end, it provides regular training for employees and has created opportunities for them to raise their observations, concerns and suggestions related to safety.

The management has formulated management principles and supports behavioural patterns (also leading by example) that ensure the existence and continuous improvement of a strong safety culture.

For Paks II. Ltd., the development of safety culture is a long-term task (in July 2017, the company adopted a safety culture model based on the 2013 principles of the World Association of Nuclear Operators – WANO – adapted to the construction phase of new nuclear power plant units). The management is committed to enhancing the level of safety culture, further improving safety awareness, and encouraging staff to express their opinions and questions related to safety.

» The role of employees

The management system establishes a working environment in which employees can express and raise their views on safety without fear of negative discrimination.

The management of Paks II. Ltd. expects employees to demonstrate safety-responsible behaviour, to maintain and strengthen safety through their activities, actions and decisions, and to be prepared to challenge prevailing practices if these pose a risk to safety.

Employees are aware of and internalize the safety impact and importance of their work. All their activities and decisions are carried out with safety in mind.

» Safety issues in the use of suppliers

For the construction of the new nuclear power plant units at the Paks site, Paks II. Ltd. involves well-prepared contractual partners with proven competence, high-level expertise and professional experience, recognised within the industry, and audited according to standards. In addition, in the course of engaging contractors, their capabilities are assessed in advance, and their performance is evaluated based on

qualification and assessment criteria grounded in safety requirements. Paks II. Ltd. strives for constructive and proactive cooperation with the external parties and institutions involved in the implementation.

10.4. Regulatory Review and Control

The HAEA dedicated 2024 as the "Year of Safety Culture", during which its inspections paid particular attention to assessing the adequacy of safety culture, and during monthly internal technical meetings inspectors were repeatedly provided with short messages related to safety culture.

In 2024, the HAEA conducted a comprehensive inspection in which dedicated inspector groups examined the safety culture and management system of the licensee of Paks NPP.

During the reporting period, the HAEA also reviewed the safety culture of Paks II. Ltd. in the framework of several ad hoc inspections. In 2024, in view of the importance of safety culture, the HAEA carried out a three-part inspection series at Paks II. Ltd., during which it examined safety culture at all levels of the licensee, including middle and senior management.

Furthermore, during the reporting period, the HAEA on several occasions inspected supplier auditing and qualification activities carried out by licensees.

Summary of Significant Changes Since Previous Report

In respect of this Article, no significant changes occurred in Hungary during the reporting period.

11. Financial and Human Resources

Convention on Nuclear Safety, Article 11

> *"1. Each Contracting Party shall take the appropriate steps to ensure that adequate financial resources are available to support the safety of each nuclear installation throughout its life.*
> *2. Each Contracting Party shall take the appropriate steps to ensure that sufficient numbers of qualified staff with appropriate education, training and retraining are available for all safety-related activities in or for each nuclear installation, throughout its life."*

Summary Statement for Article

Hungary fulfils the obligations under Article 11 of the Convention. The availability of financial and human resources necessary to ensure nuclear safety falls under the responsibility of both the State and the licence holder. To ensure the safe management and final disposal of radioactive waste, the costs must be borne by the current beneficiaries of nuclear energy.

It is the responsibility of the licence holder to provide personnel with appropriate qualifications and experience for positions that directly affect nuclear safety. The continuous training of staff and the maintenance of their competence are also the tasks of the licence holder, which are regularly supervised by the Authority. For positions of special safety significance, official approval is required before work can commence.

11.1. Financial Resources

Financial resources of MVM Paks NPP Ltd.

» Operational resources

For the sale of the electricity generated, MVM Paks NPP Ltd.. concluded an electric power purchase agreement with MVM Partner Energy Trade Ltd., as the trader. The agreement ensures the sale of the electricity produced until 31 December 2027.

» Decommissioning preparation

In accordance with the provisions of the *Atomic Act*, in 1998 the CNFF was established as a segregated state financial fund to finance the fulfilment of tasks related to the final disposal of radioactive waste, the storage of spent fuel, the closure of the nuclear fuel cycle and the decommissioning of nuclear installations, as well as to support municipal associations established for oversight and information purposes. Users of nuclear energy whose activities generate radioactive waste or spent fuel are obliged to bear the costs of its management. The financial resources of the CNFF may be used exclusively to finance these activities. The revenue side of the CNFF consists of annual payments by MVM Paks NPP Ltd., occasional payments from Paks II. Ltd., support from the central budget, and other occasional (in particular deliveries of radioactive waste to the storage facility) income.

The managing body of the CNFF is the ministry headed by the minister responsible for energy policy, currently the ME[6].

The tasks related to the management of radioactive waste and spent fuel generated at the Paks Nuclear Power Plant, as well as the decommissioning of the facility, are summarised in a medium- and long-term plan approved annually by the competent minister. This plan includes the costs incurred in carrying out the above activities, for which the Paks Nuclear Power Plant must make annual payments into the CNFF, evenly distributed until the end of its operating lifetime. The payment obligation is calculated using the net present value method, the essence of which is that the present value of future costs equals the present value of the resources available from the CNFF's assets together with further paymentss from MVM Paks NPP Ltd.

The paymentss made by MVM Paks NPP Ltd. are intended to finance tasks related to waste management, decommissioning, and the management of spent fuel up to the 2084. The purpose of the CNFF is to provide coverage for the financing of these activities, thereby avoiding the imposition of undue financial burdens on future generations.

For its use, PURAM prepares medium- and long-term plans (extending until the decommissioning of nuclear installations and the end of active institutional control of radioactive waste repositories) as well as annual work programmes, which are approved by the minister responsible for the CNFF (currently the Minister of Energy). The medium- and long-term plans must be reviewed annually and updated as necessary. The aim is to ensure that the CNFF provides realistic coverage for expenditures due in the distant future (after the shutdown of the Paks Nuclear Power Plant). This reflects the fundamental principle that the generation making use of nuclear energy should bear the costs of the future activities arising from such use, and that no undue burden should be passed on to subsequent generations.

The *Atomic Act* stipulates that the calculation of the nuclear power plant's payment must be carried out using the net present value method with a 3% real discount rate, in such a way that the present value of the amount formed from the plant's payment, the central value-preservation contribution, and the accumulated assets equals the present value of the future costs prescribed by the *Atomic Act*.

The rules of payment were supplemented by an amendment adopted by Parliament in December 2024, which introduced a new provision requiring that, in the case of a nuclear power plant, the amount of the payment must also fully cover the costs associated with activities preparing the implementation of alternative scenarios under the national programme for spent fuel and radioactive waste management, related to the further operation of the plant beyond its extended operating lifetime (SSLE).

□ Paks II. Ltd.

For the new units to be established at the Paks site, the licensee (Paks II. Ltd.) must begin making payments to the CNFF in the year following the commissioning of the first new unit, in order to provide financial coverage for long-term tasks related to the management of radioactive waste, the management of spent fuel, and decommissioning. Prior to the entry into force of the operating license, the licensee of the new nuclear units must provide financial coverage, through occasional payments as prescribed by the *Atomic Act*, for the preparatory tasks arising in connection with

[6] Pursuant to Section 8 (5) b) of the Atomic Act, the minister responsible for energy policy (currently the Minister of Energy) has authority over the CNFF, and its managing body is the ministry led by that minister (currently the Ministry of Energy).

the management of radioactive waste and spent fuel. The amount of the occasional payment is determined by the law on the central budget for the given year.

Civil liability for nuclear damage

In accordance with *Council of Ministers' Decree 24/1990. (II. 7.) on the promulgation of the International Convention on Civil Liability for Nuclear Damage, signed in Vienna on 21 May 1963*, and pursuant to the *Atomic Act*, for nuclear installations such as nuclear power plants, nuclear heating plants, and facilities producing or processing nuclear fuel, the amount of strict liability of the licensee for a nuclear accident occurring at the installation may not exceed 100 million SDR (Special Drawing Rights). For other nuclear installations, as well as for nuclear accidents occurring during the transport or storage of nuclear fuel, the amount of liability per accident may not exceed 5 million SDR. The State of Hungary shall compensate for nuclear damage exceeding the amounts specified above; however, the total amount available for such compensation shall in no case exceed 300 million SDR.

11.2. Human Resources

11.2.1. Main Requirements and Administrative Arrangements

In Hungary, the regulatory requirements concerning the personnel of nuclear installations are defined by the *Atomic Act*, the *Nuclear Safety Decree*, and the *Training Decree*.

The *Atomic Act* stipulates that users of nuclear energy must ensure the technical-technological, material, and human conditions necessary for the safe use of nuclear energy, as well as for maintaining and developing safety. It also specifies that only persons who possess the educational background and professional qualifications prescribed by regulation, who meet the legal conditions of employment, and who comply with the prescribed health requirements may be employed in the field of nuclear energy.

The *Training Decree* requires the licensee to regulate in writing the conditions for the selection and employment of workers, including the requirements concerning employees' basic education, professional qualifications, and suitability. The decree defines the mandatory content of the various training programmes, which must comply with the provisions set out in the *Nuclear Safety Codes*.

The *Training Decree* lays down requirements in the following areas:

- requirements for the selection of workers;
- general and detailed provisions regarding training programmes;
- introductory specialised training;
- refresher specialised training;
- requirements for the supervision of training programmes;
- requirements for final and qualifying examinations;
- educational and professional qualifications prescribed for specific positions.

The preparation of the training programme is the responsibility of the licensee, and it shall be based on analysis and aligned with the qualification, nuclear-specific certification, and examination requirements prescribed for the given position. Training programmes must follow changes introduced in the nuclear installation, its structures, systems and components, the mode of operation, technical and administrative

instructions, as well as changes considered necessary and implemented based on operational experience. Training programmes and study materials must be reviewed periodically – at least every three years. It must be ensured that educational materials of appropriate quality and quantity, along with supplementary materials, operational documentation, guides, and tools supporting practical training, are available for employee preparation.

The *NUCLEAR SAFETY DECREE* sets out additional requirements for workers, including the stipulation that the number and expertise of operating staff required for safe operation shall be systematically analysed and documented, and their suitability verified. The training programme must ensure that operating staff at all organisational levels understand the paramount importance of nuclear safety and are able to perform their duties correctly during operational occurrences and accident situations.

Filling positions of safety significance is subject to a nuclear safety authority certification. To obtain such a certificate, candidates shall pass an authority certification examination in nuclear safety, the internal regulation of which, prepared by the licensee, is subject to approval by the nuclear safety authority.

11.2.2. Human resources of the licence holder

Paks Nuclear Power Plant

» Staff and qualifications

On 31 December 2024, the staff number of MVM Paks NPP Ltd. was 2,627, of which 96 were employed in managerial positions. The number of employees in the operations area was 830, those engaged in maintenance activities numbered 699, and staff providing background support (safety, technical, economic and human resources activities) totalled 1,098. 44% of the plant's employees hold a higher education degree. At MVM Paks NPP Ltd., 484 employees hold either an authority certificate or a special company certificate.

» Recruitment

MVM Paks NPP Ltd. continuously enforces the requirement that only persons who hold the prescribed qualifications, training and examinations for their position, and who meet the medical, psychological and public security requirements, may perform independent work at the nuclear power plant.

The process of workforce search and multi-level selection requires close cooperation between the professional organisations and the human resources organisation. The head of the requesting organisational unit defines the professional requirements of the position to be filled, the human resources organisation carries out the preparation, screening and assessment necessary for the decision, and the evaluation of candidates' competencies is conducted jointly. This process is supported by the "Career Portal" online platform, used across all member companies of the MVM Group, as a tool for recruitment and selection activities.

The selection process includes a job interview conducted jointly by the professional and human resources organisations, in which only candidates meeting the application criteria participate. Also as part of the selection process, MVM Paks NPP Ltd. applies a system consisting of medical and psychological fitness examinations of the candidates and the assessment of the level of competencies required for the given position. As a result of the selection process, the decision on the most suitable candidate is made by the manager exercising future employer authority.

If the recruitment concerns a position requiring nuclear power plant-specific professional and/or practical experience that cannot be acquired in school education, or only partially, and cannot be replaced from internal resources (reassignment), the manager exercising employer authority may initiate the launch of a training programme at the human resources organisation. The training programme is implemented through the Training Centre of ATOMIX Ltd., a company wholly owned by MVM Paks NPP Ltd. The Training Centre organises the modules of the introductory training, ensures the trainee's participation in the courses, and provides the conditions necessary for carrying out the tasks of the given position.

During the training programme, trainees are not authorised to perform independent work. The training courses within the programme shall be carried out in accordance with the relevant requirements of the Paks Nuclear Power Plant. After the successful completion of the training programme, the requesting professional organisation may initiate the employment of the worker in the staff of MVM Paks NPP Ltd.

MVM Paks NPP Ltd. operates an integration and professional mentoring programme for employees newly hired or transferred to a new position. The purpose of this is to support the integration of new entrants, to familiarise them with the organisational culture, and, for those moving to a new position, to help them practice work techniques, to convey organisational values and expectations, and to ensure the most effective possible transfer of knowledge and professional experience from the company's highly qualified specialists with extensive and specific expertise to the next generation.

One of the possible medium-term sources of recruitment is represented by young people participating in higher education who are interested in the nuclear industry and are hosted by the Paks Nuclear Power Plant each year for professional internships. This provides them with the acquisition of professional knowledge and local familiarity, which may in the future facilitate their employment at the plant. The network of relations and cooperation between the Paks Nuclear Power Plant and universities is continuously expanding. This cooperation also extends to dual training, in which the Paks Nuclear Power Plant acts as a professional training site.

» Training system

MVM Paks NPP Ltd. operates its own professional training system, for which it provides the financial, material and human resources. The professional training system established at the Paks Nuclear Power Plant complies with international expectations and Hungarian legal requirements. Training is based on job task analysis and systematically structured, modular, job-specific training programmes, following the SAT methodology favoured by the IAEA. In addition to theoretical classroom training, the programmes also include practical exercises carried out on a simulator, at the Maintenance Training Centre, or in the nuclear power plant itself. Training is complemented by practical on-the-job instruction in a real working environment. Each stage of training concludes with an examination, and at the end of the job-specific training the candidate acquires the authorisation for independent work by passing a company, special company or authority certification examination. Training does not end with the acquisition of a license or job authorisation; refresher and retraining courses, as well as regular knowledge checks, are also conducted alongside employment. For employees working in positions requiring an authority, special company, or company certificate, periodic re-examinations are held every three to five years, the prerequisite of which is also the periodic renewal of job-specific fitness (including medical and psychological examination).

The general procedure for the design and implementation of training programmes, the designation of positions and activities requiring special nuclear qualifications, and the content requirements of training programmes are set out in the *Nuclear Safety Decree*, the *Training Decree*, and internal procedures.

Radiation protection training covers the widest and largest group of employees. Separate training is provided for those professionally engaged in radiation protection, for operational personnel, for maintenance staff, and for those performing technical support activities. The provisions relating to the fulfilment of qualification and examination requirements shall also apply to external employees engaged on a contractual basis.

MVM Paks NPP Ltd. carries out professional training independently, in its own training centres. The training infrastructure is fully available, the facilities of the training centres are well equipped, and the teaching and instructor staff are qualified and well prepared.

Since 1989, the Simulator Centre has operated a full-scale simulator serving all four units. The simulator has been continuously developed so that it follows the modifications implemented on the units. In addition to the training of control room personnel, the simulator plays an important role in technological development.

With the support of the IAEA, the Maintenance Training Centre was commissioned in 1997. Its training workshops, equipped with actual large-scale primary circuit components and mechanical equipment, are unique worldwide. A particular feature is that training and practice are carried out on full-size, inactive primary circuit components (reactor, steam generator, main coolant pump, etc.) and on equipment identical to the system components built into technological systems, as well as on training mock-ups.

The training system is complemented by the company's knowledge management toolkit, developed in line with IAEA guidelines and requirements, which contributes to ensuring the continuous availability of knowledge necessary for the operation of the units. Its focus is on knowledge preservation, knowledge sharing, and the reduction of the risk of knowledge loss. The most common reason for staff turnover at the company is retirement; therefore, several "IAEA-compatible" tools are applied to map the implicit, tacit knowledge of colleagues with decades of experience and to support knowledge preservation activities prior to their retirement. In addition, a company knowledge portal has been developed, in a way considered an international good practice, a working group with contributors delegated by organisational units has been established to organise knowledge management events, promote communication on knowledge management, and support periodic specialised organisational tasks. The organisational unit responsible for knowledge management maintains active contacts with relevant national and international organisations in order to acquire and adapt the latest knowledge and best practices of the field.

» Improvement of working conditions

According to the collective agreement of MVM Paks NPP Ltd., overtime work shall not exceed 300 hours per employee per year. The rules in force at the nuclear power plant are in line with the provisions of *Act I of 2012 on the Labour Code*. The human resources organisation continuously records the workload of employees.

To ensure calm working conditions, the plant has developed and operates a social welfare system and a wage system based on job analysis and evaluation, which in

several areas exceeds the benefits generally available in Hungary. In addition, a high-level package of non-wage benefits is provided for employees.

» Future development of human resources characteristics

In order to ensure a well-prepared supply of personnel, the human resources organisation of the nuclear power plant continuously assesses the plant's optimal staffing needs and manages deviations in headcount (shortages or surpluses) in line with the expected lifetime of the plant.

The aim of MVM Paks NPP Ltd. is to operate the four units of the nuclear power plant for an additional twenty years beyond the already authorised 50-year operating lifetime, thereby opening up the possibility of long-term career paths.

The performance evaluation system operates continuously and effectively. The evaluation enables regular, substantive feedback and supports differentiated incentives based on individual performance. The efficiency of the system is further enhanced by a reward framework that serves to recognise outstanding performance in accordance with the wage agreement.

The management of the Hungarian Power Companies Group, of which MVM Paks NPP Ltd. is a member, has taken into account, and intends to do so even more in the future, the opinions and observations of employees concerning their employer, their working conditions, and their opportunities for personal development.

□ Paks II. Ltd.

» Staff

On 31 December 2024, the closing headcount of Paks II Ltd. was 495 employees, while the average staff headcount actively participating in its operation in 2024 was 490 employees.

» Recruitment

Human resource planning is linked to the life cycle of the plant, with recruitment tasks already associated with the construction phase.

Paks II. Ltd., taking into account the characteristics of the nuclear installation under design and the tasks related to construction, defined the list of safety-important positions, including safety-significant positions. Following the issuance of the construction license, this list was included in the Preliminary Safety Analysis Report (PSAR), as revised by Paks II Ltd., as well as in the related design documentation. The development of the organisation shall follow the life cycle phases of construction, taking into account the expectations detailed in Section 11.2.1. The recruitment and training of simulator instructors participating in the training of the technological staff of the new units is in progress.

The objective of the recruitment and selection process of Paks II. Ltd., taking into account the company's strategy, is to ensure an optimally sized and qualified workforce necessary for efficient operation. From the corporate applicant CV database, job interviews are organised with external or internal candidates who best meet the job requirements. Following the interviews, an employment offer is prepared for the selected candidate with the involvement of the head of the relevant organisational unit, and the offer is approved by the human resources director and the chief executive officer. In the case of new hires, or for internal candidates, the onboarding or transfer may begin only once the selected candidate has accepted the offer.

One of the possible sources of professional recruitment for Paks II. Ltd. is students, primarily from higher education institutions, who possess adequate theoretical knowledge and motivation to complete their internships at Paks II. Ltd., and potentially to take up employment at the company thereafter.

Recruitment is further supported by close professional cooperation with the Paks Energy Technical School and College, as well as participation in the work of the foundation that maintains and operates the institution (jointly with MVM Paks NPP Ltd.), thereby supporting the professional development of students participating in training programmes tailored to the needs of the electricity industry and facilitating their future employment.

» Training system

The training and development system of Paks II. Ltd., and in this context the internal system for ensuring a supply of qualified specialists, is under continuous development. In accordance with the applicable legal and regulatory requirements, the company treats employee preparedness and commitment to nuclear safety as a priority, and applies as a fundamental principle the definition of the specialised knowledge and practical skills required for each position, and the requirement that employees possess these. Paks II. Ltd. prepares a detailed training plan, with particular focus on courses providing specific nuclear knowledge necessary for the development and operation of the nuclear power plant, for filling individual positions, and for maintaining professional expertise, as well as on regularly renewable examinations arising from legal obligations. (A significant part of these training programmes is carried out by MVM Paks NPP Ltd. on the basis of framework agreements on training concluded between the two licensees.) In addition, the company provides its employees with opportunities to participate in further professional courses, conferences, and foreign language training.

In order to ensure that the knowledge acquired by employees becomes part of the company's shared knowledge base, Paks II. Ltd. operates a knowledge management system that takes into account international recommendations and guidelines. The primary objective of this system is the sharing and preservation within the company of the expertise of external and internal lecturers/experts, the familiarisation of organisational units with the characteristics and operational environment of other professional areas within the company, and the implementation of internal training through e-learning.

» Improvement of working conditions

At Paks II. Ltd., keeping staff turnover at an acceptable level is a task of key importance for both the human resources department and senior management. The company is continuously working to maintain the elements that support this process, such as providing professional challenges, operating professional mentoring and integration programmes to assist new employees, offering a wide-ranging system of benefits, and providing various training opportunities.

In addition, Paks II. Ltd. is committed to establishing a corporate culture based on equal opportunities and promoting workplace diversity. A key objective of the company is to ensure equal treatment and equal opportunities for all employees, both prospective and employed, already prior to the commencement of employment and throughout the entire period of employment.

» Future development of human resources characteristics

The training of technological staff and the creation of a stable technical team with senior-level experience is a long process, which requires establishing links with the next generation. For this reason, Paks II. Ltd. places increasing emphasis, through its recruitment programmes (such as professional internships and part-time job opportunities for students pursuing MSc studies), on getting to know potential future employees and broadening the recruitment base.

Paks II. Ltd. operates a psychological support system, which since 2022 has been expanded with a psychological fitness testing system, in view of the expanding recruitment and selection tasks, with particular attention given to employees who will be involved in future operation.

Cooperation between the licensees

For both MVM Paks NPP Ltd. and Paks II. Ltd., the availability of an adequately staffed and qualified workforce is essential for their operation. In order to ensure, both in the short and long term, the workforce necessary for the operation of the currently running units, as well as for the construction and operation of the new units, closer cooperation between the two companies is required. To this end, the heads of the HR organisations of the two companies hold regular consultations on this matter.

11.2.3. Regulatory Review and Control

The internal regulation of the licensees concerning the acquisition of nuclear safety authority certificate shall be approved by the HAEA, which also participates in the authority certification examinations and verifies both the adequacy of the examinations and the preparedness of the employees.

For every modification of safety importance, the HAEA requires the presentation of the related training programme as part of the licensing process.

In addition, the licensee of the operating nuclear power plant shall report on its training activities related to positions requiring an authority certificate in a separate chapter of the annual report on the operation of the installation, which is evaluated by the HAEA.

In the case of Paks II. Ltd., during 2022–2024 the HAEA examined, within the framework of inspections carried out in the various professional areas, the level of competence existing and required in each area. As part of the preparation for the operation of the new units, simulator instructor training has been ongoing at Paks II. Ltd. since autumn 2022, and the examinations held within this training have been inspected by the HAEA on several occasions.

Summary of Responses to Applicable Challenges and Suggestions

9th Review Meeting – Challenge 1: Paks II. Ltd. shall develop a human resources plan for the new project to ensure that, in every phase of its implementation, adequate skills and resources are available on both the regulatory and the operator side for safe execution.

Paks II. Ltd. has aligned its staff management with the volume of tasks to be performed, thereby ensuring the necessary and sufficient human resources for work, and has developed a concept to ensure the availability of operating personnel. In scheduling future recruitments, Paks II. Ltd. shall also pay particular attention to securing the required resources in line with project progress.

To retain employees and facilitate future staff expansion, Paks II. Ltd. is committed to maintaining a remuneration policy that ensures competitive income compared to industry and market peers. To expand the specialist base, at the initiative of MVM Paks NPP Ltd. and Paks II. Ltd., a dual correspondence programme in electrical engineering will be launched in Paks from September 2025. The theoretical professional foundation for this will be provided by the University of Pécs, while the Energy Technical School and College will serve as the training venue. Both companies regard the Energy Technical School and College as a strategic partner and co-financier. The objective is that as many graduates as possible continue their studies at the University of Pécs and subsequently join one of the companies.

Summary of Significant Changes Since Previous Report

With regard to this Article, no significant changes occurred in Hungary during the reporting period.

12. Human factors

Convention on Nuclear Safety, Article 12

> *"Each Contracting Party shall take the appropriate steps to ensure that the capabilities and limitations of human performance are taken into account throughout the life of a nuclear installation."*

Summary Statement for Article

Hungary fulfils the obligations under Article 12 of the Convention, since the Atomic Act stipulates the provisions of Article 12 as a requirement, and the Nuclear Safety Decree sets out further detailed requirements for taking the human factor into account.

12.1. Main Requirements and Administrative Arrangements

The regulatory requirements related to human factors are primarily contained in the *ATOMIC ACT* and in the annexes of the *NUCLEAR SAFETY DECREE*.

The *ATOMIC ACT* stipulates that, for the sake of safety, the capabilities and limitations of human performance must be taken into account throughout the entire lifetime of nuclear facilities.

The *NUCLEAR SAFETY DECREE* sets out a number of additional requirements concerning human factors. Among other things, it prescribes that human–machine interaction and human factors must be considered at every stage of design and in the development of operational conditions. It also requires that the workplaces, working environments, and human–machine interactions of operating personnel must be analysed from an ergonomic perspective and in terms of the potential for erroneous interventions. The human–machine interface and ergonomic design of systems and components must be planned in such a way that, taking into account the assumed physical environment and expected psychological conditions, properly trained personnel are able to successfully carry out their tasks within the required timeframe whenever necessary.

The evaluation of human factors must be presented separately during the PSRs and in the FSAR.

12.2. Implementation by licence holder

Paks Nuclear Power Plant

The safety policy of the Paks Nuclear Power Plant states that commitment to safety shall be reflected, among other things, in the open identification of factors that impair safety and in the pursuit of improvements in safety and safety culture. The purpose of investigations is to make use of the experience gained, not to impose accountability.

At the Paks Nuclear Power Plant, procedures regulate the investigation and analysis of unplanned operational events. If the investigation establishes that the event was caused by human error, a detailed analysis of that error is also carried out. Specialists participate in uncovering the causes leading to personal error and in the psychological processing of the relevant information. With their assistance, the direction of the

necessary changes or modifications is determined. The results of the investigations are recorded in a protocol with the definition of specific tasks and measures.

At the Paks Nuclear Power Plant, a healthy working environment is established in compliance with normative values. If the presence of any of these conditions at a given workplace is in doubt, professional measurements are carried out, on the basis of which supplementary measures are taken. Depending on working conditions, the use and proper wearing of necessary personal protective equipment are ensured through regular inspections and sanctions.

It is a general practice to adjust and modify external conditions, the ergonomic environment, and the human–machine interface in such a way as to significantly reduce the likelihood of errors or repeated mistakes. Tools, measuring instruments, maintenance devices, etc., meet the requirements both in terms of quantity and quality.

Paks II. Ltd.

Paks II. Ltd. pays particular attention, in connection with its operation, to the human factor during the construction phase of new nuclear facilities, with special regard to those positions that are subject to statutory inspection obligations. The operating organisation shall at all times comply with the written requirements applicable to the specific task concerning staffing levels, educational background, professional qualifications, practical skills, commitment to nuclear safety, health status, and physical and psychological fitness. These requirements shall ensure that the operating personnel are able to perform their duties even under plant conditions that deviate from normal operation.

Paks II. Ltd. also focuses on assessing and managing construction-related risks, as well as evaluating and utilising both internal and external experience related to construction. The purpose of the Operating and Construction Experience Working Group established within Paks II. Ltd. is to determine how operating and construction experience gained during the construction of the Paks II Nuclear Power Plant, as well as in other nuclear power plants under construction or in operation (collectively: external experience), shall be utilised and shared.

Safety-related observations or comments may be reported by anyone. These are evaluated and investigated without delay at the appropriate organisational level according to their significance, and the staff working on the project are duly informed of the corrective or preventive measures implemented.

The management of Paks II. Ltd. continuously ensures the conditions necessary for the effective performance of construction-related tasks, in compliance with the applicable legal and corporate requirements as well as international good practice. This includes an environmentally friendly and ergonomic working environment, appropriate work equipment, and personal protective equipment, the existence and adequacy of which are verified through regular inspections.

The management regularly, but at least during the annual management review, reassesses the personnel, material, and organisational conditions for safe and healthy working, in order to preserve the health, safety, and working capacity of all company employees and to improve their working conditions. In managerial decision-making, the safety and health of employees take precedence over economic considerations. A safe working environment refers to the provision of conditions under which work can be carried out without endangering the physical integrity and health of either those performing the work or those present in the work area. From the construction phase onwards, hazards typical of construction, assembly, and industrial environments

appear, the management of which is ensured by Paks II. Ltd. in real time, in parallel with the progress of activities, through the involvement of dedicated experts.

12.3. Regulatory Review and Control

In the course of its regulatory oversight activities, the HAEA gives special attention to human and organisational factors in the areas of licensing, inspection, and assessment. Within the HAEA, a dedicated department supports the work of the organisational units responsible for individual facilities in supervising human and organisational factors, including the organisational structure and management systems of licensees, their technical and regulatory documents, as well as the investigation of events and the assessment of supplier compliance.

The HAEA specifically evaluates the fulfilment of expectations related to human factors during PSRs, and it also places particular emphasis on this area when assessing event investigations.

During an inspection held in connection with the modification of Paks II. Ltd.'s OOR at the beginning of 2024, the HAEA also examined human and organisational factors.

Summary of Significant Changes Since Previous Report

With regard to this Article, no significant changes occurred in Hungary during the reporting period.

13. Quality assurance

Convention on Nuclear Safety, Article 13

> *"Each Contracting Party shall take the appropriate steps to ensure that quality assurance programmes are established and implemented with a view to providing confidence that specified requirements for all activities important to nuclear safety are satisfied throughout the life of a nuclear installation."*

Summary Statement for Article

Hungary fulfils the obligations under Article 13 of the Convention. To maintain nuclear safety, it is the duty of the licensee to establish, operate, assess, and develop a management system that ensures the primacy of safety.

13.1. Main Requirements and Administrative Arrangements

The *ATOMIC ACT* stipulates that, in the field of activities related to nuclear installations, only those institutions, organisations, and economic operators may operate which have an adequate quality management system regulated as part of the nuclear safety requirements. A separate volume (Annex 2) of the *NUCLEAR SAFETY DECREE* defines the requirements for the management systems of licensees of nuclear installations. The *NUCLEAR SAFETY DECREE* provides that the licensee shall establish, operate, assess, and continuously develop a management system. Within the management system, safety shall take precedence over all other requirements. Any modification of the management system of the licensees may be made only with the authorisation of the HAEA. During PSRs, in the PSAR, in the FSAR, and in the annual report, the adequacy of the management system shall be demonstrated.

13.2. Management system of the license holder

MVM Paks NPP Ltd.'s management system

» Management

MVM Paks NPP Ltd., as the operator and licensee of the nuclear power plant, has established, operates, and develops its management system on the basis of the requirements of *ANNEX 2 OF THE NUCLEAR SAFETY DECREE*. The description of the principles of the integrated management system is contained in the Integrated Management System Manual, and compliance with the prescribed requirements of the system is demonstrated in Chapter 17 of the FSAR, submitted annually to the HAEA.

The plant's management system is integrated; in its operation, alongside quality requirements, particular emphasis is placed on the relevant requirements of environmental protection, physical protection, occupational safety, radiation protection, fire protection, information security, anti-corruption, and energy management. The integrated approach ensures that all these requirements are observed while maintaining the primacy of nuclear safety.

The integrated management system is comprehensive with respect to the core activities, covering all processes, i.e. it sets requirements for every process. The

integrated management policy clearly records top management's general intentions and orientation concerning quality.

A system of indicators serves to evaluate the proper functioning of the integrated management system of the Paks Nuclear Power Plant. The trends of the indicators indirectly reflect the adequacy of the quality management system, and the necessary measures are determined after evaluating the indicators.

The quality management organisation regularly reviews the functioning of the integrated management system on the basis of an annual programme. The auditors carrying out the reviews participate in specialised training, and for auditing specific fields, experts familiar with those fields are involved.

Any deviations observed during the operation of the Paks Nuclear Power Plant are always followed by an evaluation. Depending on the significance of the deviation, evaluations are carried out either by the HAEA, the plant's safety and quality specialists, or the relevant departments themselves.

One of the most effective elements of quality improvement is the investigation of events of various levels and the feedback of experience gained. Accordingly, the nuclear power plant, in a manner regulated by procedures, investigates events according to their significance. The root causes and the necessary measures are determined during these investigations. The feedback of lessons learned from the investigations is also provided to the suppliers concerned.

The preparation and change control of the documents required for the operation of the Paks Nuclear Power Plant are regulated.

To assess the effectiveness of the management system and to determine the necessary corrective actions, management carries out an annual management review.

» Implementation

The design work necessary for the operation of the Paks Nuclear Power Plant is carried out by the technical support organisations or contracted out by them.

The procurement process, as well as acceptance inspections and tests, are fully regulated (from ordering through delivery to acceptance inspection). During procurement, the suitability and quality capability of designated suppliers are assessed through a preliminary evaluation in order to establish a long-term, reliable supplier base.

Operational activities are carried out in the manner prescribed in procedures, implementing instructions, and the Operational Limits and Conditions (OLCs) document regulating plant operation. Operations are performed on the basis of operating and handling instructions. Special attention is given to the unambiguous identification of equipment at all times and to the continuous monitoring of equipment condition. Shift handovers are always documented, with a clear indication of the condition of the equipment at the time of transfer. Any necessary temporary modifications are implemented on the basis of procedures.

The proper management of the maintenance process is described in procedures and implementing instructions. Maintenance activities are carried out on the basis of plans, maintenance technologies, and work programmes. An important element of maintenance quality management is the regulated, full-cycle fuel management.

The management of technical support activities is also carried out on the basis of procedures. Requirements have also been developed for reactor physics and diagnostic analyses, as well as for the process of radioactive waste management.

The auditing and performance assessment of manufacturing and service organizations/suppliers, according to differentiated requirements based on safety classification, are carried out in a regulated and regular manner.

Within the framework of the so-called Production Subsystem Operation Development (PSOD) project, the processes of the production subsystem have been supplemented in line with the Standard Nuclear Performance Model[7]. The changes affect the areas of work management and supply chain. Further changes will impact the areas of equipment reliability and configuration management, and their implementation is expected in 2026 once the necessary conditions are in place.

» Reviews

The safety and quality organizations of MVM Paks NPP Ltd. exercise internal oversight over the activities of the implementing organizations and their suppliers.

The reviews partly involve the approval of documents defining the conditions for execution and the on-site supervision of implementation. In addition, the reviews, in the form of audits, analyse the systemic and practical enforcement of the requirements defined for a given operational area.

Organizations and process owners carry out the evaluation of the operational efficiency of the organizations they manage, or the processes they are responsible for, within the framework of a self-assessment process.

The suppliers of the Paks Nuclear Power Plant are evaluated and qualified based on the safety relevance of their activities. The qualification and/or evaluation procedure, in a planned and documented manner, verifies compliance of the suppliers' quality management systems with the requirements, as well as the effectiveness of their operation.

□ The Management System of Paks II. Ltd.

» Structure of the Integrated Management System

Paks II. Ltd., as an organization holding a nuclear facility license, shall establish, operate, and continuously develop an integrated management system. The requirements of this system are defined in the manual, the internal regulations, the process instructions, and the work instructions.

Paks II. Ltd. is responsible for those processes and for the services arising from them that are partly or entirely provided by external suppliers or subcontractors. The differentiation of processes, as well as the related products and services, is carried out based on their significance from the perspective of safety.

The management has formulated and announced the following policies:

— Safety Policy,
— Quality Policy,
— Training Policy,

[7] The Standard Nuclear Performance Model, developed by the Institute of Nuclear Power Operators (INPO) and the Nuclear Energy Institute (NEI).

- Information Security Policy,
- Integrated Risk Management Policy,
- Energy Management Policy,
- Corporate Compliance Policy,
- Communication Policy,
- Alcohol and Drug Policy.

The operating model of Paks II. Ltd. was developed based on the competencies and functional divisions required for the effective performance of tasks related to the construction of the new nuclear power plant units, as well as the relevant legal requirements. A distinctive feature of the operating model is its project-based structure, which is implemented as a coordinated programme within the framework of functional organizational units.

» Review Programmes

The method of internal audit is used for the inspection and review of processes. The purpose of internal audits is to continuously monitor and improve operations and the integrated management system, to ensure efficient and high-quality work, and to verify compliance with legal, regulatory, and authority requirements.

The management continuously monitors the achievement of key objectives. In addition to management reports prepared within the framework of operational activities and control points built into processes, the management also evaluates the fulfilment of these objectives separately during the annual management review.

» Suppliers' Review

Paks II. Ltd. has developed and started operating a qualification system in accordance with the applicable legislation for the selection of suppliers, the verification of their suitability, and the continuous supervision of their activities.

Nuclear qualification procedures for activities affecting nuclear safety are carried out using a differentiated approach:

- through the review of requested documents and the performance of an on-site audit, or
- through the review of requested documents without an on-site audit.

Following the qualification of suppliers, the continuous supervision of their activities is carried out in a regulated manner through interlinked procedures.

13.3. Regulatory Review and Control

The HAEA supervises the adequacy of the licensees' management systems through inspection, licensing, and evaluation.

In 2023, within the framework of a comprehensive inspection, the HAEA set up a dedicated working group to conduct a detailed review of the management system of MVM Paks NPP Ltd. In 2022, the HAEA issued a license to MVM Paks NPP Ltd. for modifications to its management system related to the second phase of the PSOD project, which affected the areas of work management and supply chain. Furthermore, the HAEA also evaluates the adequacy of the management system based on the information included in the annual reports.

At Paks II. Ltd., the HAEA carried out a comprehensive inspection in 2023, focusing on processes related to the management system, particularly configuration management, change management, requirements management, and scheduling.

Summary of Significant Changes Since Previous Report

The licensee of the Paks Nuclear Power Plant is modifying its management system in several stages under the PSOD project. The modifications related to work management and the supply chain have been accepted by the authority. In the next step, the licensee plans to introduce changes concerning equipment reliability and configuration management, based on the Standard Nuclear Performance Model.

14. Assessment and verification of safety

Convention on Nuclear Safety, Article 14

> *"Each Contracting Party shall take the appropriate steps to ensure that:*
> *(i) comprehensive and systematic safety assessments are carried out before the construction and commissioning of a nuclear installation and throughout its life. Such assessments shall be well documented, subsequently updated in the light of operating experience and significant new safety information, and reviewed under the authority of the regulatory body;*
> *(ii) verification by analysis, surveillance, testing and inspection is carried out to ensure that the physical state and the operation of a nuclear installation continue to be in accordance with its design, applicable national safety requirements, and operational limits and conditions"*

Summary Statement for Article

Hungary fulfils the obligations under Article 14 of the Convention. Both in the design and in the operation of nuclear facilities, detailed safety assessments are prepared, comprehensively covering all factors affecting safety of the facility. These assessments are submitted to the Authority, which reviews them.

The safety assessments shall be reviewed regularly, taking into account new safety-related knowledge as well as the operational experience of the facility.

The safe operation of the facility, in compliance with legislation and authority requirements, is verified through regular inspections and audits.

In addition, in Hungary the Periodic Safety Review is mandatory every ten years, ensuring a comprehensive examination and verification of the safety compliance of the nuclear facility.

14.1. Assessment of Safety

14.1.1. Main Requirements and Administrative Arrangements

The *ATOMIC ACT* prescribes that the licensee and the nuclear oversight authority shall, within the framework of the PSR, comprehensively analyse and evaluate the nuclear safety of nuclear facilities, the fulfilment of nuclear safety requirements, and the level of risk at regular intervals throughout the entire operating lifetime following the entry into force of the operating license, taking into account operational experience and new safety-related knowledge.

The *NUCLEAR SAFETY DECREE* prescribes that the licensee shall submit a Preliminary Safety Analysis Report to the nuclear safety authority together with the application for a construction license, a preliminary version of the Final Safety Analysis Report together with the application for a commissioning license, and a Final Safety Analysis Report together with the application for an operating license. The decree further prescribes the performance of the PSR every ten years and the submission of the Periodic Safety Report. The content of the reports is prescribed by the decree, and guidance documents provide recommendations on how these requirements shall be

met. The FSAR shall be updated annually and submitted to the authority, and any modification is subject to approval.

The *NUCLEAR SAFETY DECREE* further stipulates that the reports submitted to the nuclear safety authority shall be prepared with such detail and depth as to enable the authority to conduct an independent and substantive review and assessment of the safety-related activities and events carried out by the licensee or its suppliers.

14.1.2. Implementation by licence holder

Paks Nuclear Power Plant

During the construction and commissioning of the Paks Nuclear Power Plant, the Hungarian practice followed that accepted in developed countries. Based on the Technical Design provided by the supplier, the Pre-Construction Safety Report was prepared, followed by the Pre-Commissioning Safety Report, which was intended to serve the role of the FSAR.

In order to examine the differences between the Safety Report and Western requirements, a reassessment of the plant's safety was carried out under the AGNES Project, launched in 1992, which re-evaluated the safety of the Paks Nuclear Power Plant in line with the standards of the 1990s. The AGNES Project did not identify any significant deficiencies, and its conclusion was that the plant could be operated safely. The analyses of the first PSR of the units were based on the results of the AGNES Project, with some additional supplements in certain areas.

Within the framework of the EU-supported PHARE projects, in 2003 the investigations on the suitability of the accident localization system (containment, bubbler condensers) of VVER-440/V-213 type nuclear power plants were completed. The comprehensive investigations demonstrated that the containment type applied at the Paks Nuclear Power Plant VVER-440/V-213 reactors meets the design objectives, namely, in the event of design basis accidents, environmental releases can be kept within regulatory limits.

At the Paks Nuclear Power Plant, the ten-yearly periodic safety review was carried out in 2017, and in 2019 the HAEA issued its resolution on it.

In the continuously developed and extended Level 1 PSA analyses, probabilistic safety assessments were prepared for technology-related initiating events in power and shutdown states, as well as for internal flooding, fire, and seismic initiating events. The average annual core damage frequency was calculated, and sensitivity and uncertainty analyses were performed. Later, all reasonably possible external environmental hazards affecting safety were assessed, followed by the preparation of the probabilistic safety assessment of external hazards and their combinations.

According to the results of the Level 1 PSA, the core damage frequency, taking into account all operational states, internal failures, and internal and external hazards, is below the prescribed value of 10^{-4} per year for operating units (see Figure 2).

The core damage risk from technology-related initiating events has decreased by two orders of magnitude compared to the first assessment, both for operating reactors and for reactors shut down for maintenance and refuelling. The results of the internal hazard and seismic risk analyses are also better than those of the earlier assessments.

Since 2016, a new additive risk has appeared in the results of the internal flooding analysis, which increased the risk originating from internal flooding. The appearance

of the additive factor was due to a novel analytical assumption, namely that flooding, due to the destructive effect of the medium, is also capable of causing damage in adjacent rooms, where equipment failures may increase the core damage frequency. MVM Paks NPP Ltd. initiated a modification to address this issue, and following its implementation, the risk from internal flooding was reduced by the end of 2021 practically to the low level prior to 2016.

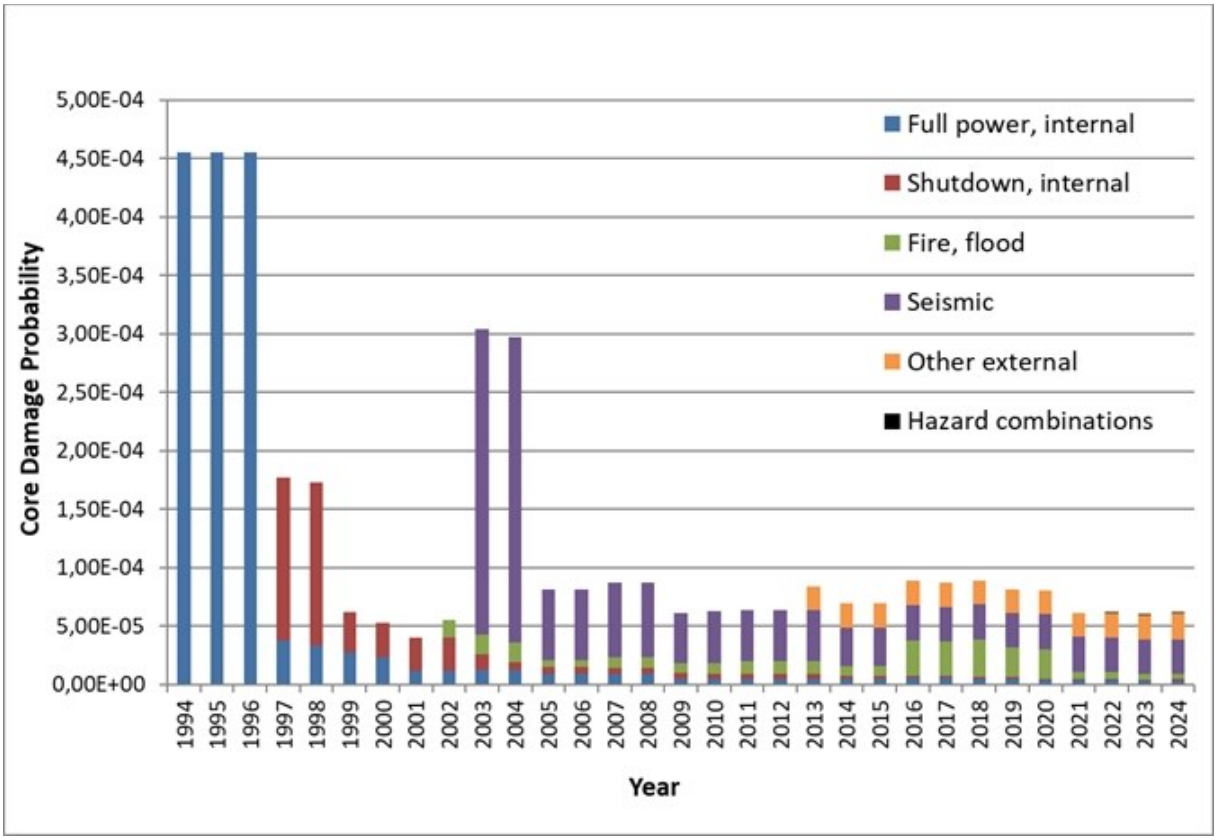
In 2012, the PSA analysis of external hazards other than earthquakes was completed. Since then, follow-up reviews of this analysis have been carried out in several areas. In 2021, the probabilistic assessment of the risk arising from combinations of external events was also completed, the results of which turned out to be significantly lower than the risk from individual external hazards.

The average annual probability of core damage resulting from accident sequences for Unit 3, as the reference unit, is as follows:

- For internal, technology-related initiating events at nominal power operation: $3.3 \cdot 10^{-6}$;
- For internal, technology-related initiating events during shutdown for outage: $1.2 \cdot 10^{-6}$;
- For all operating states, for internal fire and flooding events: $4.4 \cdot 10^{-6}$;
- For all operating states, for earthquakes: $3.0 \cdot 10^{-5}$;
- For all operating states, for external hazards other than earthquakes: $2.2 \cdot 10^{-5}$;
- For all operating states, for combinations of external hazards: $2.0 \cdot 10^{-7}$.

The evolution of the core damage risk due to internal events, as well as internal and external hazards, for Unit 3 between 1994 and 2024 is presented in Figure 2.

Figure 2. The evolution of the core damage risk due to internal events, as well as internal and external hazards, for Unit 3 between 1994 and 2024.



The deterministic accident analyses were carried out for the full design basis. The PSR documentation described the approved methodology of the analyses and presented the results obtained. The list of initiating events covered not only all events considered significant worldwide, but also cases specifically relevant to VVER reactors. The most advanced computer codes were applied in the course of the analyses.

The accident analyses were fully repeated first to justify the uprated thermal power of the units, then for the implementation of modernized fuel containing burnable absorber, as well as for the introduction of the 15-month operating cycle.

In line with the latest international expectations and European Union requirements, analyses were carried out for accidents belonging to the design basis extension conditions, compliance with the criteria was demonstrated, and the safety assessment of external hazards was also completed.

To determine the risk of large radioactive releases, a Level 2 PSA covering all operating states and initiating events previously analysed was completed in 2003, and it has since been reviewed twice. As part of this work, the containment's load-bearing capacity was determined for severe accident conditions in the event of internal pressures significantly exceeding the design values.

As part of severe accident analyses, conclusions were drawn on in-vessel processes and containment phenomena, including the dispersion of radioactive materials, based on the assessment of fundamental accident progressions. On the basis of these analyses, a new severe accident management strategy was defined, along with the scope of modifications required for its implementation. The Severe Accident Management Guideline, incorporating the new strategy, was introduced for Units 1–4, and the necessary modifications for accident prevention, management, and consequence mitigation were carried out (see details in 19.4.2).

In line with Principle 2 of the Vienna Declaration, the Paks Nuclear Power Plant regularly reviews its safety assessments and analyses, both within the framework of the ten-year Periodic Safety Reviews and beyond, based on accumulated experience. Safety improvement measures that are reasonably practicable are identified and implemented.

Paks II.

In connection with the investment in the new units, Paks II. Ltd. obtained the construction license, and the HAEA, by lifting the hold point specified in the license, accepted the revised PSAR as justification of nuclear safety at the plant level.

Following the approval of the revised PSAR, the closure of "*Configuration Baseline 1*" (CB1) was completed, and the Basic Design (BD), which served as the basis of the revised PSAR, was frozen. From this point onward, any deviation in the system- and component-level design processes must trigger a change management process. The framework for this is described in the applicable *Change Management Procedure*. A key element of this procedure from a nuclear safety perspective is the impact assessment of the modification (covering nuclear, fire safety, industrial safety, environmental, structural reliability, and geometrical aspects), and the subsequent classification of the change. Depending on this classification, and applying the principle of graded approach, a nuclear safety analysis is also prepared to accurately evaluate the impact of the change on safety.

14.1.3. Regulatory Review and Control

The HAEA's supervisory activities extend to the detailed evaluation of the safety reports submitted by the licensees, including the PSAR required for construction, the preliminary FSAR required for commissioning, the FSAR required for operation, and the PSR reports required for the periodic safety review.

These documents must demonstrate, covering all operational states, the deterministic and probabilistic safety analyses that justify the safe operation of the facility, which are thoroughly reviewed by the authority.

The largest such evaluation task in the recent period was the assessment of the PSAR for the new nuclear power plant, based on which the HAEA issued the construction license for Paks II. Ltd. in August 2022. For the lifting of the hold point specified in the construction license, Paks II. Ltd. submitted a revised PSAR. Following its review, the HAEA lifted this hold point in November 2024.

During the reporting period, the HAEA also reviewed the modifications to the FSAR of the Paks Nuclear Power Plant within the framework of a modification procedure.

14.2. Verification of Safety

14.2.1. Main Requirements and Administrative Arrangements

The *NUCLEAR SAFETY DECREE* requires that ageing processes and their characteristics be identified for each component classified into a safety class, and that the data and methods necessary for the development of an ageing management programme and system to be implemented during operation be provided. The ageing management system defined by the designer shall be consistent with the maintenance programmes, the qualification of inspections, the environmental qualification of components, as well as with the programmes ensuring the preservation of the qualified state.

For structures, systems and components important to nuclear safety, ageing management requirements must be developed. These requirements shall cover the identification of ageing locations and the ageing processes expected to occur in systems and components important to nuclear safety, the estimation of the expected progression of these ageing processes, the maintenance, surveillance, testing and monitoring activities necessary to manage ageing, as well as the determination of measures to slow ageing and degradation processes and to mitigate their adverse effects.

The *NUCLEAR SAFETY DECREE* further requires the licensee to establish preventive maintenance, testing and surveillance programmes to ensure that systems and components retain the characteristics that meet design requirements.

The maintenance, testing and surveillance programme shall cover activities related to in-service and shutdown inspections, repairs and replacements of parts, overhauls and general maintenance, replacements, post-maintenance adjustments and requalification, including their planning, implementation and evaluation, the authentication of legally significant measurements, the regular inspection and testing of structures, systems and components to demonstrate their reliability and to determine whether they are suitable for the continued safe operation of the nuclear power plant unit or whether corrective measures are needed, as well as the monitoring,

analysis and evaluation of the ageing of structures, systems and components caused by operational effects.

14.2.2. Implementation by licence holder

Programme elements for the continuous verification of safety at the Paks Nuclear Power Plant

» In-service inspections and tests, material testing

The proper technical condition of systems and equipment performing safety functions in nuclear facilities must be maintained. At the Paks Nuclear Power Plant, the appropriate technical condition and functional availability are demonstrated by inspections and tests carried out during operation, by inspections and tests performed in connection with the online maintenance introduced in 2017 and during outages, as well as by the periodic material testing of pressure-retaining equipment and fittings.

» Ageing management programme

The *NUCLEAR SAFETY DECREE* contains separate chapters on ageing management and lifetime management. At the Paks Nuclear Power Plant, the management of equipment ageing is carried out in line with these requirements, with a detailed description provided in Annex II.

» Seismic safety

Between 1996 and 2002, a full seismic safety review was carried out and the necessary reinforcements were implemented. The *peak ground acceleration* (PGA) value was determined to be 0.25g for an earthquake with a frequency of 10^{-4}/year.

The Paks II Nuclear Power Plant is being built on the site of the Paks Nuclear Power Plant, north of the operating facility. In accordance with Hungarian legislation, a comprehensive site survey and assessment was carried out at the Paks II site, based on the results of forty years of investigations and reviews. On this basis, a critical review of the seismic design basis of the Paks Nuclear Power Plant was performed, which resulted in the maximum acceleration used for design purposes being revised from the earlier 0.25g to 0.26g. The calculations carried out in the 1990s and 2000s, which formed the basis for the reinforcement of the plant, were extremely conservative. As a result, the structural response, particularly that of the main building, conservatively covers the response (floor spectra) determined using the updated seismic input. Therefore, this change in the design basis does not require any measures for already reinforced and qualified structures, systems, and components. For newly constructed structures, systems, and components, the updated seismic input is the governing factor.

In addition to the free-field measurement, each twin unit is equipped with three triaxial accelerometers located practically at the foundation slab, as well as three more at structurally and mechanically important points of the reactor's main building. The earthquake monitoring system provides sufficient measurement data for evaluation. In Hungary, 32 permanent seismographic stations are in operation, of which 5 are borehole seismographs (seismometers located at the bottom of a 150-meter lined borehole) and 27 are surface stations (16 broadband and 11 short-period stations). This network includes the 10-station microseismic network of the MVM Paks NPP and the 5-station microseismic network of the Paks II Nuclear Power Plant. The processing and interpretation of their data are carried out in an integrated manner, in accordance with the relevant IAEA recommendations and the requirements of the Hungarian nuclear regulatory authority.

The control and safety rods fall their full length into the reactor within 10 seconds, therefore the automatic actuation of reactor protection is not justified for any earthquake characterized by free-field acceleration and duration. For this reason, and to avoid unnecessary reactor shutdowns caused by spurious signals, the seismic monitoring system does not send a signal to the reactor protection system and does not automatically shut down the reactor. In the event of an earthquake alert, it is the staff who decide whether to shut down the reactor. In line with international recommendations and current practice, the shutdown criterion is defined as exceeding the limit value set for the cumulative absolute velocity and the response spectrum (see IAEA Seismic Report Series No. 66). The OLC and the Emergency Operating Procedure specify the actions to be taken by the staff in the event of an earthquake.

Safety measures related to design by Paks II. Ltd.

Paks II. Ltd. regularly and in a documented manner – in line with its integrated management system – conducts reviews to ensure compliance with the nuclear safety requirements prescribed by legislation, international regulations, and internal rules.

To ensure the adequacy of design and certain manufacturing processes, Paks II. Ltd. took several steps before the process began. On the one hand, the Main Contractor, together with the General Designer, established the management system governing the design process, which includes several key documents (e.g., the Design Manual) that must be adhered to by all parties involved in the design. On the other hand, before commencing design and manufacturing, Paks II. Ltd. continuously verifies and qualifies the competence of participating suppliers. Part of this qualification/competence assessment included the existence and effective operation of a unified management system at the suppliers.

14.2.3. Internal review by the licence holder of safety cases to be submitted to the regulatory body

Paks Nuclear Power Plant

The management system of MVM Paks NPP Ltd. is in line with international and national regulations, and covers and regulates all activities within the licensee's scope of responsibility that have safety relevance. To ensure compliance with the related obligations, it also regulates the preparation, review, and approval of safety reports and assessments. A specific part of the safety assessments concerns the modification of systems and system components of the operating nuclear power plant, where the relevant safety assessments are prepared in accordance with the content requirements of the corresponding license applications.

One of the fundamental principles in the development of the licensee's management system is the principle of a graded approach. By applying this principle, the level of review and approval within each process is determined according to the safety relevance of the given case, activity, or document. Independent professional organizations, separate from the preparers, as well as organizations with a dedicated supervisory function, participate in the review of safety assessments, and independent experts are involved when necessary. The organizations performing independent supervisory functions within the Safety Directorate have a dual role:

— on the one hand, already during the preparation of the safety assessments, typically within company review panels, they ensure that the relevant safety considerations are enforced,

— on the other hand, before submission to the authority, they carry out an independent quality assurance review of every safety assessment to be forwarded, involving independent experts when necessary.

Paks II. Ltd.

For the review and approval of each technical and licensing documentation, Paks II. Ltd. has developed a multi-stage verification system in line with the relevant legislation and regulatory guidelines. In addition to the reviews carried out by the designer and by Paks II. Ltd., an important element of this verification system, in certain cases, is an independent expert review, which is conducted on the basis of strict legal requirements.

The documentation is submitted to the HAEA for approval only after the successful completion of the above-described steps. The corresponding verification levels is presented in Figure 3.

Figure 3. Levels of documentation verification

During the preparation and review of documentation, the Paks II. Ltd. and the Main Contractor regularly assess the lessons learned and feed them back into the processes in the form of corrective measures.

The primary aspect of the verification activities carried out by Paks II. Ltd. is to ensure that the licensee obtains proper justification of compliance with the nuclear safety requirements set out in the applicable legal regulations, as well as with the requirements laid down in the three contracts in force between the Main Contractor and Paks II. Ltd. (see Annex IV), and with the proper application of standards. The general contractor agreement, in addition to Hungarian legislation, relies extensively on the requirements and standards of the IAEA, WENRA, and the *European Utility Requirements for LWR Nuclear Power Plants* Rev. D, as well as on the feedback of construction and operational experience with VVER-type reactor units. Thus, compliance with all available requirements together ensures that the two new nuclear power plant units to be built at Paks will be implemented in line with relevant operational experience and international best practices in terms of nuclear safety and technical solutions.

14.2.4. Regulatory Review and Control

In 2023, within the framework of a comprehensive inspection, the HAEA examined the ageing management and maintenance system of the Paks Nuclear Power Plant through dedicated working groups focusing on electrical and instrumentation and control, mechanical systems, civil engineering, and maintenance effectiveness monitoring.

The HAEA also performs random inspections on the execution of operational tests and trials that serve to demonstrate safety.

As required by the *NUCLEAR SAFETY DECREE*, the technical requirement system for the periodic inspection programmes of pressure-retaining equipment and pipelines serving to demonstrate safety, the periodic inspection programme of the primary circuit, as well as the scope and methods of material testing of safety-classified system components, the acceptance criteria for test results, and their scheduling are subject to approval by the regulatory authority.

The authority continuously monitors the demonstration of safe operation through ad hoc inspections and the evaluation of regular reports submitted by the operating nuclear power plant.

For the current lifecycle phase of Paks II. Ltd., the HAEA has carried out the evaluation of safety demonstration by examining the technical content of the PSAR. In addition, the oversight of safety demonstration is ensured through the evaluation of manufacturing and construction license applications, as well as through ad hoc and regular supervision of manufacturing and construction processes.

Summary of Significant Changes Since Previous Report

Taking into account the results of the site investigation and assessment carried out prior to the construction of the new units, the value of the peak ground acceleration forming the design basis of the Paks Nuclear Power Plant was recalculated, resulting in 0.26g instead of the previous 0.25g. Considering the conservative calculations applied during the earlier seismic safety reinforcement project, the recalculated value did not require any measures for the structures, systems and components.

15. Radiation Protection

Convention on Nuclear Safety, Article 15

> *"Each Contracting Party shall take the appropriate steps to ensure that in all operational states the radiation exposure to the workers and the public caused by a nuclear installation shall be kept as low as reasonably achievable and that no individual shall be exposed to radiation doses which exceed prescribed national dose limits."*

Summary Statement for Article

Hungary complies with the obligations under Article 15 of the Convention. Hungary has established dose limits for radiation exposure, taking into account international standards and recommendations. The Atomic Act stipulates that radiation exposure for both workers and the public must be kept as low as reasonably achievable. To this end, licensees are required to implement appropriate radiation protection measures and to install and operate monitoring and measuring equipment.

The environment of the facility must be continuously monitored, and discharges must be carried out under controlled conditions in accordance with the provisions of the license.

With regard to personal radiation protection, supervision is carried out by the Hungarian Atomic Energy Authority, while the protection of the environment, as well as the monitoring of discharges, falls under the competence of the Baranya County Government Office (BCGO).

15.1. Main Requirements and Administrative Arrangements

The *Atomic Act* stipulates that during the use of nuclear energy it shall be ensured that the annual radiation dose received by workers and the public from all sources does not exceed the dose limit established by the applicable safety regulation, taking into account the most recent verified scientific results as well as the recommendations of international and domestic expert organizations. Furthermore, radiation exposure must always be reduced to the lowest level reasonably achievable, and accordingly the maximum quantity, concentration, and release method of radioactive materials discharged into the environment – defined by their physical, chemical, or other characteristics – must be regulated. The highest reasonably achievable level of safety must be optimized by complying with these requirements.

The licensing tasks related to regulatory radiation protection activities shall be carried out by the HAEA. Discharges and environmental protection fall within the competence of the Capitol and County Government Offices, while regulatory responsibilities concerning the radioactivity of soil, vegetation and foodstuffs fall under the National Food Chain Safety Office, operating under the supervision of the Ministry of Agriculture. The *Atomic Act* shall define the responsibilities of the users of nuclear energy and of the authorities.

15.1.1. Principal legal instruments currently applied in the field of general radiation protection

» Radiation Protection Decree

The Radiation Protection Decree (↪ *HAEA Decree 2/2022. (IV. 29.) on the protection against ionizing radiation and the corresponding licensing, reporting and inspection system*) establishes the fundamentals of radiation protection and the rules of the regulatory activity in radiation protection, following ICRP Publication 103 and the IAEA GSR Part 3 requirements. The regulation complies with the provisions of *Council Directive 2013/59/EURATOM laying down basic safety standards for protection against the dangers arising from exposure to ionizing radiation and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom and 2003/122/Euratom*.

The *Radiation Protection Decree* organizes radiation protection on the basis of the principles of justification, optimization and dose limitation. It requires that a radiation protection organization shall be established in every facility using atomic energy. Every user is obliged to prepare a radiation protection description and a workplace radiation protection regulation, which serve as the supporting documents for the license issued by the HAEA. The decree defines the dose limits for workers and the public, the principles of radiation safety at workplaces, the duties of the radiation protection service, the system of radiation protection training, the conditions of dosimetry control, the personal requirements for carrying out radiation-hazardous activities, and the categorization of radiation-hazardous workplaces. It also lays down the requirements for the application of radioactive materials and the operation of equipment emitting ionizing radiation. Furthermore, it defines the reference levels for indoor radon exposure and for radiation from building materials.

» Care of radiation-injured persons

A ministerial decree (*decree of the Minister of Health 16/2000. (VI. 8.) on the implementation of certain provisions of Act CXVI of 1996 on atomic energy*) regulates the operation of the National Duty Service for Radiological Health and the medical treatment of radiation-injured persons or persons suspected of radiation injury.

» Monitoring of releases

The Releases Decree (↪ *Decree of the Minister of Environment 15/2001. (VI. 6.) on the radioactive releases into the air and into the water during the use of atomic energy, and on their control*) derives the annual release limit from the dose constraint determined by the HAEA. The legally regulated value of the dose constraint for additional radiation exposure of individuals in the most exposed group of the population living near the Paks site is 90 μSv/year for the Paks Nuclear Power Plant and 90 μSv/year for the new units to be constructed. The release restriction system prescribed by the *Releases Decree* compares both liquid and gaseous releases with isotope-specific release limits derived from the dose constraint (90 μSv) established for the nuclear power plant. Compliance with the release limits shall be demonstrated by calculating the release limit criterion.

The release limit shall be derived for each release pathway and for each radionuclide or group of radionuclides that may be released.

Release limit criterion calculation:

$$\sum_{ij} \frac{R_{ij}}{El_{ij}} \leq 1;$$ where:

— El_{ij}: the release limit of radionuclide i for release pathway j (Bq/year);
— R_{ij}: the annual release of radionuclide i for release pathway j (Bq/year).

In the case of the Paks Nuclear Power Plant, the release of radioactive substances into the environment during its activities may take place solely in a regulated and authorised manner, through controlled pathways.[8] For the determination of radioactive releases, a release monitoring system shall be operated, and the release shall be measured and determined in accordance with the requirements laid down in the EMR and in the RMR, which is approved by decision of the BCGO. In addition to the monitoring of radioactive releases, an environmental monitoring system shall also be operated.

» Environmental Radiation Exposure

The *Government Decree 489/2015. (XII. 30.) on the system of control of the environmental radiation situation determining the natural and artificial radiation exposure of the population and on the scope of quantities to be mandatorily measured* contains regulations in line with *Recommendation 2000/473/Euratom* and with *Council Directive 2013/51/Euratom of 22 October 2013, which lays down requirements for the protection of the health of the general public with regard to radioactive substances in water intended for human consumption*.

The Government Decree regulates the operation and tasks of the National Environmental Radiation Monitoring System (NERMS). Its main provisions concern the ambient dose rate of environmental radiation measurable within the territory of the country, as well as the activity concentrations of radioactive isotopes in environmental media, foodstuffs, drinking water, and animal feed, and of radon and radon decay products occurring outdoors and inside buildings. It also defines the collection, analysis, registration, and evaluation of results relating to the internal radioactive contamination of the human body caused by an extraordinary event leading to an unplanned release of radioactive substances into the environment. Furthermore, it includes the regulatory assessment of the radiation situation in the vicinity of priority facilities and lists the institutions and authorities participating in the programme.

» Preparation for radiological and nuclear events

The HNERS Decree (↪ *Government Decree 167/2010. (V.11.) on the National Nuclear Emergency Response System*) concerns the management of, and preparedness for, radiological and nuclear events occurring in the course of the peaceful use of atomic energy, which is ensured by the Hungarian Nuclear Emergency Response System (HNERS). It further provides for the operation of the National Radiation Monitoring, and Alarming System (NRMAS). It defines the central, sectoral, regional and local authorities and organizations involved, as well as their responsibilities.

» Nuclear Safety Decree

The *Nuclear Safety Decree* assigns to the HAEA the technical issues of radiation protection related to nuclear facilities and to the systems and equipment of such facilities. *Annex 1 of the Nuclear Safety Decree* requires the regular analysis of operational radiation protection indicators and the use of the lessons learned in the framework of the PSR. *Annexes 3 and 3A*, within the requirements for the design of nuclear power plants, set out the principles of radiation protection, the provisions on the management of fresh and spent fuel and radioactive waste, as well as the

[8] In compliance with the provisions of Section 9 (1) a) and b), and Section 9 (2) of the *Releases Decree*.

requirements for dosimetry monitoring and measuring instruments, biological shielding, and systems affecting radioactive releases. *ANNEX 4 OF THE NUCLEAR SAFETY DECREE*, on the requirements for operation, also lays down the requirements for carrying out and documenting radiation protection activities. The same volume also addresses the requirements related to the management of nuclear fuel and radioactive waste.

15.1.2. Provisions of radiation protection regulation

The main framework of radiation protection regulation is provided by the *ATOMIC ACT* and the *RADIATION PROTECTION DECREE*. The central element of the system is the ALARA principle ("As Low As Reasonably Achievable"), according to which radiation exposure shall be optimized to the lowest level reasonably achievable, taking into account economic and social factors.

The *RADIATION PROTECTION DECREE* specifies the radiation protection requirements for nuclear facilities, including the obligation to determine dose constraints and the system of public protection.

» System of dose limitation

Table 4 summarizes the dose limits defined in the *RADIATION PROTECTION DECREE*.

Table 4. Dose limits

Limited quantity	persons exposed to radiation		
	Workers (over 18 years of age)[9] [10]	Apprentices and students (between 16 and 18 years of age)[11]	Members of the public[12]
Effective dose[13] [14] [15]	20 mSv/year	6 mSv/ year	1 mSv/ year

[9] The dose limits shall apply to the sum of workers' annual occupational exposures resulting from all authorized practices, to occupational radon exposure at workplaces, and to other occupational exposure situations arising from existing exposure situations.
[10] Pregnant women, as well as women who have recently given birth or who are breastfeeding, shall not be employed as workers exposed to radiation from the time they notify the employer of this fact.
[11] Apprentices and students who have reached the age of eighteen, and who, in the course of their studies, are required to work with radiation sources, shall be subject to the occupational dose limits. Apprentices and students under the age of sixteen shall be subject to the public dose limits.
[12] The public dose limits shall apply to the sum of exposures received by members of the public in a given year from all authorized practices, but shall not apply to medical exposures.
[13] The HAEA may, in a given year, authorize an effective dose exceeding the annual limit but not greater than 50 mSv, provided that over any consecutive five-year period the average dose does not exceed 20 mSv.
[14] At the employer's request, and based on the opinion of the Chief Medical Officer, the HAEA may authorize an additional effective dose of up to 10 mSv per year, if the worker gives written consent and the employer demonstrates compliance with the requirements of the justification principle.
[15] Except in emergency situations, the HAEA may also approve that certain designated workers exceed the prescribed occupational dose limits, provided that such exposures are time-limited, restricted to specifically defined work areas and tasks, and do not exceed the exposure limits established by the HAEA for the given case.

Equivalent dose to the lens of the eye	20 mSv/ year	15 mSv/ year	15 mSv/ year
Equivalent dose to the skin, averaged over any 1 cm^2 area of skin	500 mSv/ year	150 mSv/ year	50 mSv/ year
Equivalent dose to the extremities	500 mSv/ year	150 mSv/ year	–
Effective dose over the entire lifetime	400 mSv/lifetime	–	–

In an emergency, the reference level for the effective dose to persons participating in the mitigation of the consequences of an accident is 50 mSv, 100 mSv, or 500 mSv, depending on the severity of the mitigated or prevented event. However, if the projected dose exceeds 100 mSv effective dose, the mitigation activity may only be undertaken on a voluntary basis.

15.2. Implementation of radiation protection programmes by the licence holders

Paks Nuclear Power Plant

» Annual radiation exposure

According to the WRPR of MVM Paks NPP Ltd., workers employed in radiation-hazardous positions – both the plant's own employees and those of external companies – are assigned to either radiation protection category "A" or "B" based on their expected annual radiation exposure. The external exposure of category "A" workers[16] is monitored with regulatory dosimeters, while that of category "B" workers[17] is monitored with workplace dosimeters. In the regulatory dosimetry system, thermoluminescent (TL) dosimeters are used. In addition, work-level neutron dosimeters and local dose meters are also employed for supplementary measurements. To complement the regulatory dosimetry, the internal rules of MVM Paks NPP Ltd. prescribe that all workers in the controlled zone of the health building must also wear an electronic operational dosimeter.

The maximum individual annual doses of workers and the collective doses, as measured by regulatory dosimetry, are presented in Figure 4 and Figure 5.

[16] Category "A" includes exposed workers whose radiation exposure may exceed an annual effective dose of 6 mSv, or an annual equivalent dose of 15 mSv to the lens of the eye, or 150 mSv to the skin or to the extremities.
[17] Category "B" includes exposed workers who do not fall into Category "A."

Figure 4. Maximum individual annual doses based on regulatory dosimetry monitoring

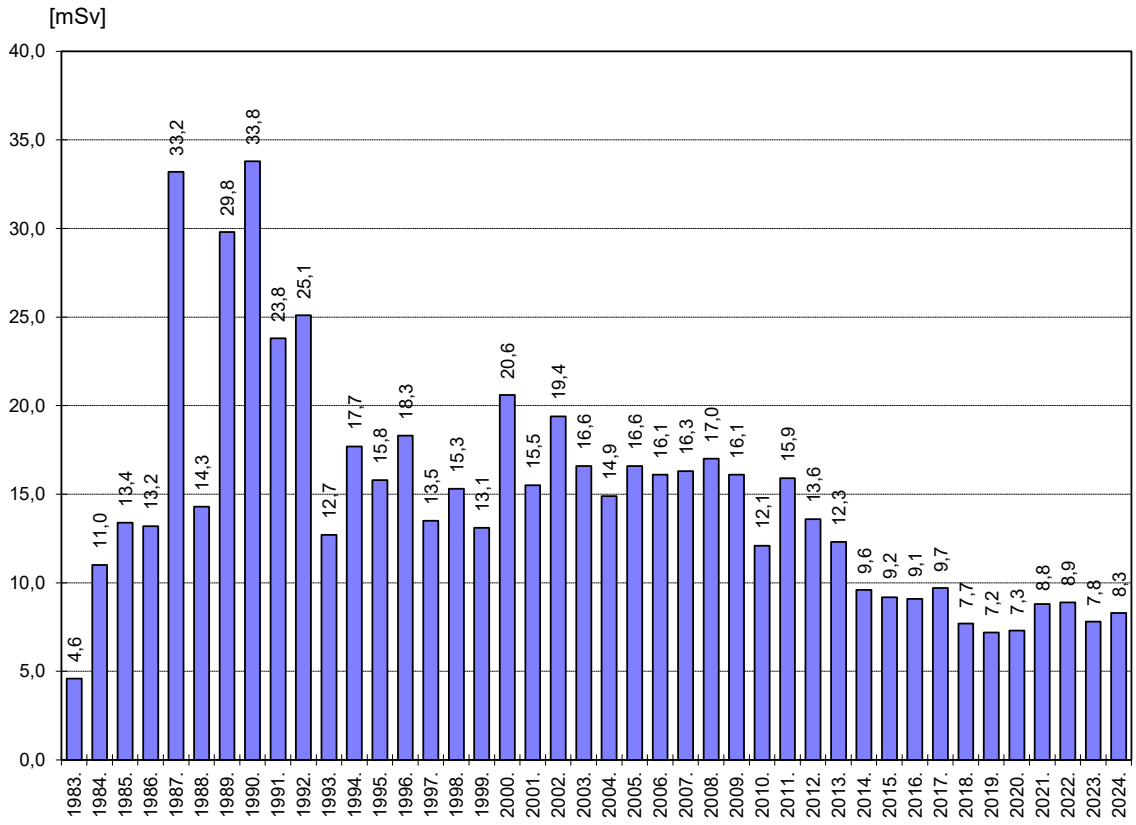
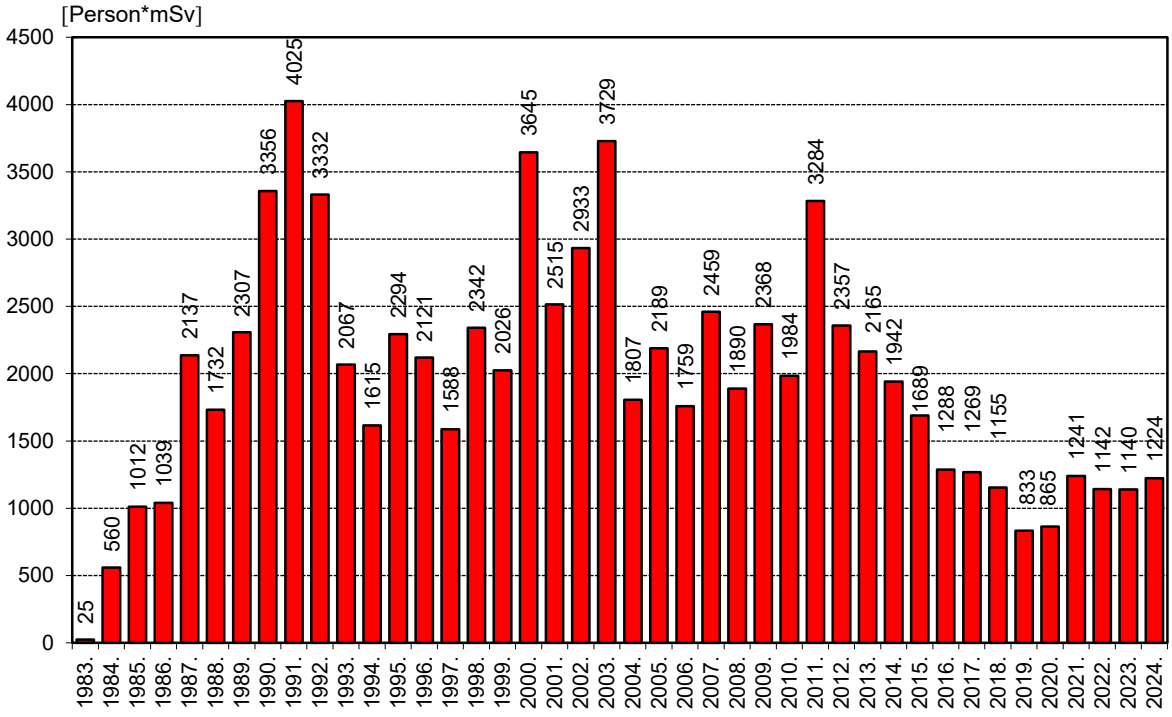


Figure 5. Annual collective doses based on regulatory dosimetry monitoring



The collective dose of workers classified in radiation protection category "B" was 36.2 person·mSv in 2022, 56.6 person·mSv in 2023, and 66.7 person·mSv in 2024.

» Exposure during outages

At the Paks Nuclear Power Plant, the majority of personnel radiation exposure occurs during outage periods in connection with the outages. Given that only a minor fraction of exposure arises from reactor operation itself, it is appropriate to assess personnel doses by analysing the exposures received during outages.

Dose planning, radiation protection licensing of individual outage tasks, and the determination of necessary protective measures are based on the extensive radiation monitoring programme carried out by the radiation protection division at the start of each outage, immediately after reactor shutdown, in the vicinity of major equipment and in the rooms affected by outage activities. The data obtained on radiation conditions can also be used in planning the following year's outage doses.

Radiation exposure of personnel engaged in maintenance and related activities during outages is determined from the dosimetry data of the Paks Nuclear Power Plant.

The collective doses for the years 2022–2024 are shown in Table 5.

Table 5. Radiation exposure of maintenance personnel between 2022 and 2024

unit/year	Collective dose [person*mSv]		
	2022	2023	2024
1.	426	169	-
2.	-	153	165
3.	127	446	174
4.	110	-	457

The internal radiation exposure is regularly monitored by whole-body counting, thyroid measurements, and tritium excretion tests carried out by MVM Paks NPP Ltd. Internal exposure generally represents only a very small fraction of the workers' annual radiation dose. In 2022, 2023, and 2024, no worker reached the investigation level of 0.1 mSv. The tritium activity concentrations in urine that reached or exceeded the recording level of 2.5 Bq/cm^3 are shown in Table 6.

Table 6. Tritium concentrations in urine exceeding the recording level of 2.5 Bq/cm^3

Year	Number of events	Max. concentration [Bq/cm^3]	Max. committed effective dose [μSv]
2022	7	6.4	13
2023	6	5.7	12
2024	5	5.59	8.7

The plant itself organizes the dosimetry monitoring of employees of external companies working under its employment.

In summary, it can be stated that since the start of its operation, no exceedance of the regulatory dose limits has occurred at the Paks Nuclear Power Plant. Personnel radiation exposure remains at an appropriately low level in international comparison.

» Application of the ALARA principle

At the Paks Nuclear Power Plant, radiation protection optimization is ensured through administrative and technical measures.

The technical measures include those aimed at providing shielding by distance, reducing radiation fields, and minimizing the time spent in radiation areas. Among the technical measures, the outage cooling plan applied during outages should be mentioned, the purpose of which is to favourably influence the deposition of corrosion products during cooldown.

Since the majority of collective doses occur during outages, the expected collective dose of maintenance activities significant from a radiation protection point of view, as well as the radiation protection measures required to reduce doses, are analysed and optimized before the outages. Following the outages, the effectiveness of the radiation protection measures is evaluated, and, if necessary, further corrective radiation protection measures are implemented for subsequent outages.

The preparation of high-radiation-risk tasks essentially involves the development of a qualitative ALARA programme for those activities where the radiation conditions of the work area (>4 mSv/h) or the nature of the activity justify it. These programmes include all technical and administrative measures necessary to optimize the activity from the perspective of radiation protection.

» Atmospheric and liquid releases

The utilization of the release limits for the past three years is presented in Table 7. The data in the table clearly show that the releases were very low.

Table 7. Utilization of the release limits of the nuclear power plant for the four units

Year	Number of operating units	Limit utilization [%]
2022	4	0.32
2023	4	0.37
2024	4	0.33

The site of the Paks Nuclear Power Plant is divided, from a radiation protection perspective, into a free zone and a controlled zone. In the free zone, the radiation level shall not exceed 1 μSv/h. Within the controlled zone, rooms are classified into three categories according to the permitted radiation level and surface contamination: manageable, conditionally manageable, and non-manageable rooms. Continuous radiation protection monitoring of the plant site is carried out using a fixed radiation protection system with 625 measurement channels, which covers the measurement of room dose rates and airborne activity concentrations, as well as the determination of the activity of various technological media. The detector signals are transmitted to the Dosimetry Control Room, where visual displays and acoustic alarms (warning and emergency levels) are applied, and the measurement results are displayed and archived by computer. In addition to the fixed system, on-site measurements and sample-based laboratory measurements are also performed.

The monitoring of the plant's operational releases and its environment is carried out in two main ways:

— The on-line system includes remote measuring devices installed at various locations, such as the chimneys (for the measurement of aerosol, iodine, noble gas activity, and air flow), the water monitoring stations (for total gamma

activity concentration), the meteorological monitoring systems, and the environmental monitoring stations located within about 1.5 km around the plant. These stations are of type A (measuring airborne aerosol and iodine activity concentration, as well as gamma dose rate) and type G (measuring gamma dose rate).

— The off-line laboratory measurements serve to refine and verify the continuous data provided by the remote monitoring systems.

The measurements of the remote monitoring systems are supplemented by isotope-specific laboratory analyses carried out with sensitive techniques on a large number of samples taken from releases and the environment. At the stations, off-line measurements are performed for deposition, grass, soil, aerosol, iodine, carbon-14, atmospheric tritium activity, and dose (using thermoluminescent dosimeters).

In addition, so-called type C sampling stations are located within a 30 km radius of the Paks Nuclear Power Plant, where thermoluminescent dosimeters are installed. Their regular replacement and evaluation form part of the environmental monitoring programme. Beyond this, a wide range of environmental sampling (water, sludge, fish, plants, milk, soil) is also carried out in the plant's surroundings. Based on the measurement results so far, nuclear power plant-derived radioisotope activity in the environment has only been detectable in a few cases, and even then at such low levels that the resulting additional public radiation exposure does not reach the order of nSv/year.

The monitoring of releases and the environment is also carried out independently of the plant's own monitoring system by the competent authorities, who obtain essentially similar results.

Radiation protection activities at Paks II. Ltd.

The current tasks of the radiation protection organisation include the review of technical design documentation, as well as the establishment of the technical and administrative conditions necessary to fulfil facility-related radiation protection duties, in close professional cooperation with MVM Paks NPP Ltd., which operates the existing units.

At the construction site, radiation protection supervision of works involving the use of radioactive sources has become necessary. The required instruments and equipment have been procured, ensuring the material conditions for control activities. The instruments are regularly calibrated and maintained by the radiation protection organisation. A regulatory document concerning radiographic inspections has been prepared, based on which the radiation protection organisation carries out ad hoc on-site inspections at the construction area.

The radiation protection organisation currently consists of four staff members, each holding radiation protection expert qualifications as required by regulation. In total, ten persons have such authorisation, and a radiation protection officer has also been appointed.

15.3. Regulatory review and control

» Personal radiation protection

The approval of the HAEA is required for any modification of the WRPR. In this framework, the HAEA reviews compliance with radiation protection requirements,

including the adequacy of optimisation methods, the process of demonstrating justification, and the application of appropriate limits. Within the radiation protection programme, the WRPR serves as the fundamental document of radiation protection regulation.

The HAEA carries out general-purpose radiation protection inspections during outages, in which it examines compliance with legislation and internal rules, performs inspections with measuring instruments to verify contamination and dose conditions, and reviews the proper calibration of measuring instruments. In addition to these general inspections, the HAEA also conducts random inspection of work activities. These include verifying compliance with the conditions set out in dosimetry permits, such as the use of personal dosimeters and individual protective equipment, the availability of required approvals, and the adequacy of radiation protection measuring instruments (hand-foot monitors, radiation gates, deployed measuring devices).

The HAEA evaluates radiation protection activities through regular reports (quarterly, annual), which include the review of differences between radiation protection planning and measured values, as well as the development of radiation exposures associated with maintenance and modification activities.

» Environmental and release monitoring

Based on the *RELEASES DECREE,* the BCGO verifies compliance with the provisions concerning radioactive releases and their environmental impact, conducting inspections at nuclear facilities on a quarterly basis. These inspections may only be carried out with the involvement of a laboratory accredited for such examinations. Facilities, in accordance with the RMR, must provide for sampling required for regulatory oversight, on-site measurements, and supply samples to the Laboratory Division of the Public Health Directorate of BCGO. Radiological examinations of all environmental media are carried out by this Laboratory Division.

Nuclear facilities are required to submit an annual report by 31 March of the following year, in the form and with the content defined by legislation, and in addition to these annual reports, they must also prepare quarterly interim reports.

By 15 December of the preceding year, nuclear facilities must notify BCGO in writing of their planned annual operating schedule, releases and their monitoring, as well as any planned events or measures that may affect environmental monitoring.

The submitted reports contain aggregated measurement results of releases and their limits. In addition to annual inspections, the environmental authority, together with the Laboratory Division, also performs on-site regulatory inspections on a quarterly basis. During these inspections, the results measured by the Laboratory Division are compared with the release data provided by the facility, and the findings are recorded in official records. If the release data do not comply with the release limit criteria defined in the currently valid license, the BCGO may initiate proceedings against the facility.

Summary of Significant Changes Since Previous Report

In relation to this Article, no significant changes occurred in Hungary during the reporting period.

16. Emergency Preparedness

Convention on Nuclear Safety, Article 16

> *"1. Each Contracting Party shall take the appropriate steps to ensure that there are on-site and off-site emergency plans that are routinely tested for nuclear installations and cover the activities to be carried out in the event of an emergency. For any new nuclear installation, such plans shall be prepared and tested before it commences operation above a low power level agreed by the regulatory body.*
> *2. Each Contracting Party shall take the appropriate steps to ensure that, insofar as they are likely to be affected by a radiological emergency, its own population and the competent authorities of the States in the vicinity of the nuclear installation arc provided with appropriate information for emergency planning and response.*
> *3. Contracting Parties which do not have a nuclear installation on their territory, insofar as they are likely to be affected in the event of a radiological emergency at a nuclear installation in the vicinity, shall take the appropriate steps for the preparation and testing of emergency plans for their territory that cover the activities to be carried out in the event of such an emergency."*

Summary Statement for Article

Hungary fulfils its obligations under Article 16 of the Convention. According to the relevant legislation, nuclear facilities regularly verify the availability of the personnel, equipment, and organisational conditions necessary for the effective management of a potential emergency, in line with the Emergency Preparedness Plans approved by the Authority.

Emergency situations in Hungary are addressed by the Hungarian Nuclear Emergency Response System, which is supported by a detailed, pre-established procedure (Hungarian Nuclear Emergency Response Plan). This plan includes the prompt and accurate communication of information to the public and the notification of neighbouring countries, in compliance with international obligations.

Hungary also places strong emphasis on practical implementation: the national nuclear emergency response system is regularly tested and improved through domestic and international exercises, ensuring adequate response capability in the event of a nuclear emergency.

16.1. Emergency Plans

16.1.1. Measures and regulatory requirements

According to the *ATOMIC ACT* responsibilities related to nuclear emergency response fall under the minister in charge of disaster management. At the highest level of the technical regulatory framework for nuclear emergency response activities stands the Hungarian Nuclear Emergency Response Plan (HNERP), which is approved by the Chair of the Disaster Management Coordination Inter-Ministerial Committee (DMCIC), the minister of the interior.

The structure of the national disaster management system, the prevention, preparedness, and response tasks of the ministers and state bodies involved in disaster

management, as well as the responsibilities of the governmental coordination body for disaster management, are regulated by *ACT CXXVIII OF 2011 ON DISASTER MANAGEMENT AND THE AMENDMENT OF CERTAIN RELATED ACTS*, its implementing regulation *GOVERNMENT DECREE 234/2011. (XI. 10.) ON THE IMPLEMENTATION OF ACT CXXVIII OF 2011 ON DISASTER MANAGEMENT AND THE AMENDMENT OF CERTAIN RELATED ACTS,* and *GOVERNMENT RESOLUTION 1150/2012. (V. 15.) ON THE ESTABLISHMENT OF THE DISASTER MANAGEMENT COORDINATION INTER-MINISTERIAL COMMITTEE AND THE DEFINITION OF ITS ORGANIZATIONAL AND OPERATIONAL RULES*.

The *ATOMIC ACT* stipulates that the user of nuclear energy shall take all necessary measures to prevent a nuclear or radiological accident and to mitigate its consequences, shall develop a Nuclear Emergency Response Plan, have it approved by the competent authorities, and shall establish the personal, material, and organizational conditions for effective nuclear emergency response and regularly ensure their availability. The licensee shall inform the public and the competent authorities of any extraordinary event.

Based on the *ATOMIC ACT*, the nuclear regulatory authority, by organizing, preparing, and operating the emergency response organization, fulfils the nuclear emergency response tasks defined for it by regulation, as well as those rapid notification, liaison, and regulatory tasks related to nuclear accidents that stem from membership of the European Union, from international conventions on early notification of nuclear accidents and on assistance in the case of a nuclear accident or radiological emergency promulgated by regulation within the framework of the International Atomic Energy Agency, and from related bilateral international agreements.

16.1.2. Operation of the Hungarian Nuclear Emergency Response System

The structure and tasks of the Hungarian Nuclear Emergency Response System (HNERS) are laid down in the *HNERS DECREE*. The tasks related to the management of HNERS, the preparation of Government decisions concerning disaster management, and the sectoral coordination of emergency response tasks are carried out by the DMCIC.

In normal periods, the organizations of HNERS perform preparedness, standby, and exercise activities. In addition, the organizations concerned also carry out continuous measurement data and information collection, radiological data exchange, as well as planning, information, and cooperation tasks.

The alert and notification of HNERS are carried out by the central body of the professional disaster management service, MoI NDGDM.

In a nuclear emergency, the nationwide coordination of the implementation of tasks ensuring the radiological protection of the population is performed by MoI NDGDM. The professional decision-preparation is the responsibility of the DMCIC Nuclear Emergency Response Working Committee (DMCIC NERWM), directed and operated by HAEA.

The execution of nuclear emergency response tasks is the responsibility of the head of the nuclear installation within the facility, at national level the chair of the DMCIC, and in the counties and in the capital the chair of the territorially competent Territorial Defense Committee.

The chair of the Territorial Defense Committee is the incumbent Chief County Officer of the County Government Office, while in disaster management his deputy is the head of the territorial body of the professional disaster management organization.

To provide the information required for the decision-preparation and decision-making activities of the DMCIC, the NRMAS also operates, which is responsible, among other things, for the continuous monitoring of the national radiological situation, as well as for the collection, verification, analysis, evaluation, and signalling of radiological data.

The tasks of the NRMAS – whose central body is the Nuclear Emergency Information and Evaluation Centre (NEIEC) operating within the MoI NDGDM – include the continuous monitoring, signalling, and verification of the national radiological situation, as well as providing the basis for alerting and notification in line with the operating status of the HNERS, by maintaining the conditions for national nuclear emergency early warning.

In the event of a nuclear emergency, the evaluation of the nuclear safety and radiological protection situation is the responsibility of the user of atomic energy and the HAEA. Based on the data and information provided for the evaluation, the HAEA Emergency Response Organisation and the MoI NDGDM NEIEC develop proposals for protective actions for the population. The MoI NDGDM carries out the early warning tasks based on the continuous monitoring of the national radiological situation. It also hosts the RODOS nuclear emergency decision support system *(Real-time, On-line, Decision Support System – RODOS)*, developed with the support of the European Union, and the national centre of the international radiological monitoring data exchange system.

16.1.3. Hungarian Nuclear Emergency Response Plan

The regular review of the HNERP is carried out by a High-Level Working Group operated by the HAEA with the involvement of the relevant governmental bodies, while the HNERP is approved by the Chair of the DMCIC.

In December 2023, the High-Level Working Group issued the revised HNERP and, in order to develop more detailed technical regulations and guidance reflecting best practices to be followed, also considered the possibility of reviewing the individual guides and professional aids related to certain chapters and annexes of the HNERP. The currently valid guides and professional aids are:

- Legal basis of the HNERP;
- Protective strategy underpinning the introduction of public precautionary measures;
- Critical tasks of the HNERS;
- Assessment of the critical tasks of the HNERS;
- Organized assistance in emergency response.
- Structure and operation of the NRMAS;
- Accident monitoring strategy;
- Planning work related to preparedness by the organizations participating in HNERS;
- Communication among the organizations participating in HNERS;
- Development and continuous maintenance of Organizational Nuclear Emergency Response Plans;
- Preparation, execution and evaluation of nuclear emergency response exercises;

— Preparation, conduct and evaluation of HNERS alert drills;
— Local management of radiological emergencies;
— Organization of the treatment and care of radiation-injured persons.

16.1.4. Nuclear Emergency Response System of the Nuclear Power Plant

The emergency response preparedness of the Paks Nuclear Power Plant is integrated into the Hungarian Nuclear Emergency Response System, its framework being defined by the Comprehensive Emergency Management and Response Plan (CEMRP).

One of the starting points for preparing for emergency scenarios is the system of emergency classes, which is based on predetermined, measurable technical and radiological parameters and characterises the severity of an emergency. Classification into a given emergency class is followed by the implementation of specific measures. This system supports the consistent national and international interpretation and management of the severity of an emergency.

In the event of an emergency, measures determined according to the emergency classification must be introduced, or preparations made for their implementation, within concentric zones of varying radii around the nuclear power plant. Of the three planning zones, the innermost is the 3-kilometre "precautionary action zone", where protective measures must be prepared for immediate implementation even before the onset of an emergency. This is surrounded by the 30-kilometre "urgent protective action planning zone", followed by the largest, the 300-kilometre "food consumption restriction zone". For the latter two zones (and for the Hungarian territory within the 300-kilometre zone), legislation and the HNERP set out the general radiological protection criteria and derived intervention levels, which must be taken into account in defining the protective actions to be applied in the event of an emergency.

The assessment of the radiological situation is supported by the power plant's real-time, on-line computer-based dispersion calculation software, which, taking into account release data, measured environmental radiation levels, and meteorological parameters, calculates both the expected and the avoidable radiation exposure, including cases of simultaneous or staggered multi-unit releases.

The 30-kilometre urgent protective action planning zones of foreign nuclear power plants located near Hungary's borders do not extend into Hungarian territory. Within the surrounding 300-kilometre food consumption restriction zones, the same radiological protection general criteria and derived intervention levels apply as in the corresponding planning zone of the Paks Nuclear Power Plant.

» Comprehensive Emergency Management and Response Plan of MVM Paks NPP Ltd.

The main document governing nuclear power plant emergency preparedness is the CEMRP of MVM Paks NPP Ltd. The plan has a modular structure: in addition to regulating general operations, it contains separate modules for handling various types of emergencies, such as nuclear emergencies, general disaster situations, fires, and civil protection emergencies. The plan sets out the organisational and technical measures required to assess, mitigate, and respond to emerging emergency situations.

The plan, based on the assessment of emergency situations, defines the current emergency planning category, the structure and procedures of emergency management and leadership, the composition and functioning of the plant's Emergency Response Organisation, and the emergency duties assigned to individual positions. It

specifies emergency response scenarios, setting out the tasks to be performed during an emergency, together with the required resources and equipment. To enable the rapid establishment of the Emergency Response Organisation, the plant maintains an appropriate alert system.

The plan sets out the procedures for internal and external alerting and notification, as well as the operation and verification of the communication systems required for this purpose. The protection of personnel, including mustering, evacuation, decontamination, and protective measures, is strictly regulated. The plan also contains an inventory of the material and technical assets available for emergency response. Detailed regulations for individual tasks are set out in the plan's modules, associated procedures, and implementing instructions. The plan further specifies the arrangements for the training, instruction, and regular exercises of staff.

The CEMRP is regularly reviewed and revised on the basis of lessons learned from exercises and in response to changes in domestic and international requirements.

Under the cooperation agreement between Paks II. Ltd. and MVM Paks NPP Ltd., during the construction phase the emergency management tasks are carried out by MVM Paks NPP Ltd., while Paks II. Ltd. has fulfilled the tasks assigned to it.

16.1.5. National framework for preparedness and exercises

International, national, on-site and off-site exercises are conducted at defined intervals, based on long-term and annual planning.

Hungary, as a member of the OECD Nuclear Energy Agency, regularly participates in INEX international nuclear emergency exercises, in various levels of ConvEx nuclear emergency exercises organized by the IAEA, as well as in exercises conducted under the framework of the European Union's ECURIE *(European Community Urgent Radiological Information Exchange)* system.

According to the annual training and exercise plan approved by the DMCIC, the various organizations of the HNERS participate in the following types of exercises:

- alert drills, aimed at checking the vigilance and operational readiness of the contact points of the organizations, as well as the availability of their personnel;
- thematic exercises, in which a specific HNERS organization performs and practices its emergency tasks on the basis of a prepared accident scenario, without the involvement of the others;
- full-scale exercises, during which the entire HNERS staff is engaged;
- in addition to the above, the HAEA regularly participates in international communication tests initiated by the European Commission, the IAEA, and neighbouring countries.

In addition to the above, individual sectors also hold partial and full-scope exercises independently of central coordination. The sectoral emergency response plans prescribe regular tests to verify the reliability of communication links.

The entire staff of nuclear facilities and radioactive waste repositories is trained for emergency tasks. Members of the facility emergency response organizations receive regular training for their specific duties. Facility-level exercises are conducted on the basis of an annual training and exercise plan prepared under the long-term programme, submitted to the HAEA, and reviewed by the HAEA. The exercises can be

grouped according to their objectives (training or verification), the participating staff (complex, table top, or partial exercise), and the manner of their initiation (announced or unannounced). In the preparation of full-scope or command post exercises, facilities may also involve off-site emergency response organizations in order to practice cooperation.

In recent years, national nuclear emergency response exercises based on the exercises conducted at the Paks Nuclear Power Plant have confirmed the adequacy of the disaster management and national nuclear emergency response regulatory framework.

» International exercises

The HAEA regularly participates in international exercises. During the reporting period, the HAEA took part in the following international exercises, ranging from communication tests to full-day exercises:

— ComTest2022 (bilateral agreement states and the European Union),
— ConvEx 2a - 2022,
— ECUREX - 2022,
— ComTest2023 (bilateral agreement states and the European Union),
— ECUREX 2023,
— ConvEx 2a - 2023,
— ECUREX-BE 2023,
— RODOS User Group - Short Exercise - 2023,
— ConvEx 2c - 2023,
— INEX-6 - 2024,
— ConvEx 2a - 2024,
— ConvEx 2b - 2024,
— ECUREX - 2024.

16.1.6. Regulatory Oversight Activities

The HAEA supervises emergency response exercises with the aim of verifying that the licensee properly implements the requirements set out in the legislation and in the plans.

Amendments to the CEMRP are subject to authorization; the most recent amendment of the CEMRP of Paks Nuclear Power Plant took place in 2024 and was approved by the HAEA.

At the beginning of each year, the licensee submits to the HAEA the annual training and exercise plan as well as the evaluation of the previous year's training and exercises, which the HAEA reviews.

16.2. Information of the Public and Neighbouring States

16.2.1. Public Information System in a Nuclear Emergency and Media Relations

In the event of an emergency, public warning is carried out through the disaster management system and the national public service media. Within a 30 km radius of the Paks Nuclear Power Plant, the disaster management authority operates an installed acoustic warning and information system. A total of 228 modern public warning and

information devices are in operation across 74 municipalities. The acoustic endpoints are equipped with uninterruptible local power supply, ensuring operability even in the event of a power outage. The high-performance loudspeakers are capable not only of emitting siren sounds but also of broadcasting pre-recorded announcements in up to seven languages, as well as live voice messages. The system can be activated on the order of the chairpersons of the three affected county assemblies from the Paks NPP Protected Command Centre, the Backup Command Centre completed in 2024 as a result of TSR measures, the plant's control room, mobile devices, the National Directorate General for Disaster Management (NDGDM) Central Duty Office, or the Tolna County Disaster Management Directorate Duty Office. Hungary also operates an SMS-based public warning and emergency information system. In an emergency, national public service media are responsible for disseminating information, but the nuclear power plant is also prepared to issue press releases, coordinated with the HAEA, and to provide information to the public through local and national radio, television, and newspapers. Additionally, mayors of municipalities within the plant's vicinity, as well as authorities involved in emergency response, receive SMS notifications of certain events related to the plant in order to ensure rapid information flow.

Hungary conducts bilateral radiological monitoring data exchange with Austria, Croatia, Slovenia, and Slovakia among the neighbouring countries.

With the support of MVM Paks NPP Ltd., the municipalities in the surrounding area have established the Social Control and Information Association, which serves as a platform for more direct consultation between the plant and the affected municipalities, while also contributing to public information and emergency preparedness. Through its established relations with local and national media, MVM Paks NPP Ltd. provides regular updates to the public on its emergency preparedness and response activities.

In the event of a nuclear emergency occurring near Hungary's borders, the central bodies of the national emergency response system inform the public about the situation and the necessary protective actions through the public service media, based on information received from partner authorities.

To further strengthen public awareness, the MoI NDGDM has developed the Emergency Notification Service (ENS) application for smartphones and tablets, which is available free of charge. With this tool, users can instantly access real-time information on the current situation, warnings, and alerts concerning their place of residence, travel destination, monitored routes, counties, or even the entire country.

In addition to the mobile application, both the MoI NDGDM and the HAEA operate Facebook pages, which allow them to quickly disseminate important information to a wide audience. Through these platforms, citizens can also gain insight into the organizations' daily activities, learn more about disaster prevention, emergency response efforts, and the regulatory aspects of the peaceful use of nuclear energy.

16.2.2. Notification of Neighbouring Countries

» International Conventions

Hungary was among the first to sign the following international conventions established in 1986:

— the Convention on Early Notification of a Nuclear Accident,

— the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency.

For the purpose of preparing for the implementation of the convention, the IAEA established the international *Response Assistance Network* (RANET) and its associated database, which contains the assistance capabilities offered by individual countries (for example, mapping of contaminated areas, professional medical care for radiation casualties, and on-site technical support).

In the IAEA database, Hungary is represented with the offers of the HUN-REN CER, the HAEA, NDGDM, HungaroMet Hungarian Meteorological Service, the National Public Health and Pharmaceutical Center's Department of Radiation Biology and Radiation Health, the PURAM, and the MVM Paks NPP Ltd. Hungary's contribution includes the provision of laboratories, measuring instruments, as well as radiation protection and nuclear experts, with the condition that the terms of assistance are determined by Hungary on a case-by-case basis.

In 1990, Hungary signed the Joint Protocol relating to the application of the Vienna Convention on Civil Liability for Nuclear Damage and the Paris Convention on Third Party Liability in the Field of Nuclear Energy.

In 1991, Hungary joined the use of the International Nuclear Event Scale (INES).

Hungary is a participant in the European Union's ECURIE (European Community Urgent Radiological Information Exchange) system, under which a Member State that experiences an accident is obliged to notify the European Commission and the affected Member States directly.

» Bilateral intergovernmental agreements

Hungary has concluded bilateral agreements with the following countries on rapid notification, mutual information exchange, and cooperation:

— Republic of Austria (1987)
— Czech Republic and Slovakia (1991)
— Federal Republic of Germany (1991)
— Republic of Slovenia (1995)
— Romania (1997)
— Ukraine (1997)
— Republic of Croatia (2000)
— Republic of Serbia (2014).

» International Data Exchange

The Euratom Treaty requires all EU Member States to continuously monitor the radioactivity of air, water, and soil and to provide data to the European Union. Through the *European Radiological Data Exchange Platform* (EURDEP), the radiological monitoring data are also transferred to the International Radiation Monitoring Information System (IRMIS), operated by the IAEA, which covers the entire world.

Hungary's tasks related to its membership in the EURDEP and IRMIS systems are carried out by the MoI NDGDM NEIEC, which continuously monitors changes in the international radiological situation and the impact of extraordinary events on Hungary's radiological status.

Among neighbouring countries, Hungary conducts bilateral radiological data exchange with Austria, Croatia, Slovenia, and Slovakia. In addition, it also transmits data to EURDEP. The data exchange is carried out through the MoI NDGDM NEIEC.

Based on the Austrian–Hungarian bilateral agreement, a high-sensitivity, modern aerosol sampling and radiation monitoring remote station operates near the Paks Nuclear Power Plant, in the municipality of Gerjen, Tolna County. Its measurement data are transmitted every half hour to the MoI NDGDM NEIEC, from where they are forwarded to the Austrian State Early Warning Centre.

The MoI NDGDM also monitors the radiation data provided by 10 similar aerosol sampling remote monitoring stations located in Austria, as well as the Austrian nationwide background radiation monitoring data.

Based on the Slovak–Hungarian bilateral agreement, as part of the planned expansion of the Mochovce Nuclear Power Plant, the further development of the existing radiological data exchange between the two countries has been completed. Within this framework:

— Three Hungarian radiological monitoring remote stations operate in the area surrounding the Mochovce Nuclear Power Plant, on the side facing Hungary. These remote monitoring stations transmit their measurement results every ten minutes directly and online to the MoI NDGDM NEIEC.
— A mutual exchange of measurement data takes place from aerosol sampling monitoring stations operated by Austria in the vicinity of the Paks Nuclear Power Plant in Hungary and the Bohunice Nuclear Power Plant in Slovakia.

By developing cooperation in radiological monitoring data exchange, Hungary and the Slovak Republic demonstrate their strong commitment to enhancing nuclear safety, which increases both the actual safety and the sense of security of the population. The early warning capability provided by the radiological remote monitoring stations supports the timely and reliable public information, and if necessary, the warning and alerting of the population.

16.3. Emergency Preparedness for Contracting Parties Without Nuclear Installations

Subsection 16.3 does not apply to Hungary, as it is a Category 2 Contracting Party.

Summary of Significant Changes Since Previous Report

During the reporting period, the geographically separated backup control centre of the Paks Nuclear Power Plant (Backup Command Centre) was completed, serving as an equivalent and with the same functions as the Protected Command Centre.

D. SAFETY OF INSTALLATIONS

Part D consists of the following articles:

Article 17: Siting

Article 18: Design and construction

Article 19: Operation

17. Siting

Convention on Nuclear Safety, Article 17

> *"Each Contracting Party shall take the appropriate steps to ensure that appropriate procedures are established and implemented:*
> *(i) for evaluating all relevant site-related factors likely to affect the safety of a nuclear installation for its projected lifetime;*
> *(ii) for evaluating the likely safety impact of a proposed nuclear installation on individuals, society and the environment;*
> *(iii) for re-evaluating as necessary all relevant factors referred to in sub-paragraphs (i) and (ii) so as to ensure the continued safety acceptability of the nuclear installation;*
> *(iv) for consulting Contracting Parties in the vicinity of a proposed nuclear installation insofar as they are likely to be affected by that installation and, upon request, providing the necessary information to such Contracting Parties in order to enable them to evaluate and make their own assessment of the likely safety impact on their own territory of the nuclear installation."*

Summary Statement for Article

Hungary fulfills its obligations under Article 17 of the Convention. The assessment of the site is the responsibility of the licensee and the prospective licensee, and is subject to official review as part of the licensing procedure. The site of the Paks Nuclear Power Plant has been subject to thorough and detailed examination both during the selection period and in connection with the expansion.

Relevant information on the site is contained in the Final Safety Analysis Report, which is reviewed regularly. In addition, site factors are reviewed and assessed during the ten-yearly Periodic Safety Review.

During the preparation of the new Paks II Nuclear Power Plant, Hungary involved the surrounding countries in the environmental impact assessment procedure in accordance with the Espoo Convention and consulted with the authorities of the neighboring countries on several occasions. During these consultations, the contracting parties were able to review the results of the site assessments and were informed about the process of establishing the facility.

17.1. Evaluation of Site-Related Factors

17.1.1. Main Requirements and Administrative Arrangements

In Hungary, the selection and evaluation of sites for nuclear facilities are primarily regulated by the *Atomic Act* and the *Nuclear Safety Decree*. These regulations provide for a two-step licensing system for sites:

- first, a site investigation and assessment license, and then
- a site license must be obtained prior to the construction of nuclear facilities.

Stricter requirements apply to new nuclear power plant units. Under the legislation, the licensee must provide detailed evidence of the suitability of the site, taking into account all possible external hazards. The *Nuclear Safety Decree* stipulates that the

design basis must assess factors affecting nuclear safety during the planned lifetime of the nuclear facility, with particular regard to the specific characteristics of the site. In the case of new units, the site assessment programme must be carried out using up-to-date scientific methods that go beyond the data available for previous facilities.

Annex 7 of the *NUCLEAR SAFETY DECREE*, entitled "Site investigation and assessment of nuclear facilities" sets out the nuclear safety requirements for the site of a nuclear power plant and for determining the characteristics of the site in relation to the site su, construction, commissioning, and operation phases of the life cycle.

17.1.2. The Paks site

The Paks Nuclear Power Plant is located 118 km south of Budapest. The nuclear power plant is located 5 km south of the town of Paks, 1 km west of the Danube and 1.5 km east of the main road No. 6, at the geographical coordinates 46°34'24" north latitude and 18°54'53" east longitude. Only activities related to nuclear power generation are carried out on the site.

The technological equipment can be transported to the nuclear power plant by road, rail and water.

A detailed assessment of the meteorological, hydrological and geological conditions at the site is provided *in Annex A3* to the *Eight National Report*.

17.1.3. Assessment of the suitability of the Paks II site

The site for the two new nuclear power plant units to be built is located in the northern vicinity of the Paks Nuclear Power Plant. In accordance with the legislation in force, the site of the new nuclear facility had to be comprehensively assessed and evaluated prior to the start of planning. During this process, the suitability of the site had to be verified and the input data for the design had to be systematically determined.

From the perspective of the authorities, this was a two-step process, in which the investigation programme was first approved with a site investigation and assessment license, while the site license served to accept the results.

During the site investigation and assessment, all external sources of hazards were examined. Due to the specific characteristics of the Paks site, geological factors represent the greatest risk to be managed, which is why this area was subject to a special investigation within the framework of the Geological Survey Programme (GRP). The aim and task of the GRP carried out in 2015-2016 was to provide a basis for the geological assessment of the planned site of the new units.

Based on the 3D geological and geophysical model created within the GRP, the tectonic conditions of the area, the fault systems and their neotectonic activities were mapped. The development history and structural evolution of the area from the Miocene to the present day were reconstructed. The geological model also served as a basis for hydrogeological and geodynamic model calculations.

During the GRP geotechnical investigations, the geotechnical soil parameters necessary for assessing earthquake hazard and soil liquefaction potential, which are critical for the design of the new units, were determined. The investigation showed that there are no geotechnical conditions that would exclude the establishment of new units in the investigated area. From a geotechnical point of view, the area examined is suitable for the construction of new units.

The probabilistic earthquake hazard analyses carried out as part of the research provided the characteristics of the earthquake included in the design basis (maximum ground acceleration, response spectrum, duration) and the surface hazard curve. According to the results of the analysis, the average maximum horizontal peak ground acceleration of an earthquake with a return period of 100,000 years is 0.34g.

The research methods used in the GRP were developed in line with current standards, using the most advanced technical solutions available in both the local and regional environment of the site. The data obtained from the research were interpreted with the required objectivity, revealing the characteristics of the site. These provide appropriate input data for determining the design basis and design specifications, thus complying with Principle 1 of the Vienna Declaration.

17.1.4. Impact of the construction of the new units on the operation of the Paks Nuclear Power Plant

The area designated for the construction of the new units is located in the immediate vicinity of the four operating units of the Paks Nuclear Power Plant. The new nuclear facility may have an impact on the safety of the operating units.

The identification, assessment and management of possible impacts on the operation of the Paks Nuclear Power Plant are required and enabled by various rules and regulations, which are as follows:

- Pursuant to the Cooperation Agreement concluded between MVM Paks NPP Ltd. and Paks II Ltd., MVM Paks NPP Ltd. shall be notified of all administrative procedures and activities taking place on site and shall receive all necessary information from Paks II Ltd. on the basis of which it can assess how the procedure affects the licenses of the Paks Nuclear Power Plant or the operating units. Paks II Ltd. may only initiate the procedure and construction activities with the consent of MVM Paks NPP Ltd. In order to enable MVM Paks NPP Ltd. to assess any risks arising from the activities carried out at all Paks II Ltd. sites, Paks II Ltd. shall prepare a risk assessment, which it shall make available to MVM Paks NPP Ltd.
- In general, a HAEA decision requires existing and planned nuclear facilities to share all nuclear safety data with each other and to evaluate the data received in terms of its impact on nuclear safety. The evaluations must be repeated after notification of any changes.
- Under the provisions of the law, the HAEA must involve MVM Paks NPP Ltd. as a client in the procedures specified in the legislation during its oversight activities.

MVM Paks NPP Ltd. is also responsible for analyzing the impact of the new units on the existing power plant. Based on the new (updated) schedule required for construction, the operations and technological information arising from the construction process that pose an external hazard must be identified, and the construction must be analyzed and assessed as an external human-made hazard source.

The design of the new nuclear power plant units must also take into account the hazards arising from the operation of the existing units 1-4, with particular regard to a possible nuclear accident. Therefore, preparations must be made for the evacuation of workers at the site, the provision of protective equipment and, if necessary, their isolation. On this basis, Paks II Ltd. has concluded a cooperation agreement with MVM Paks NPP Ltd., under which the nuclear emergency response tasks during the construction period will be performed by the Emergency Response Organization of

MVM Paks NPP Ltd. In the case of buildings to be erected in the construction support area, assembly points will be designated on an ongoing basis and the relevant regulatory documents of MVM Paks NPP Ltd. will be updated accordingly.

It is important to note that the SFISF facility of PURAM, another nuclear facility operating at a slightly greater distance but in the vicinity of the new units, must also be taken into account during the design and construction. The cooperation obligation imposed by the HAEA also extends to this facility.

17.1.5. Regulatory Review and Control

As specified in the *NUCLEAR SAFETY DECREE*, the authority examines the methods used in the site investigation and assessment, and the suitability of the site in separate licensing procedures. During the licensing process, HAEA examines in detail the geological, seismological, hydrological and meteorological characteristics of the site, the hazards arising from human activities, and demographic and environmental aspects. HAEA involves a wide range of competent authorities in the site licensing process, thereby ensuring that environmental, geological, water and other aspects are taken into account.

17.2. Impact of the Installation on Individuals, Society and the Environment

The population within a 30 km radius of the Paks Nuclear Power Plant was 224,080 at the time of the 2011 census. The area is mainly characterized by agricultural land. The only industrial facility located in the safety zone of the power plant is the SFISF. This facility is independent of the Paks Nuclear Power Plant and has its own Safety Analysis Report and operating license issued to PURAM as the licensee of the SFISF.

The area north of the existing units 1-4 of the nuclear power plant has been designated for the construction of new units.

There are no military or public airports, take-off and landing protection zones or military facilities in the immediate or wider vicinity of the Paks Nuclear Power Plant. According to airspace regulations, flights are controlled by radar at an altitude of 5950 m above sea level, while below this altitude and within a 3 km radius of the nuclear power plant, flights are prohibited and only permitted in exceptional cases. According to conservative estimates, the frequency of heavy transport aircraft and military aircraft crashes in peacetime in the area most sensitive to the safety of the nuclear power plant is below the regulatory screening value ($1x10^{-7}$/year).

Sports and other civil related airports are located in the immediate vicinity of the Kalocsa area, while in the wider area there are airports in Dunaújváros, Érsekcsanád and Őcsény.

According to an analysis based on updated statistics on road and water transport accidents involving dangerous substances, the frequency of dangerous substances reaching the nuclear power plant site and resulting in processes that endanger the safe shutdown of the units (e.g., poisoning or explosion) is below the regulatory screening level.

The nearest railway line to the Paks Nuclear Power Plant site is the 40 km long single-track line No. 42 of the Hungarian State Railways between Mezőfalva and Paks, with the terminus in Paks. An industrial railway line leads from the Paks terminus to the

power plant site, which can only be accessed by special trains. Currently, only freight transport operates on the railway line between Mezőfalva and Paks; public passenger transport has been suspended since December 13, 2009.

17.3. Re-evaluation of Site-Related Factors

17.3.1. Main Requirements and Administrative Arrangements

In accordance with the *NUCLEAR SAFETY DECREE*, the PSR must cover the identification and evaluation of new knowledge and facts resulting from scientific findings and technical developments, as well as from the monitoring of parameters, and must review the site characteristics and the resistance to external hazards.

17.3.2. Reassessment of factors

The most recent comprehensive assessment of other external hazards was carried out in connection with the 2017 PSR, during its preparation and the completion of the tasks arising from it. The site characteristics identified during the site investigation of the new units of Paks II were taken into account when carrying out the assessments.

According to the results of the studies related to the 2017 PSR, the risk from human-induced hazards remains negligible.

In 2018, the extreme conditions characteristic of the site were reviewed with regard to external hazards of meteorological origin, taking into account the meteorological data collected to date. The reviewed meteorological extremes did not change significantly compared to their previous values.

Among the external hazards, the low water level of the Danube, which was previously considered a negligible risk, and the icing of the Danube were also reviewed in 2023 based on previous operating experience. The risk arising from low water levels in the Danube is relatively low, while the risk arising from ice formation on the Danube is moderate compared to the risks arising from other quantified external hazards. The Paks Nuclear Power Plant has detailed instructions for dealing with both events.

Since the previous National Report, a site reassessment of the earthquake safety of the Paks Nuclear Power Plant has also been carried out, which is described in Section 14.2.2.

17.3.3. Regulatory Review and Control

The PSRs must include a separate chapter on site characteristics and resistance to external hazards, which is reviewed by the HAEA.

The HAEA issued the site license in 2017 in relation to the site characteristics associated with the construction of Paks II. According to the *NUCLEAR SAFETY DECREE*, the site license for the new units of the Paks II Nuclear Power Plant issued by the HAEA in 2017 is valid until the construction license becomes final, but for a maximum of 5 years from the date of issue. The validity of the site license may be extended for up to two additional periods of five years upon request, provided that the conditions for the issuance of the license are still met. In November 2021, Paks II Ltd. submitted an application for the extension of the site license, confirming that the conditions for the license remain unchanged and that no new information has become available since the

license was issued that would affect the content of it. On this basis, the site license was extended for a further five years in 2022.

The site license was valid until the construction license became final. The construction license was issued by the HAEA on 25 August 2022, which also stipulated the fulfillment of the conditions set out in the site license. The deadline for fulfilling the conditions specified in certain points of the site license was the date of submission of the construction license application. Paks II Ltd. demonstrated compliance with these conditions in its Summary Report, which formed part of the construction license application, on the basis of which the authority accepted the verification of compliance with the conditions.

17.4. Consultation with other Contracting Parties likely to be affected by the installation

The environmental impact assessment procedure for the construction of the two new nuclear power plant units included an assessment of significant transboundary environmental impacts in accordance with the provisions of the Espoo Convention. The 11 parties that registered for the international phase of this procedure were provided with the opportunities for participation required by the Espoo Convention. A summary of the environmental impact assessment procedure is provided *in Annex A3 to* the *Ninth National Report*.

Bilateral Austrian-Hungarian, Croatian-Hungarian, Serbian-Hungarian and quadrilateral Czech-Slovak-Slovenian-Hungarian meetings of authorities are held regularly every year (since 2024, Poland and Finland have also been included), at which the progress and current status of the Paks II project and the supervisory activities of HAEA are presented.

Summary of Significant Changes Since Previous Report

In 2022, the HAEA extended the validity of the site license for the new units planned for the Paks site by a further five years and issued the construction license, which also concluded the fulfilment of the conditions set out in the site license.

18. Design and construction

Convention on Nuclear Safety, Article 18

> *"Each Contracting Party shall take the appropriate steps to ensure that:*
> *(i) the design and construction of a nuclear installation provides for several reliable levels and methods of protection (defense in depth) against the release of radioactive materials, with a view to preventing the occurrence of accidents and to mitigating their radiological consequences should they occur;*
> *(ii) the technologies incorporated in the design and construction of a nuclear installation are proven by experience or qualified by testing or analysis;*
> *(iii) the design of a nuclear installation allows for reliable, stable and easily manageable operation, with specific consideration of human factors and the man-machine interface."*

Summary Statement for Article

Hungary fulfills the obligations under Article 18 of the Convention. The requirements to be taken into account in the design of nuclear installations are laid down in the Nuclear Safety Decree, which contains detailed provisions on the multiple levels of protection, the applicable technologies, and the operating conditions.

The technical design, operating concept and safety systems of nuclear power plants in operation and planned in the country are proven to meet these requirements, which are documented by the licensees in detailed safety analysis reports.

The legislation sets out requirements for reliable, stable and easily controllable operation, taking into account human factors and human-machine interaction.

Compliance with the design requirements is verified by the HAEA during the licensing procedures and continuously monitored during the operation of the facility.

18.1. Implementation of Defense in Depth in Design and Construction

18.1.1. Main Requirements and Administrative Arrangements

The *NUCLEAR SAFETY DECREE* stipulates that nuclear facilities must prevent radioactive material or radiation from being released into the environment by means of defense in depth and ensure that accidents resulting from failures, or combinations thereof, resulting in significant releases of radioactive material, occur with a sufficiently low probability. Defense in depth must ensure that possible human errors or technical failures are compensated for, that the effectiveness of barriers are maintained, and that the public and the environment are protected in the event that the effectiveness of the barriers is reduced. Safety analyses shall demonstrate that defense in depth has been taken into account in the design of the power plant.

In accordance with the principle of defense in depth, the following shall be ensured:

— design solutions must ensure that essential safety functions can be achieved by maintaining the barriers and reducing the consequences of failures or deviations from normal operating conditions,

— systems with safety functions shall be used to prevent and manage operational disturbances and accident conditions,
— the harmful consequences of human error during operation or maintenance shall be prevented,
— technical means shall be provided to ensure that the condition of the nuclear power plant can be managed in such a way that, in the event of malfunctions or deviations from normal operating conditions, the need for the operation of systems performing safety functions is minimized, and
— it shall be ensured that the controllability of the nuclear power plant is highly reliable even in conditions requiring the operation of safety systems and does not require intervention by operating personnel at an early stage of the process.

During the design and construction of nuclear facilities, all levels must be taken into account and the systems and components assigned to the different levels of defense in depth must be implemented with appropriate physical and functional separation. Within each level, redundant, diverse systems must be used, taking into account possible common cause failures.

The nuclear safety decree sets stricter requirements for new nuclear power plants than for existing ones, including the following:

— Events involving large or early releases must be practically eliminated.
— For new nuclear power plants, the combined frequency of event sequences with large or early releases for all initial operating conditions and effects, except in cases of sabotage, shall not exceed 10^{-6} /year.
— For design basis and design extension conditions, it must be demonstrated that no urgent protective measures are necessary beyond a distance of 800 m from the nuclear reactor, no temporary measures are necessary beyond a distance of 3 km from the nuclear reactor, i.e. no temporary relocation of the population is necessary, no late protective measures are necessary beyond a distance of 800 m from the nuclear reactor, i.e. no permanent relocation of the population is necessary, and no long-term restrictions on food consumption are necessary.
— In order to ensure greater independence of the systems, it must be systematically ensured, to a reasonable extent, that a safety classified system or component is only linked to a specific level of defense in depth, regardless of the initiating events.

18.1.2. Implementation by licence holder

Paks Nuclear Power Plant

The design of the Paks Nuclear Power Plant units was carried out in two stages based on Soviet standards. Strictly conservative engineering practices were applied in establishing the design basis.

The safety requirements taken into account during the design of the Paks Nuclear Power Plant units are essentially that, during normal operation and anticipated operational occurrences, the first three physical barriers (the fuel element, the fuel cladding and the reactor coolant pressure boundary) must not be breached, thus the fourth barrier, the containment, which would prevent the release of radioactive material, has no role in managing such conditions. In the case of postulated accidents used in the design of the power plant, which are highly unlikely to occur, the fuel pellets cannot be damaged or melt. However, the fuel cladding (to a limited extent) and the

primary circuit may be damaged, in which case the containment function may become important. The power plant has been designed so that the amount of radioactive material released into the environment and the radiation exposure of workers as a result of postulated accidents do not exceed the relevant health regulations. The original design principles of the units did not directly address the management of accidents and severe accidents that are more serious than design basis accidents but are very unlikely to occur.

The elements of the defense in depth principle were implemented in the nuclear power plant in accordance with the requirements of Soviet regulations.

Based on the lessons learned from the deterministic analyses, Probabilistic Safety Assessment (PSA levels 1 and 2) and severe accident analyses, recommendations were made for safety-enhancing modifications and further complex analyses (see Section 14.1.2).

Between 2011 and 2014, modifications related to severe accident management were implemented at the Paks Nuclear Power Plant units. These modifications had been planned before the Fukushima accident:

- The possibility of external cooling of the reactor vessel was created. The purpose of this is to keep the molten core inside the reactor vessel in the event of a severe accident, thus preserving the integrity of the reactor vessel.
- In order to ensure the proper handling of hydrogen released during severe accidents, 60 additional high-performance accident hydrogen recombiners were installed in the hermetic space, in addition to the existing hydrogen recombiners. These devices prevent hydrogen explosions and ensure that the integrity of the hermetic space is not compromised.
- In order to implement the severe accident management strategy, it was also necessary to install an emergency power supply system that ensures the electrical supply of the equipment required for primary circuit pressure reduction and external cooling of the reactor vessel, as well as the emergency measurement system, even in the event of a station blackout, i.e. when neither external nor on-site emergency power sources are available. The independent power supply system was created by installing four 100 kW mobile diesel generators and connecting them to the main safety switchboards. Each unit has its own mobile diesel generator, taking into account the possibility of a simultaneous total loss of power in several units.
- Accurate monitoring and knowledge of the technological parameters are essential for the use of Severe Accident Management Guidelines and for making the right technological decisions. As part of the development of a measurement system that is independent of operational measurements and is operational even under accident conditions, the following parameters are measured: reactor pressure, core outlet temperature, hermetic space water level, reactor pit water level, hermetic space pressure and temperature, hermetic space hydrogen and oxygen concentration, spent fuel pool water level, reactor hall dose rate and emission measurements have been established for all units. Currently, the measurements can be monitored in the main control room, the backup control rooms of each unit, the Protected Command Centre and the Backup Command Centre.
- The cooling system of the spent fuel pools and the service cavity of the units have also been modified to improve safety. Level-controlled motor-operated slide valves have been installed to replace the previous manual valves, significantly reducing the amount of coolant escaping in the event of a pipe

rupture, preventing flooding of intact cooling circuit equipment and enabling the backup cooling circuit to be put into operation.

Further modifications taken into account in response to the lessons learned from the Fukushima accident are described in previous national reports, and modifications completed or still in progress are described in this report in Chapter 6.1.3 and Annex III. The same chapter also lists safety-enhancing measures and other modifications that are ongoing outside the TSR framework.

In accordance with Principle 2 of the Vienna Declaration, safety analyses are also subject to comprehensive and systematic review within the framework of the PSR, the results of which are also used for safety-enhancing modifications.

- **Paks II.**

The plans are developed and reviewed as described in Chapter 14.2.3. The five-level review described therein ensures that defense in depth is implemented at all levels. The relevant domestic nuclear safety and design requirements are in line with international expectations and best practices. The experts of Paks II Ltd. participate in the work of the IAEA, the European Utility Requirements Association, WANO and the European Nuclear Installations Safety Standards (ENISS), which keeps them informed of developments in international requirements and the emergence of new requirements. This ensures that the latest regulations and recommendations relating to nuclear safety are taken into account and incorporated into the design process on an ongoing basis.

18.1.3. Regulatory Review and Control

As part of its supervisory activities, the HAEA examines whether the plans and analyses comply with the requirements, including the principle of defense in depth, within the framework of the licensing procedures, and checks during inspections whether the actual status of the power plants is in line with the design and analyses approved during the licensing procedure.

During the planned lifetime of nuclear power plant units, the HAEA assesses compliance with regulatory requirements through regular and comprehensive safety reviews (PSR and comprehensive inspections), taking into account new safety requirements that have arisen in the meantime and international best practice.

New nuclear power plants are subject to stricter design requirements (e.g. in terms of defense in depth, radioactive release and their impact). As a result of its assessment of compliance with these requirements, the HAEA issued a construction license for the new nuclear power plant in 2022. The stricter requirements and regulatory review ensure compliance with Principle 1 of the Vienna Declaration.

18.2. Incorporation of Proven Technologies

18.2.1. Main Requirements and Administrative Arrangements

The *Nuclear Safety Decree* stipulates that systems and components important for safety must be designed using proven design solutions that have been tested under similar conditions. In cases where this is not possible, technologies and products must be used whose applicability has been examined and verified. In the case of new design solutions that differ from those established in technical practice, their applicability must be verified from a safety point of view by means of adequate research, tests and

analysis of experience gained in other applications. New solutions must be tested before commissioning. The operation of the systems and components must be monitored during operation to ensure final verification of conformity.

In addition, both the HAEA and licensees shall continuously monitor domestic and international experience and scientific results (see Section 19.7).

18.2.2. Implementation by licensee

Paks Nuclear Power Plant

MVM Paks NPP Ltd. operates the units using an integrated management system developed, implemented and continuously improved in line with international best practices. The integrated management system is based on a process system covering all licensee activities. Prior to the current assessment period, the main process for configuration management of the production subsystem was developed, and the main process for equipment reliability is currently under development.

The process system fully covers all processes necessary to ensure that the functionality, technical condition and performance of the systems and components present in the configuration of the operating units and affecting safe operation are continuously monitored.

Feedback processes monitor, measure, and evaluate the compliance of safety-relevant systems and components and ensure that they are maintained at the required level through necessary interventions.

In addition to maintenance activities, a regulated implementation process has been established and is operated for modifications involving comprehensive reconstruction and smaller-scale changes. The processes for preparing technical decisions on modifications ensure, on the one hand, that decisions on necessary technological upgrades are made in a reliable manner and, on the other hand, that the physical implementation of technical changes is integrated into a verified and validated system.

In addition to implementing physical changes, it is equally important to review the use of the applicable standards from time to time or to renew the standards themselves. An example of this was the adoption of the MSZ 27000 series of standards based on the 2001 edition of ASME BPVC as part of the first service life extension. The applicability and feasibility of the 2017 edition of ASME BPVC is currently being investigated.

Paks II.

The use of proven technologies is laid down in the *NUCLEAR SAFETY DECREE*. So-called "*first of a kind*" solutions may only be used in the project if their suitability can be verified by analyses and tests.

The AES-2006 Leningrad reference nuclear power plant design is an evolutionary product of the VVER reactor family. It was developed as a further improvement of the VVER-440 and VVER-1000 types, which are based on decades of operating experience. Four 1200 MW units similar to Paks II are currently in operation: two near St. Petersburg and two in Ostrovets, Belarus. The newly planned systems, such as the steam generator and containment passive heat removal systems, the core catcher, etc., have been tested and analyzed and are proven to be reliable in performing their functions.

However, there are project-specific solutions whose functionality will be verified by the Main Contractor through analyses and factory tests. These include the main coolant pump and the emergency pressure relief system.

The processes related to the document management system of Paks II Ltd. ensure that if there is a proven technical solution for a certain function, it will be given priority and used in the design. At the same time, under certain conditions, innovative solutions that increase safety may also be incorporated into the designs. The process system used by Paks II Ltd. properly ensures that the functionality of systems and components that appear in the design and affect safe operation are verified in a controlled manner from the early stages of design.

Compliance with licensed and approved technologies is ensured and supervised by qualified personnel during the manufacturing and on-site installation of equipment and systems, based on a differentiated set of criteria developed and operated throughout the entire construction period.

18.2.3. Regulatory Review and Control

The HAEA expects and verifies the use of proven technologies in the licensing procedures and during its inspection activities. During the licensing procedures, HAEA requires licensees to demonstrate the suitability of the selected technologies, systems, and components.

With regard to operating installations, if a modification involving a new type of solution extends to several different units or redundant systems, the HAEA will typically only grant a license for one unit or system in the first instance and will require that the experience gained to be taken into account in future modifications and in modification that have already been implemented. The licensee shall prepare an assessment of all modification experience, which shall also be evaluated by the authority.

During the licensing procedure for new units, the HAEA examines in detail whether the planned systems and components comply with nuclear industry experience and best practice, whether their references are appropriate, whether their manufacturers have the necessary experience and quality management systems, and whether their special manufacturing, welding and testing procedures are verified.

Applying the principle of a step-by-step approach, the HAEA verifies that manufacturing is carried out in accordance with the relevant nuclear standards and that the manufacturing, welding and testing procedures have been certified, the conformity of manufacturing and construction activities with approved plans and procedures, and whether manufacturers and contractors have an adequate quality management system in place. For key manufacturing activities, including *"first of a kind"* solutions, the HAEA already exercises its supervisory activities during the qualification procedures and also supervises the manufacturing of raw materials and in-process inspections.

18.3. Design for Reliable, Stable and Manageable Operation

18.3.1. Main Requirements and Administrative Arrangements

When designing nuclear facilities, it is essential that the operation of the facility is reliable, stable and easily manageable, with particular attention to human factors and the optimization of human-machine interaction.

The *NUCLEAR SAFETY DECREE* stipulates that the work areas and working environment of the operating personnel and the human-machine interface must be analyzed from an ergonomic point of view and with regard to the possibility of incorrect interventions. The plans must be prepared taking into account the results of the analysis. The human-machine interface and ergonomic design of systems and components must be designed in such a way that, taking into account the assumed physical environment and the expected mental state, suitably trained personnel are able to perform their tasks successfully within the required time.

» General design principles

— Redundancy and diversity: In the case of critical systems, redundant and diverse systems shall be used so that a single failure does not lead to the loss of safety functions.
— Minimization of the effects of faults: Potential faults and their effects must be taken into account during design, and the possibility of faults propagating must be minimized.
— Consideration of human factors: Human factors must be taken into account during design, and the possibility of human error must be minimized. This includes ergonomic considerations, the appropriate design of user interfaces and control systems, and staff training.
— Quality assurance: A rigorous quality assurance system must be applied during the design process to prevent errors and guarantee quality.
— Testability: Systems must be designed so that they can be tested, and their reliability and functionality can be verified based on the test results.
— Maintenance: Maintenance requirements must be taken into account during design and maintenance must be ensured.

» Specific requirements

— Reactor protection system: The reactor protection system must automatically shut down the reactor in an emergency. This system must be particularly reliable and independent of other systems.
— Cooling systems: Cooling systems must ensure adequate cooling of the reactor in all conditions, including accident conditions.
— Backup power supply: The facility must have a backup power supply to ensure the operation of critical systems in the event of a power failure.
— Control and monitoring systems: Control and monitoring systems shall ensure the stable and safe operation of the reactor.
— Staff training: Staff shall be adequately trained to operate the facility safely.

18.3.2. Implementation by licence holder

Paks Nuclear Power Plant

A special feature of the design of the Paks Nuclear Power Plant is that, due to the conservative design of the systems and equipment in accordance with safety requirements, the number of operational incidents occurring for technical safety reasons is low. Another feature of the facility is that if a malfunction does occur, it is mostly handled automatically by the control and protection systems.

The safety of operation is ensured by the establishment of an appropriate organization for the operation of the nuclear power plant, the training of personnel, and procedures to ensure that systems and equipment are operated as designed, their condition is monitored, necessary maintenance is performed, and the operating limits and

conditions specified as part of safety analyses are ensured. In addition, radiation protection, physical protection of the power plant and preparedness for nuclear emergency response are also important aspects of the safe operation of the facility.

The protection functions are activated automatically when the main parameters of the unit change to a given value. The reactor protection system also allows the operating personnel to activate the protection functions manually. The control and safety system is designed to control and shut down the chain reaction in the reactor core. Based on signals received during start-up, shutdown, and normal operation, the system maintains nuclear parameters within specified values. The systems have advanced self-diagnostic capabilities and also allow for testing during unit start-up and operation.

Control panels located at various locations are used to control and monitor the technological processes of the nuclear power plant, depending on the tasks to be performed. In the event of a failure of the main control room, the backup control room is used to shut down and cool the unit. In addition, the following locations are used for operational control: Power Plant Control Center, joint operational control room for controlling the technologies established to serve the two reactor units, auxiliary building control room, dosimetry control room, waterworks control room, electric network control room, accident control room, Protected and Backup Command Centre.

Paks II.

With regard to the design of the new units, the designer has fully taken into account the relevant legal requirements, i.e. that the operation of the new units must be reliable, stable and easily controllable, with particular regard to human factors and the optimization of human-machine interaction.

At the current stage of the project, these have been implemented at the technical design level and can be verified in these designs. However, during the verification and approval process, the licensee has satisfied itself that the designs of the units meet the legal requirements and international best practices. All design principles, such as redundancy, diversity, simplicity, independence, fault tolerance and fail-safe design, single failure tolerance, reduction of common cause failure frequency, and autonomy targets, which serve to ensure reliable and stable operation, have been incorporated into the designs. Particular emphasis has been placed on compliance with the requirements of the „*European Utility Requirements for LWR Nuclear Power Plants*" Rev D.

In addition, the feedback of the results of the Probabilistic Safety Assessment into the design, with particular regard to safety significance, and the tightening of the reliability requirements for systems and components also serve to ensure reliable operation. It should be emphasized that the very strict availability requirement (92%) also serves to further improve reliability compared to the reference unit, and, as is well known, the reliability of normal operating systems fundamentally influences the overall nuclear safety of the units. The lower the frequency of initial events, the fewer challenges the safety systems face and the less likely it is that operational events will escalate.

In accordance with legal and professional requirements, a backup control room with appropriately designed functionality and associated technical support centers will be established alongside the main control room. It is essential for safe operation that the human factor is taken into account during the design phase.

Furthermore, the Protected Command Centre and Backup Command Centre will also be established in accordance with these principles. Their serviceability, "liveability"

and ergonomic design are also subject to strict requirements. However, detailed plans are not yet available, and implementation planning has not yet begun.

Computer security aspects, and compliance with them, for digital control systems is becoming increasingly important for the safe operation of the units. During the detailed design phase, in accordance with the "secure by design" principle, nuclear security, and within that, the protection of programmable systems will be given the same weight as nuclear safety in the functional design.

Efficient operation and power plant control will be supported by a training and simulation center aligned with the overall project schedule, where operating personnel will be trained.

18.3.3. Regulatory Review and Control

The HAEA primarily examines the design ensuring reliable, stable and manageable operation within the framework of the construction license for the nuclear power plant, which serves to verify compliance with the design requirements set out in the legislation. The PSAR, which serves as the basis for the license, must include a separate chapter on human-machine interaction and the reliability assurance programme.

The licensee of an operating nuclear power plant shall present the results of maintenance efficiency monitoring activities ensuring stable and reliable operation as part of its regular reports, which shall be evaluated by the HAEA.

Summary of Significant Changes Since Previous Report

In respect of this Article, no significant changes occurred in Hungary during the reporting period.

19. Operation

Convention on Nuclear Safety, Article 19

> *"Each Contracting Party shall take the appropriate steps to ensure that:*
> *(i) the initial authorization to operate a nuclear installation is based upon an appropriate safety analysis and a commissioning programme demonstrating that the installation, as constructed, is consistent with design and safety requirements;*
> *(ii) operational limits and conditions derived from the safety analysis, tests and operational experience are defined and revised as necessary for identifying safe boundaries for operation;*
> *(iii) operation, maintenance, inspection and testing of a nuclear installation are conducted in accordance with approved procedures;*
> *(iv) procedures are established for responding to anticipated operational occurrences and to accidents;*
> *(v) necessary engineering and technical support in all safety-related fields is available throughout the lifetime of a nuclear installation;*
> *(vi) incidents significant to safety are reported in a timely manner by the holder of the relevant licence to the regulatory body;*
> *(vii) programmes to collect and analyse operating experience are established, the results obtained and the conclusions drawn are acted upon and that existing mechanisms are used to share important experience with international bodies and with other operating organizations and regulatory bodies;*
> *(viii) the generation of radioactive waste resulting from the operation of a nuclear installation is kept to the minimum practicable for the process concerned, both in activity and in volume, and any necessary treatment and storage of spent fuel and waste directly related to the operation and on the same site as that of the nuclear installation take into consideration conditioning and disposal."*

Summary Statement for Article

Hungary fulfills the obligations under Article 19 of the Convention. The operation of nuclear installations may only commence with an operating license issued by the Authority, which shall only be granted after the facility has successfully undergone the required tests and inspections, and on the basis of safety analyses.

The OLC document approved by the HAEA precisely defines the safety framework for operation, on the basis of which the licensee operates the facility. Regular review and amendment of this document as necessary ensures continuous compliance with the latest scientific and technical requirements and operational experience.

The Nuclear Safety Decree requires that emergency and accident situations be managed in accordance with detailed, well-documented procedures so that any malfunctions or incidents can be dealt with quickly and effectively.

The licensee shall ensure the continuous presence of adequate technical and support staff with the necessary qualifications, permits, and training programmes, thereby ensuring a high level of professional competence.

The conditions for reporting safety-related incidents shall be determined by HAEA, enabling the authority to respond quickly and intervene as necessary.

The continuous collection, analysis and feedback of the facility's operating experience ensures safe operation. The knowledge gained during operation is shared with the international community.

The minimization of radioactive waste generation and the safe management and storage of waste generated are carried out in accordance with the Nuclear Safety Decree and the Radiation Protection Decree, taking into account the aspects of conditioning and final disposal.

19.1. Initial Authorization

19.1.1. Main Requirements and Administrative Arrangements

The legal and regulatory requirements for the commissioning of nuclear facilities in Hungary are laid down in the *ATOMIC ACT*, the *NUCLEAR SAFETY DECREE* and its annexes.

Under the regulations, the commissioning of a nuclear facility may take place in several stages:

- Based on the construction license, commissioning activities that do not require the use of nuclear fuel during construction may be carried out (e.g., system flushing, inactive function tests).
- Commissioning activities involving nuclear fuel and the production of a nuclear chain reactions, including trial operation at the planned maximum power, may be carried out under the commissioning license.
- Following the implementation of the commissioning programme, commercial operation may commence with an operating license.

The requirements for each stage of commissioning are also laid down in legislation and are subject to regulatory approval.

The commissioning license application must demonstrate that any changes made to the PSAR are justified and, if subject to authorization, have been authorized. Furthermore, it must be demonstrated that the nuclear facility has been constructed in accordance with the plans and that the actual state is in accordance with the requirements laid down in the legislation, and the commissioning programme must be presented.

19.1.2. Implementation by licence holder

Paks Nuclear Power Plant

The Paks Nuclear Power Plant was commissioned in the 1980s, and its compliance and subsequent continuous review of safety analysis reports and other assessments are presented in Chapter 14.1.2.

Paks II Ltd.

The commissioning of the new units will begin after completion of the construction phase, for which the Main Contractor is responsible under the contract, but the final responsibility lies with the Customer (Paks II. Ltd). The current plans for commissioning are contained in the PSAR, which was approved by the authority during the construction licensing procedure. A detailed commissioning programme is currently being developed. Paks II Ltd. will define the commissioning concept, with the aim of ensuring that Paks II. participates in the commissioning activities as soon as

possible and to the greatest extent possible. The organizational structure must be established, and groups responsible for "preparation for commissioning" and "commissioning tasks" will be defined. Paks II Ltd. shall develop a responsibility matrix for the tasks, for which it shall prepare a comprehensive Customer Participation Plan and define a handover strategy for the transfer of responsibilities.

The above tasks shall be performed in line with the measures and tasks arising from the commissioning strategy currently being developed by Paks II. Ltd. and optimized to the schedule for the investment.

19.1.3. Regulatory Review and Control

There are currently no nuclear facilities in Hungary covered by the Convention that have been recently commissioned or are expected to be commissioned in the near future.

The HAEA continuously monitors the activities of nuclear installations, which will also include commissioning.

19.2. Operational Limits and Conditions

19.2.1. Main Requirements and Administrative Arrangements

The requirements for the OLC document are set out in the *NUCLEAR SAFETY DECREE*. The OLC is the basic document for the safe operation of the facility, which sets out the conditions and limits under which the facility can be operated safely. The OLC shall contain all information necessary for the safe operation of the facility. The OLC must be reviewed regularly and updated as necessary to take into account changes in the facility, technological developments, and operating experience. The OLC must be available to the personnel. The OLC and any amendments must be approved by HAEA.

Under the *NUCLEAR SAFETY DECREE*, the OLC document is a required attachment to the commissioning license application, and later also to the operating license application. Based on this, the OLC is considered a document of special importance for regulatory oversight. The *NUCLEAR SAFETY DECREE* also specifies the requirements for the content of the OLC and the requirements for the application of the OLC document during operation.

19.2.2. Implementation by licence holder

Paks Nuclear Power Plant

Until October 23, 2018, the document containing the operational limits and conditions of the Paks Nuclear Power Plant was the so-called Technical Specifications (TS), which is a key element of the operating documents. On 24 October 2018, the OLC document was introduced as the legal successor to the TS.

The TS was prepared in 1988 by the operating organization based on the design and operating documentation of the nuclear power plant unit. The TS contained the general requirements, basic rules and operating parameters that ensure the safe operation of the nuclear power plant in the operating modes and operating states taken into account during its design. The primary purpose of the operating conditions and restrictions set

out in the TS was to prevent situations that could lead to accidents and, if such situations did arise, to mitigate their consequences.

In terms of its form and scope, the TS was increasingly burdened by problems that made it difficult to apply the document properly and did not fully comply with international guidelines that had appeared in the meantime.

With the amendments to the *NUCLEAR SAFETY DECREE* and HAEA Guideline No. 4.2, Operational Limits and Conditions for Operating Units (2015), the HAEA created the domestic regulatory environment for a comprehensive review of the TS and the creation of the OLC document to replace it. During the development of the OLC, the Paks Nuclear Power Plant took into account, in addition to the Hungarian regulatory system, the IAEA Safety Standards Series NS-G-2.2, "Operational Limits and Conditions an Operating Procedures for Nuclear Power Plants". The US standards governing the operation of nuclear power plants, NUREG 1431, volumes 1-2, relating to technical specifications, provided assistance in determining the form of the OLC and the essential rules for its application.

Taking into account the above regulations, the licensee developed a special set of criteria for establishing the content of the OLC and for determining the systems and components to be restricted, which helped to eliminate the shortcomings that existed in the TS. As a result of the modification, an OLC document was produced which, compared to the TS, contains more information on the rules for the use and application of the document, and a more user-friendly structure and unit operating states were developed. The limits contained in the OLC have not changed significantly compared to the TS. The Paks Nuclear Power Plant validated the developed OLC document with version number 1.0 with the participation of the operating personnel. Errors and discrepancies identified during the validation process were corrected in the OLC document prior to its introduction, resulting in the creation of version 1.1 of the OLC. Prior to the introduction of the document, training was provided for operating personnel on the use of the OLC.

In the period following the introduction of the OLC, its actual use revealed several errors and omissions in the document. For this reason, the Paks Nuclear Power Plant decided to conduct a minor review of the OLC. Following approval by the HAEA of the document with the revisions made during the review, version 1.2 of the OLC was introduced on July 21, 2021.

The legally valid paper copies of the OLC are available at all times at the organizational units primarily concerned, as specified in the internal regulations of the Paks Nuclear Power Plant. The legally valid electronic version is available to authorized employees in the electronic document management system (EDMS) of the Paks Nuclear Power Plant.

Keeping the document up to date is the responsibility of the technical organization designated for this purpose, in accordance with HAEA guideline No. A1.55. Technical modifications to the power plant, the implementation of safety measures, technical modernization, and content changes necessitated by developments in background science may be introduced and applied with the approval of the authority. Personnel using the document shall be regularly trained on any modifications.

Paks II.

Paks II Ltd. submitted the planned OLC for the facility to the HAEA as part of the Preliminary Safety Analysis Report.

19.2.3. Regulatory Review and Control

The HAEA first reviews the preliminary OLC of the facility during the construction licensing, then during the commissioning and operating license procedures, as well as during the modification license procedures for operating facilities affecting the OLC. The HAEA conducts regular and unannounced on-site inspections at the nuclear power plant. During these inspections, the inspectors examine all aspects of operation, including compliance with Operational Limits and Conditions. The licensee is required to submit regular reports to the HAEA on the operation of the nuclear power plant, incidents, and maintenance work. HAEA experts analyze these reports and verify that operations comply with the OLC. The licensee is also required to report to the authority as incidents any violations of the OLC and, in many cases, any deviations from the OLC that have already been identified.

The OLC may be modified or temporarily modified through a regulatory licensing procedure.

19.3. Procedures for Operation, Maintenance, Inspection and Testing

19.3.1. Main Requirements and Administrative Arrangements

The *NUCLEAR SAFETY DECREE* requires that a programme shall be established for the in-service or periodic inspection, review, and material testing of all systems and components important to nuclear safety, including the method and frequency of integrity checks and functional tests, planned preventive maintenance, and other maintenance strategies, tightness checks and functional tests, as well as the design specifications for planned preventive maintenance and other maintenance strategies. Parameters characterizing operability and conformity must be defined. Conformity criteria shall be specified for these parameters, and their fulfilment shall be measured and verified during tests and inspections. The necessary measures shall be planned in case of deviations from the acceptable values, including modifications to the maintenance programmes. The cycle time, frequency of review, requirements for performance, and method and conditions of maintenance of functional tests of systems and components important for nuclear safety shall be determined and established during design in such a way as to ensure that they are consistent with the principles of design and construction of the system and components, and that the safety function of the system and components is verified by means of functional tests. System component design principles and construction ensure that the given safety function is reliably performed during system and component testing, review and maintenance, and that the removal of the system or component from operation for testing, review or maintenance is tolerable from a nuclear safety perspective. The frequency of review, testing and maintenance shall not lead to a reduction in nuclear safety.

With regard to outages, the nuclear reactor may only be made critical after fuel reloading or fuel replacement in the nuclear power plant reactor with the permission of the nuclear safety authority. The application for a restart permit shall be submitted to the authority at least two weeks before the planned restart. The application for authorization must demonstrate that the nuclear power plant unit complies with nuclear safety requirements after the replacement of fuel elements, that the safety analyses and the provisions of the OLC document are fulfilled in addition to the new zone installed, the maintenance, repair, modification work and inspections necessary for the safe operation of the nuclear power plant unit have been carried out.

19.3.2. Implementation by licence holder

Paks Nuclear Power Plant

The management system of the Paks Nuclear Power Plant fully includes regulations (rules, procedures) related to the operational elements necessary for the operation and maintenance of the nuclear power plant units, implementation instructions (maintenance, handling, operating, testing instructions, etc.) and related forms and reports. The regulatory documents cover procedures to be followed in normal, abnormal and accident situations.

Activity-level regulations appear at the level of procedures and - if the complexity of the activity, its impact on safety, or specific requirements so necessitate - in separate implementation instructions linked to the process or to individual activities within the process. Employees also participate in the development of process documents in an editorial capacity. Activities related to the development, regular review, modification, approval, and documentation of processes are regulated in the processes themselves.

The regulatory and procedural documents and their annexes (instructions, forms) are available to nuclear power plant employees on the company intranet and on the Supplier Page created for suppliers. Those affected receive electronic training on any changes, whether occasional or periodic. For those involved in operational activities, all elements of the documents governing operation and in-service testing are available at all times in electronic form, and in printed form at the operational workplaces. All employees have the opportunity to report any non-compliance with the regulations.

The information required by suppliers is provided in accordance with the relevant contractual terms and conditions. The process of preparing, entering into force, reviewing, retaining and withdrawing documents governing operation is controlled by the operational control system in accordance with the applicable procedure. Those carrying out the activities are involved in the document preparation process as consultants.

The purpose of nuclear power plant maintenance activities is to maintain the technological equipment ensuring energy production in a condition suitable for performing its functions, or to restore it to such a condition, and to prevent, reduce or eliminate the consequences of failures, with reasonably necessary expenditure. Nuclear safety is the most important requirement during maintenance activities. The central elements of the maintenance system are systematic planning and the optimal implementation of preventive maintenance and condition-based maintenance. Certain system components are operated until they fail, which is also part of the maintenance strategy.

Outages consist of the following activities:

- technical-safety reviews implemented within the Periodic Inspection Programme;
- periodic and individual maintenance works;
- inspections laid down by material testing framework programmes;
- works originated from regulatory requirements;
- repairing failures occurred during operation;
- safety improvement measures, modifications, reconstructions.

Online maintenance of the units is carried out on equipment that can be taken out of service alongside the unit's nominal operation, with adequate reserves, which reduces the work to be done at outages.

Regular maintenance inspections are carried out to assess the condition of operating or standby equipment; repairs and maintenance are scheduled on the basis of any deviations found.

» Outage strategy

One of the most important factors determining the availability of the Paks Nuclear Power Plant is the duration of outages. In recent years, priority has been given to optimizing the duration of outages and, where possible, ensuring spare time for the necessary repair work.

In the long term, the strategy aims to implement a series of measures that will help maintain outage intervals at a level that is consistent with the technical condition of the equipment and optimal in terms of both cost-effectiveness and labor utilization.

The maintenance strategy introduced in recent years for outages of the units is as follows:

- Short outage: cyclical work and repairs of malfunctions.
- Medium outage: fuel removal and loading, core barrel removal, internal inspection and overhaul of the main gate valve assembly that can be performed with the reactor drained.
- Long outage: fuel removal and loading, inspection of the reactor vessel and reactor internals, internal inspection and overhaul of the main gate valve assembly that can be performed with the reactor drained, steam generator pressure test (can also be performed during medium outages if necessary).

» Maintenance execution schedule

In 2023, the Paks Nuclear Power Plant introduced work management processes for the production subsystem.

The work management processes include the processes for ensuring the materials and services necessary for the work and the modification of the associated operational processes (exclusions). The work management procedures regulate the entire work organization process in detail, which is used to assess new work, select its scope, plan, schedule, and execute it to ensure a high level of safe and reliable operation of the power plant. The work management processes define the basic structure for the efficient use of the power plant's available resources and for the overall improvement of the condition of the equipment. This is a continuously improved set of rules that incorporates the best practices currently available in the industry.

The internal regulation of maintenance activities is set out in process instructions under the production subsystem and in maintenance instructions. These documents cover

- the systems and equipment concerned and their components;
- preparatory and preliminary activities related to maintenance;
- the activities to be performed;
- documentation, evaluation and experience feedback of maintenance activities;
- materials used directly and indirectly during the activities.

Quality control activities related to maintenance are carried out in accordance with the internal procedure documents of the control and monitoring subsystem.

The system of requirements ensures that activities related to the architectural, electrical, control engineering and mechanical maintenance of the Paks Nuclear Power

Plant are performed to the required quality. Compliance with quality requirements is verified by maintenance inspections performed during maintenance work, subsequent quality control and, where applicable, by HAEA.

The most important documents for maintenance work are: work instructions, maintenance instructions and the related quality control plan, the technical decision sheet, as well as the reports, plans, technical descriptions and permits recorded during maintenance.

The planning procedure for long, medium and short outages and Online Maintenance covers the documentation tasks and also defines the responsible persons. The outage planning body is the Maintenance Work Committee, whose operation is governed by meeting rules. The implementation of an outage is determined by the outage approval plan, the outage network plan, and other applicable instructions.

The planning and implementation of scheduled preventive and periodic maintenance work is governed by separate instructions. The lower level of maintenance regulation consists of hundreds of equipment-specific maintenance instructions.

The procedure for involving suppliers in maintenance activities is also regulated in detail. At the Paks Nuclear Power Plant, suppliers are involved through classic service contracts, where they are commissioned to perform independent tasks. The contract, technical inspection of the activities performed by the supplier, approval of the technology used, work instructions, handover of the work area and the inspection obligations of the managers responsible for the area of expertise together ensure that the work is carried out in a controlled manner.

19.3.3. Regulatory Review and Control

The HAEA regularly conducts walk-downs, main control room, operational test, trial, and maintenance inspections for the purpose of supervising operations. HAEA pays particular attention to the supervision of maintenance activities, given that a significant part of its inspections take place during outages at nuclear power plants and that it conducts separate start-up authorizations for the restart of individual units following outages.

19.4. Procedures for Responding to Operational Occurrences and Accidents

19.4.1. Main Requirements and Administrative Arrangements

In accordance with the *NUCLEAR SAFETY DECREE*, the licensee of a nuclear facility shall take technical and organizational measures to prepare for the prevention and response to extraordinary events and nuclear emergencies, and shall prepares a Nuclear Emergency Response Plan, establishes an Emergency Response Organization, trains it and keeps it ready for use, including through drills as necessary, in accordance with the provisions of the regulatory requirements.

The *NUCLEAR SAFETY DECREE* also stipulates that

— emergency operating procedures must be available for the managing of accident conditions analyzed in the nuclear facility's safety analysis report and subsequently identified accident conditions. The emergency operating

procedures shall include the measures necessary to restore the safe state of the nuclear power plant unit;
- the emergency operating procedures for abnormal operating conditions shall be symptom-based instructions or a combination of symptom-based and event-based instructions and shall be based on appropriately qualified system components and measurements;
- nuclear emergency response procedures shall be designed on the basis of the results of the analysis of operational occurrences and accidents, taking into account that the above conditions may occur simultaneously in all reactors and nuclear facilities at the site;
- procedures for complex events shall be symptom-based only;
- the emergency operating procedures and accident management guidelines shall take into account the environmental conditions expected in connection with the events, in particular radiological conditions and the state caused by the initial event or hazard that triggered the situation to be managed;
- the simulator used shall ensure effective practice of normal operating procedures, the use of emergency operating procedures and accident management guidelines, and the practice of effective cooperation of operating personnel.

19.4.2. Implementation by licence holder

Paks Nuclear Power Plant

The development of the Symptom-Based Emergency Operating Procedures (SBEOP) system began in 1996. The completed instructions were validated on the power plant simulator and then introduced in 2003 after comprehensive training and testing of the personnel.

After the introduction of SBEOP for full power operation, MVM Paks NPP Ltd. aimed to create a comprehensive, interlinked instruction system that would enable personnel to handle all operational incidents and accidents.

In order to achieve the above objective, the entire system was reviewed by the end of 2009, and symptom-based operating procedures for handling malfunctions of reactors not at power and incidents in the spent fuel pools (S-SBEOP) and Severe Accident Management Guidelines (SAMG) were prepared.

The completed procedures for non-power operation came into effect in 2011 in all units. The introduction of SAMGs in each unit took place as planned between 2011 and 2014, following the implementation of the related technical modifications.

The SBEOPs and SAMGs take into account the simultaneous handling of events affecting multiple units as well as the modifications related to accident management that have been implemented in the meantime. The latest SBEOP and SAMG amendments were introduced by MVM Paks NPP Ltd. in 2020.

Compliance with Principle 2 of the Vienna Declaration is ensured by regularly – but at least every five years – reviewing the SBEOP and SAMG documents and, where necessary, updating them in line with the technical modifications implemented. These documents have been and will continue to be amended accordingly, taking into account the TSR's safety enhancement measures and the current results of the Level 2 PSA.

19.4.3. Regulatory Review and Control

The revision of the emergency operating procedures and accident management guidelines is approved by HAEA. In certain cases, the HAEA also inspects on site that these documents are available and up to date, and that they are used in emergency response exercises.

19.5. Engineering and Technical Support

19.5.1. Implementation by licence holder

Paks Nuclear Power Plant

» Technical and preparatory organizations

At the Paks Nuclear Power Plant, the technical background is divided according to professions in the current organizational structure. The safety role and responsibilities of the technical background are fulfilled through the following:

- System analysis, condition monitoring, and formulation of technical programmes and tasks based on the monitoring of operational and maintenance events; and their implementation to ensure the safe, reliable, and economical operation of the nuclear power plant;
- Ensuring that the units comply with the applicable technical and safety requirements, utilizing the results of international nuclear energy research;
- Technical justification, planning and implementation of safety improvement measures, modifications, renovations and investments;
- Condition monitoring, trend analysis, ageing management and life cycle management tasks in the fields of mechanical, electrical, control engineering, architectural and chemical engineering, as well as tasks and tests to maintain the certified condition of equipment;
- Performing technical and closely related safety and economic calculations, analyses and reviews;
- Technical design, planning, preparation of technical submissions for HAEA, maintenance of related technical documentation;
- Preparing implementation documentation for storage and transfer to storage;
- Establishing and preparing technical developments (e.g., technological optimizations, technical changes, efficiency improvements, decommissioning);
- As a key strategic objective of the Paks Nuclear Power Plant, company-level management and coordination of tasks related to operation beyond the planned operating life;
- Operation of the company's technical documentation system, technical documentation management, operation of documentation repositories;
- Performing master data management activities for technical databases;
- Establishing the technological basis for maintenance and repair work, preparing, planning and obtaining permits for such work, ensuring documentation, preparing maintenance, repair and installation technologies and programmes, and obtaining permits for them;
- Recording and evaluating maintenance experience, providing feedback, designing and approving implementation plans and repair tools for maintenance, repair and troubleshooting work;
- Developing and improving medium- and long-term fuel utilization strategies;

— Designing core loads, coordinating fuel supply, stockpiling and related tasks. Supervising the safe operation of fuel loads;
— Determining the long-term, medium-term and annual maintenance programme for the Paks Nuclear Power Plant;
— Updating the cyclical maintenance plan for equipment;
— Preparation of company-level development and investment programmes.

The technical background necessary to perform the above tasks is available in the areas of the nuclear facility affected by safety considerations. Accident situations are handled by the Emergency Response Organization, which has the necessary technical resources. The technical equipment necessary for handling design basis accident, severe accidents and situations identified during the TSR is available and owned by the company.

The necessary background institutions, such as HUN-REN CER, the Nuclear Safety Research Institute Ltd. and VEIKI Energia+ Ltd.., are available to provide other technical support activities.

» Decision-making committees

Committees with decision-making powers may be set up on a regular or periodic basis to carry out tasks that arise. Their tasks and operating procedures are laid down by the body that sets them up. The most important technical committees are the Technical Meeting and the Maintenance Working Committee.

» Domestic and foreign background institutions

MVM Paks NPP Ltd. maintains close relations with all domestic companies that provide technical support to the power plant. MVM Paks NPP Ltd. maintains relations with foreign companies (and their successor companies) that were involved in the design, construction and manufacture of equipment, such as TVEL, ATEP, Škoda and Gidropress.

Close relations are also maintained with foreign companies with extensive experience in nuclear technology. Some of the more important companies with which MVM Paks NPP Ltd. has working relations are: Electric Power Research Institute (EPRI), Westinghouse, Rosenergoatom and Framatome.

Based on existing contracts, the main consular functions are performed jointly by HUN-REN CER and the Nuclear Safety Research Institute Ltd.

19.5.2. Regulatory Review and Control

HAEA supervises areas related to nuclear safety at the licensee's nuclear facility, including the licensee's suppliers. According to the legislation HAEA is authorized to inspect licensees' suppliers either directly or indirectly. Indirect inspections include the review of on-site nuclear qualification audits of licensees' suppliers and on-site inspections of licensees' suppliers and manufacturers. During direct on-site inspections of licensees' suppliers, the HAEA must ensure that the activities performed by the supplier for the licensee that have an impact on nuclear safety are carried out in accordance with the licensee's internal regulations and the requirements laid down in the legislation. The licensee shall be present during the direct inspection of the supplier. The details of all suppliers with nuclear certification of licensees are recorded in the HAEA supplier database.

19.6. Reporting Incidents Significant to Safety

19.6.1. Main Requirements and Administrative Arrangements

The *NUCLEAR SAFETY DECREE* stipulates that the licensee has a reporting obligation.

Depending on the safety significance of the event, the licensee shall report events to the HAEA that are subject to immediate reporting, non-immediate reporting, or urgent information providing obligation. The scope of events subject to reporting obligations shall be determined by the authority in an official decision. Incidents subject to immediate reporting must be reported to the HAEA within 2 hours, and incidents subject to non-immediate reporting must be reported no later than 14 hours after the incident occurs. Incidents subject to urgent information providing are those that may be of interest to the press (e.g., unplanned shutdowns).

All reportable events must be classified according to INES, and the relevant proposal must be submitted to the HAEA within 16 hours of the event. The public must be informed within 24 hours of any event classified as INES 1 or higher, and regularly of any events classified as INES 0 or lower. The licensee must provide this information in consultation with the HAEA.

The event investigation report shall be submitted to the HAEA within 45 days of the occurrence of the event. In the case of events important for nuclear safety, a preliminary investigation shall be carried out as soon as possible, but within 5 days at the latest, in order to determine whether urgent measures are necessary. The event investigation report shall include a description of the event, a comparison with similar events, the safety impact, actual and potential consequences, the actions of employees and managers, the compliance of regulated processes and regulations, deviations, causes, and corrective measures.

The licensee shall submit an annual report to the HAEA, providing a comprehensive analysis and presentation of the events that occurred during the year and reporting on the status of corrective measures.

19.6.2. Implementation by license holder

Paks Nuclear Power Plant

The licensee of the nuclear power plant shall report events to the authority in accordance with the provisions of the legislation and official decisions.

Events that have occurred since the previous working day are evaluated at the morning operational management meeting, which may overturn the previous decision of the person who reported the event, i.e. it may classify the event as reportable, and the head of the management meeting may take measures to ensure that further action is taken.

The start of the investigation of reportable events shall be announced by the head of the safety organization at the morning operational management meeting.

Incidents that have occurred shall be subject to an appropriate level of investigation/assessment, the experience gained shall be carefully analyzed, and corrective measures shall be identified to prevent similar incidents from occurring or to reduce the likelihood of their occurrence. The morning management meeting shall decide on the investigation of incidents, designate the organization responsible for the investigation, and appoint the investigator. The investigator shall gather the

information necessary for the investigation, analyze the incident, identify deviations, and prepare an investigation report, which shall be finalized after internal consultations with the relevant disciplines. The final investigation report shall be reviewed by the head of the investigation and approved by the senior director. The investigating organization shall forward the tasks specified in the investigation report to the persons responsible for implementation, monitor implementation, and ensure that the documents produced are handled appropriately.

Internal and external operating experience shall be evaluated in order to identify lessons learned, technical or operational improvements and to effectively inform the power plant personnel. Methods for incorporating experience into day-to-day activities include pre-work briefings and the preparation of documents to assist in work planning, including pre-work briefings for external suppliers. The experience gained from incidents shall be processed and SOL (Safety from Organizational Learning) analyses shall be carried out to ensure effective organizational learning.

The process description in force regulates the method of evaluating the corrective measures decided upon during investigations, the examination of the effectiveness of short- and long-term measures, and the evaluation of experiences and trend analyses of minor incidents. Furthermore, it regulates the method of preparing regular and ad hoc reports and data submissions, the functioning of the incident evaluation committee, and the handling of operational experience to be transferred to the list of safety issues. It covers the sharing of experience from internal incidents, the handling of questions to international partners, and the determination of necessary measures. It also regulates the annual evaluation of the effectiveness of international experience exchange and the evaluation process for the utilization of WANO reports (SOER) with significant operating experience.

No events classified as INES 1 or higher have occurred at the operating nuclear power plant since 2012. The number of reportable events is shown in Table 8.

Table 8. Number of reportable events at the Paks Nuclear Power Plant (2019-2024)

Year	2019	2020	2021	2022	2023	2024
Number of events	10	20	11	4	16	9

19.6.3. Regulatory Review and Control

The HAEA receives reports of incidents through its permanently available standby duty service, which immediately informs the relevant organizational units and managers about the incident and reviews the INES sheet prepared by the licensee. Depending on the information available and the safety significance of the event, the HAEA conducts a more in-depth investigation of the circumstances of the events and evaluates the investigation reports. Depending on the safety significance of the event, the HAEA reviews the event investigation reports with the involvement of the relevant specialist areas or, if necessary, in a separate group set up to evaluate the event.

In 2022, the HAEA conducted a comprehensive inspection of MVM Paks NPP Ltd.'s event investigation processes.

The HAEA may request further information in connection with the events and, if necessary, order a separate investigation based on the information contained in the licensee's internal memos.

The HAEA regularly informs the public about events that are important from a safety perspective and those classified as INES 1 or higher.

19.7. Operating Experience

19.7.1. Main Requirements and Administrative Arrangements

The detailed requirements for achieving the general objectives set out in the *ATOMIC ACT* are contained in the *NUCLEAR SAFETY DECREE*, including:

- The legislation shall be reviewed at regular intervals, but at least every five years, taking into account national and international experience.
- The licensing procedures laid down in the legislation and the PSR must demonstrate how domestic and international experience has been used.
- The licensees' regular and event reports shall also include information on the use of experience.
- The licensee shall establish processes in its written management system for the utilization of internal and external experience. This shall include regular evaluation and improvement of the effectiveness of the experience utilization process.

ANNEX 4 of the *NUCLEAR SAFETY DECREE* contains detailed requirements for the utilization of operating experience, including the preparation, implementation, and evaluation of modifications. The licensee shall apply a safety indicator system during operation and based on the results, shall take measures as necessary.

After the implementation of authorized modifications, the licensee shall submit a modification evaluation report to the authority, providing a comprehensive assessment of the experience gained from the modification.

19.7.2. Implementation by licensee

Paks Nuclear Power Plant

» Own operating experiences

The objective of the Paks Nuclear Power Plant is to evaluate and utilize internal operational events in order to increase the safety and reliability of the power plant. The reports, investigation reports and documents produced during the process must comply with the HAEA requirements, the policies and internal regulations of MVM Paks NPP Ltd. and take into account the WANO recommendations.

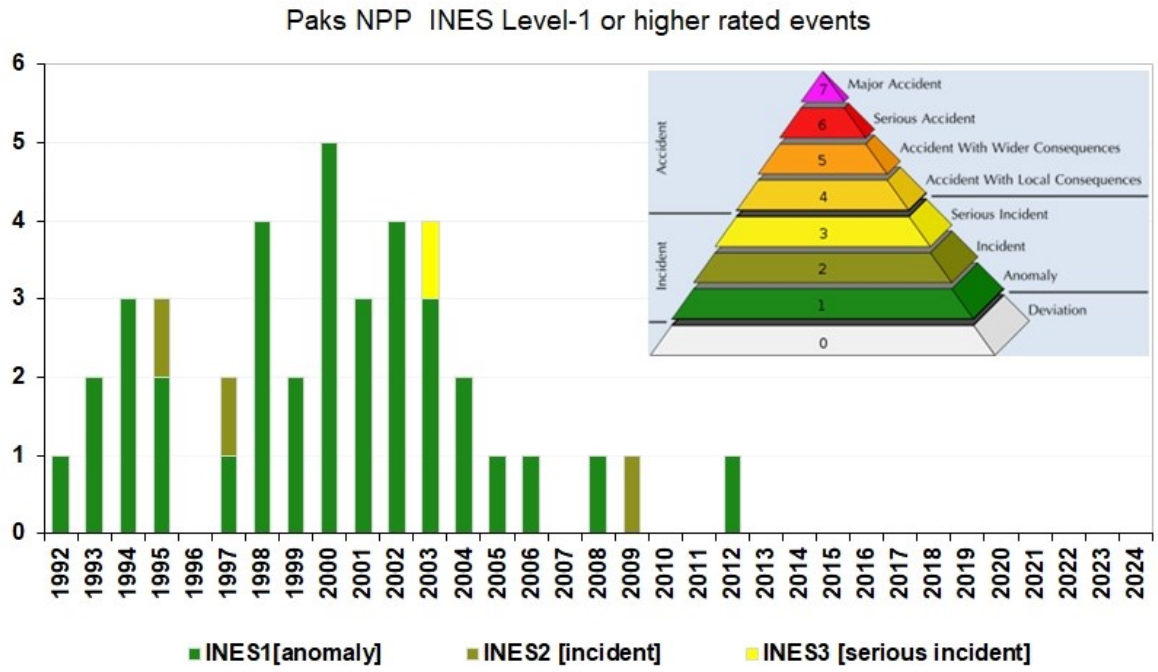
Data collection and processing are separate for equipment and activities in the mechanical, control engineering and electrical fields. As a result, the depth and comprehensiveness of monitoring and the use of the data obtained differ. To ensure uniform collection and processing, the data collected for each field is managed in a common database.

The analysis of reliability and availability indicators provides a basis for the replacement, modernization and modification of equipment and system components. The data is also used in safety analyses. The safety systems have good indicators in international comparison. In order to ensure that data collection within the organizational units of the power plant is uniform and consistent, plant-level internal regulations have been developed.

Safety-related incidents at the Paks Nuclear Power Plant are always investigated with the involvement of the relevant experts. Incidents are investigated at different levels within the nuclear power plant, depending on the severity of the incident. Incidents that are reportable to the HAEA and incidents ordered to be investigated by the authorities are investigated at the power plant level in accordance with the relevant requirements, while other incidents are investigated by the relevant departments or through professional evaluation. Since 1992, events have also been classified according to the INES scale introduced by the IAEA for external information purposes, with the classification of previous events at being carried out retrospectively. Since 2000, certain events have also been analyzed using probabilistic tools.

Between 1992 and 2024, safety-related events at the four units of the Paks Nuclear Power Plant were classified according to INES as shown in Figure 6. No events classified as INES 1 or higher occurred during the period covered by the report.

Figure 6. Number of INES 1, 2, and 3 events at the Paks Nuclear Power Plant since 1992



The results of the investigations, the identified deviations and the corrective measures are widely communicated. In all cases, the measures are linked to deadlines and responsible persons, thus ensuring their traceability. Not only individual events are monitored but also trends and changes in the reliability of safety systems over time. If necessary, the trends identified lead to modifications or other technical or administrative interventions. The experience gained is used in training and simulator training. Feedback from operating experience is reflected in the continuous and regular revision of operating instructions and the OLC.

The Operations Review Committee reviews the development of safety indicators, the experience gained from incident investigations, and the status of the implementation of measures taken on a quarterly basis. The Operations Review Committee is a body operated by the Safety Directorate, which coordinates proposals prepared for decision-making, with the Safety Director having the final decision-making authority.

» Utilization of experience from other power plants

It is in the fundamental interest of MVM Paks NPP Ltd. to learn about and utilize operational and other experience gained from other facilities and international information sources. MVM Paks NPP Ltd. participates in the work of major international nuclear organizations (IAEA, OECD NEA). More direct cooperation involves participation in specific professional work as a member of groups of nuclear power plant operators, such as WANO and the VVER 440 Operators Club. The closest cooperation is possible between partner nuclear power plants. This type of relationship involves a wide range of mutually beneficial individual or long-term activities, from joint projects and experience sharing to data provision, as described at. In recent years, EPRI has provided significant support for the extensive cooperation between VVER operators.

» External reviews

The main international reviews of the Paks Nuclear Power Plant are presented Table 9.

Table 9. International safety reviews carried out at the Paks Nuclear Power Plant

Year	Subject of the review	Conducted by
1984-1987 annually	Operation, maintenance	Experts invited by the Soviet supplier
1988	1st OSART (full scope)	IAEA
1990	Operation, maintenance	Experts from 4 countries invited by the power plant
1991	Design for safety	IVO
1991	Post-OSART review	IAEA
1992	1st peer review	WANO
1992	ASSET	IAEA
1993-1996	Site seismicity - 6 occasions seismic safety programme – 2 occasions	IAEA
1995	Post-ASSET review	IAEA
1995	Follow-up of the 1st peer review	WANO
1996	Assessment of the accomplishment of safety improvement measures	IAEA
1997	Nuclear Liability Insurance Engineering Inspection	International experts of the insurance pool
1997	Quality assurance audit	Blayais Nuclear Power Plant
1999	PSA analysis of low power states (IPERS) (VEIKI-Paks NPP joint studies)	IAEA
2000	Pre-OSART mission	IAEA, Paks NPP
2001	OSART mission	IAEA
2001	Nuclear Liability Insurance Engineering Inspection	International experts from the insurance pool
2003	Review of Unit 2 event	IAEA
2003	Review of Unit 2 event	WANO
2003	Expert mission concerning the development of organizational operation	IAEA
2004	Expert mission on organizational development	IAEA

2004	Follow-up mission of the serious incident that took place at Unit 2	WANO
2005	Follow-up missions of OSART and expert missions	IAEA
2005	nuclear liability insurance engineering review	International experts from the insurance pool
2005	2nd peer review	WANO
2008	nuclear liability insurance engineering review	International experts from the insurance pool
2008	Follow-up of the 2nd peer review	WANO
2012	3rd peer review	WANO
2013	nuclear liability insurance engineering review	International experts from the insurance pool
2014	Follow-up of the 3rd peer review	WANO
2014	OSART mission	IAEA
2014	Corporate level peer review	WANO
2016	4th peer review	WANO
2016	Corporate level follow-up peer-review	WANO
2016	OSART follow-up mission	IAEA
2018	Follow-up of the 4th peer review	WANO
2018	nuclear liability insurance engineering review	International experts from the insurance pool
2021	5th peer review	WANO
2021	2nd company-level peer review	WANO
2024	5th follow-up partner review	WANO
2024	nuclear liability insurance engineering review	International experts from the insurance pool
2024	4th OSART review	IAEA

Overall, it can be said that all safety reviews have been concluded with a positive overall assessment, but based on international experience, recommendations have also been made to further improve safety. The implementation of action plans to implement the recommendations will play a significant role in raising the safety level of the nuclear power plant.

As part of the renewal process following the Fukushima nuclear accident, WANO is conducting its previous six-yearly partner reviews more frequently, every four years, at its member plants. Taking into account the follow-up review, the nuclear power plant will thus undergo an international review every two years.

Paks II.

The licensee continuously monitors its own internal, domestic and international experience in relation to construction, commissioning and operation. It has established internal processes for this purpose as part of its management system. In accordance with the conditions set out in the construction license issued by the HAEA, the licensee reports on the results of these activities in its annual report.

19.7.3. Regulatory Review and Control

The HAEA evaluates the annual report submitted by the licensee of the operating nuclear power plant, which includes, among other things, a report on operating experience, a comprehensive analysis of events that have occurred, and the utilization of external experience.

The HAEA evaluates the reports prepared by the licensee following the implementation of authorized modifications, presenting the experience gained from the modifications.

In 2022, the HAEA conducted a comprehensive inspection of MVM Paks NPP Ltd.'s experience utilization process and practices.

Paks II Ltd. reports in its annual report on the collection and evaluation of operating experience from power plants similar to the planned nuclear power plant, which is regularly reviewed and evaluated by the HAEA.

The HAEA collects and shares international operating experience through its various bilateral and multilateral relations with authorities and through its participation in the work of various international organizations and their working groups. Of particular importance are the monitoring of information appearing in the IAEA Incident Reporting System, participation in the OECD NEA Expert Group on Operating Experience, and cooperation with the authorities of countries operating VVER reactors. Based on the experience gained, the HAEA will, if necessary, request the licensee to examine the lessons learned from an event in relation to its own facility.

19.8. Management of Spent Fuel and Radioactive Waste Onsite

19.8.1. Main Requirements and Administrative Arrangements

In accordance with regulations from European Union, Hungary has developed a National Policy on the Management of Spent Fuel and Radioactive Waste, the primary objective of which is to set out the expectations and basic principles for the management of radioactive waste and spent fuel. The National Policy covers all radioactive waste and spent fuel generated in the country, from their generation to their final disposal, taking into account the decommissioning of nuclear facilities, and sets out the basic principles and policies. The National Program outlines the implementation of the objectives of the National Policy for all stages of spent fuel and radioactive waste management, from generation to final disposal, including the decommissioning of nuclear facilities.

The *Nuclear Safety Decree* stipulates that the licensee must ensure the safe control of radioactive material used, produced, stored or transported, and of all radioactive waste generated, and that the generation of radioactive waste must be kept to a minimum in terms of both activity and quantity.

Annex 3 to the *Nuclear Safety Decree* lays down the basic principles for the management and storage of fuel and radioactive waste, the requirements for systems and components, and the conditions to be ensured for management and measurement. *Annex 4* of the *Nuclear Safety Decree* deals with the requirements for the management of nuclear fuel and radioactive waste, the procedures to be followed, the safety management programmes, and record keeping. Radioactive waste is classified in accordance with the *Radiation Protection Decree*.

The safe management of radioactive waste at the nuclear power plant is the responsibility of the waste producer, i.e. MVM Paks NPP Ltd. According to the *ATOMIC ACT* and its implementing decrees, PURAM is responsible for the final disposal of radioactive waste, the temporary and final storage of spent fuel, the closure of the nuclear fuel cycle, and the decommissioning of nuclear facilities.

Radioactive waste is also subject to the rules on the clearance and release of radioactive materials. The exemption levels (general and specific exemption activity concentrations) and the procedure for release from regulatory control are regulated by the *RADIATION PROTECTION DECREE* in accordance with regulations of the European Union. The referenced legislation distinguishes between cases subject to notification and cases that can be released under the licensing procedure. The radiation protection limits for the release of radioactive materials subject to notification are specified in the *RADIATION PROTECTION DECREE*. In the case of activities or activity concentrations exceeding the limits, the release of radioactive material is subject to an authorization procedure, in which it must be demonstrated that the individual annual radiation exposure does not exceed the levels specified in the legislation. The authorization may relate to the release of an existing quantity of material or a quantity of material generated on an ad hoc or operational basis.

The activity concentration of nuclides in the radioactive material to be released shall not exceed the specific exemption activity concentration for the nuclide in question.

19.8.2. Implementation by licence holder

Paks Nuclear Power Plant

» On-site management of spent fuel elements

The Paks Nuclear Power Plant has four independent spent fuel pools for the temporary storage of irradiated or spent nuclear fuel assemblies from the reactors.

The basic normal operating function of the spent nuclear fuel storage system is to provide the free storage capacity required for the operation of the reactors for a specified period of time for spent fuel assemblies:

- Assuming steady-state operation, the required storage capacity is determined by the length of the fuel cycle and the cooling time required for transport. After storage in the spent fuel pools, the spent fuel assemblies can be transported to the SFISF for temporary storage. The minimum cooling time for first-generation fuel assemblies is 3 years. For second-generation assemblies with an average enrichment of 4.2%, the cooling time is 4 years, and for assemblies with an average enrichment of 4.7%, it is 3 years and 10 months. The 15-month refuelling cycles associated with the second-generation fuel type require significantly less storage capacity than originally planned. For the so-called SLIM fuel (a fuel assembly with optimized water-uranium ratio), introduced in 2020, the minimum storage time before delivery to SFISF is 4 years. With the introduction of the latter type, the number of spent fuel assemblies generated has been reduced from 102 to 96 per refuelling cycle, and the storage capacity required has also been reduced.
- In addition, the spent fuel storage system must be capable accommodating the removal of all fuel assemblies from the reactor core in all operating conditions, i.e. storage capacity for an additional 349 fuel assemblies and 37 absorbers must be provided.

A maximum of 1,052 storage spaces are provided in the spent fuel pool for the storage of spent fuel assemblies per unit.

The operating storage rack of the cooling pool has been designed to store 650 spent fuel assemblies and has 56 positions for storing hermetic casks, which can also be used for temporary storage of hermetic fuel assemblies. The spent fuel pool's reserve rack has space for storing 346 fuel assemblies.

Overall, sufficient storage capacity is provided in all operating conditions for the storage of fuel assemblies removed from the reactors during normal operation or in the event of a post-incident shutdown.

» On-site management of radioactive waste

The collection, processing and temporary storage of waste is carried out as part of operational tasks, while the safe final disposal and preparation for the final disposal of long-lived and high-level waste is carried out in accordance with the *National Policy* on Radioactive Waste Management and the operational document for its implementation, the National Program.

Radioactive waste is any material that is generated during a planned nuclear activity and is no longer required for further use, but whose concentration of radioisotopes exceeds the limits for release or disposal into the environment that are considered safe.

Liquid waste is temporarily stored within the power plant in auxiliary building tank farms. The total volume of the tanks is 11,225 m^3, and as of December 31, 2024, the quantity stored in them is 7,718 m^3.

The technology for reducing the volume of evaporation residues, which account for the majority of liquid radioactive waste, was put into operation in 2013. The aim of the volume reduction is to ensure that, after treatment, the purified wastewater can be discharged in accordance with the conditions specified in the power plant's water discharge regulations and the technology licenses.

Liquid waste that cannot be processed using liquid waste processing technology is solidified by cementation prior to final disposal. Active complex testing of the cementation technology equipment and cementation recipe was successfully completed in 2023. During commissioning tests, 18 compact waste packages were produced, containing cement slurry made from distillation residues and compacted solid waste. The compact waste packages met the waste acceptance requirements of the National Radioactive Waste Repository, and 17 compact waste packages were transferred to PURAM. Trial operation of the technology began in 2024. In 2024, 20 compact waste packages were transferred to PURAM.

Solid waste is categorized based on dose rate (low, medium, and high activity); for practical reasons, low and medium activity waste is treated together. Low- and medium-level solid waste (including solidified and dewatered sludge) is placed in standard 200-liter metal drums with 1.2 mm thick walls.

Based on the processing methods, the following waste types can be distinguished:

- compressible waste,
- non-compressible waste,
- sludge collected at the bottom of technological containers.

The volume of compressible radioactive waste is reduced using a 500 kN press, with an average volume reduction factor of 5. Approximately 80-90% of the low- and medium-level solid radioactive waste generated is compressible.

Non-compressible waste is placed in barrels according to material type and in an optimal arrangement (based on considerations of mass, size and dose performance).

In the case of sludge originating from different locations and with different moisture contents, the main objective is to remove moisture.

Small and medium-level solid waste is temporarily stored in storage rooms in the main and auxiliary buildings, with a total capacity of 11,355 barrels; as of 31 December 2024, the number of barrels stored is 10,274. In these rooms, waste is stored in a recoverable manner for subsequent transport to a final storage facility (possibly for recycling or disposal).

During the operation of the units, and especially during outages, in addition to low- and medium-level solid waste, high-level waste is also generated, which mainly includes components removed from the reactor (thermal elements, control rod absorbers, etc.). Most of this waste is stored in storage wells in the reactor halls and will be disposed of permanently when the power plant is decommissioned.

As of 31 December 2024, 52.61 m^3 of high-level waste will have been generated, requiring 112.72 m^3 of storage space.

The following measures have been taken to reduce radioactive waste at source:

- the delivery of packaging materials to the controlled zone is prohibited and is only possible with a special permit,
- the use of wood is prohibited,
- optimized use of personal protective equipment (based on justification),
- separation of inactive and radioactive waste during collection in the controlled zone,
- radioactive waste (contaminated materials) is strictly separated from clean materials,
- separation of work areas in the controlled zone to prevent the spread of radioactivity and contamination.

The amount of radioactive waste is also reduced by the following methods:

- washing and reuse of personal protective clothing,
- use of reusable thermal insulation,
- decontamination of tools and equipment.

The following methods are available to reduce the amount of existing low- and medium-level solid waste:

- reprocessing, which not only frees up storage capacity but also ensures compliance with waste acceptance requirements in the case of so-called "historical" waste.
- waste release, which can be used for barrels with lower dose rates and/or older sealed barrels, thus increasing temporary storage capacity and preventing "inactive" waste from entering the final repository.

As of 31 December 2024, the increase in storage capacity was 490 barrels from reprocessing and 1,735 barrels from waste release, for a total of 2,225 barrels.

» Procedures developed for the clearance of radioactive waste

The nuclear power plant carries out its waste release activities in accordance with the *RADIATION PROTECTION DECREE*. The removal of waste, materials and objects from the controlled zone is carried out in accordance with the provisions of the regulations, taking into account the release levels approved by the authorities and based on activity measurements. The activity concentration limits shall be reviewed annually.

19.8.3. Regulatory Review and Control

The liquid radioactive waste processing plant has recently been commissioned at the Paks Nuclear Power Plant, in connection with which HAEA has approved the cement slurry recipe, the processing of evaporation residues and their casting into compact waste packages.

As part of its general radiation protection inspections, the HAEA checks that radioactive waste is collected in accordance with internal regulations. In the recent period, the HAEA has carried out a number of targeted inspections of radioactive waste management, focusing primarily on the new licensed liquid radioactive waste processing technology, including checking the commissioning of the cementing plant, inspecting the production of compact waste packages on several occasions, and checking the transfer of compact waste packages ready for final disposal.

Furthermore, during its review of the annual regular report, HAEA examines compliance with the waste minimization principle based on the amount of radioactive waste generated and continuously assesses the amount of waste generated during operation, maintenance, and modifications based on trends.

Summary of Significant Changes Since Previous Report

In 2023, the Paks Nuclear Power Plant introduced work management processes for the production subsystem, which also had an impact on maintenance practices.

E. ANNEXES

I. References

I.1. List of legislation

Laws

Act CXVI of 1996	on Atomic Energy
Act I of 1997	on the promulgation of the Convention on Nuclear Safety signed in Vienna on 20 September 1994 under the auspices of the International Atomic Energy Authority
Act LXXXII of 2006	on the promulgation of safeguards agreement and protocol on the implementation of Article III, (1) and (4) of the Treaty on the Non-Proliferation of Nuclear Weapons, and on the Additional Protocol enclosed to the Agreement
Act LXII of 2008	on the promulgation of Amendments to the Convention on the Physical Protection of Nuclear Material, adopted by the International Atomic Energy Agency (IAEA) in 1979 and promulgated by Legal Decree 8 of 1987, signed on 8 July 2005 at the Diplomatic Conference organized by the IAEA
Act CXXVIII of 2011	on disaster management and amendment of certain corresponding acts
Act C of 2012	on the Criminal Code
Act I of 2012	on the Labor Code
Act II of 2014	on the promulgation of the Intergovernmental Agreement between the Government of Hungary and Government of the Russian Federation in the field of peaceful use of atomic energy
Act XXIV of 2014	on the promulgation of the Intergovernmental Agreement between the Government of Hungary and Government of the Russian Federation on granting the state loan provided for financing the construction of the nuclear power plant in Hungary
Act VII of 2015	on the investment related to maintaining the capacity of Paks NPP and the amendment of certain corresponding acts
Act CV of 2016	on the promulgation of the modifications in 2015 and 2016 of the Convention concerning International Carriage by Rail (COTIF) and its annexes in unified structure
Act I of 2017	on public administration judicial procedure
Act CVII of 2019	on special status organs and the legal status of persons employed by them
Act CXXI of 2023	amendment of Act CXVI of 1996 on Atomic Energy
Act LXXXIII of 2024	amendment of Act CXVI of 1996 on Atomic Energy

Government Decrees

Government Decree 227/1997. (XII. 10.)	on the nature, conditions and amount of insurance or other financial security for nuclear damage liability
Government Decree 314/2005. (XII. 25.)	on the environmental impact study and the licensing procedure of unified environmental use
Government Decree 148/1999. (X. 13.)	on the promulgation of the Convention on Environmental Impact Assessment in a Transboundary Context, signed in Espoo (Finland) on February 26, 1991
Government Decree 179/2008. (VII. 5.)	on the promulgation of the Agreement between the Government of the Republic of Hungary and the Government of the United States of America on the return of spent fuel elements from a research reactor to the Russian Federation and on the financing thereof
Government Decree 34/2009. (II. 20.)	on the authorization of the transboundary shipment of radioactive waste and spent fuel
Government Decree 167/2010. (V. 11.)	on the Hungarian Nuclear Emergency Response System
Government Decree 112/2011. (VII. 4.)	on the scope of activities of the HAEA in connection with its international obligations including the European Union, its authority and penalizing rights, the assignments of its co-authorities and on the Scientific Committee assisting the HAEA's activity
Government Decree 190/2011. (IX. 19.)	on the physical protection requirements for various applications of atomic energy and the corresponding system of licensing, reporting and inspection
Government Decree 246/2011. (XI. 24)	on the safety zone of nuclear facilities and radioactive waste storage facilities
Government Decree 213/2013. (VI. 21)	on the Technical Committee of the Central Nuclear Financial Fund
Government Decree 214/2013. (VI. 21.)	on the rules for subsidies granted from the Central Nuclear Financial Fund to municipal associations for control and information purposes
Government Decree 215/2013. (VI. 21.)	on the designation, activities and financial resources of the body responsible for certain tasks related to radioactive waste and spent fuel
Government Decree 180/2014. (VII. 25.)	on the promulgation of the agreement between the Government of Hungary and the Government of the Republic of Serbia on rapid notification in the event of a radiological emergency
Government Decree 489/2015. (XII. 30.)	on the system of control of the environmental radiation situation determining the natural and artificial radiation exposure of the population and on the scope of quantities to be mandatorily measured
Government Decree 490/2015. (XII. 30.)	on the reports and interventions regarding missing, found or seized nuclear and other

	radioactive materials and other actions pertaining to radioactive materials following their report
Government Decree 489/2017. (XII. 29.)	on general and specific rules for fire protection authority procedures
Government Decree 532/2017. (XII. 29.)	on supplementary procedural rules for the aviation authority
Government Decree 182/2022. (V. 24.)	on the tasks and powers of members of the Government

Ministerial decrees

Decree of the Minister of Environment 15/2001. (VI. 6.)	on the radioactive releases into the air and water during the use of atomic energy, and on their control
Decree of the Minister of Interior 47/2012. (X. 4.)	on police tasks related to the use of atomic energy
Decree of the Minister of Interior 5/2015. (II. 27.)	on specific fire safety requirements related to the use of nuclear energy and the methods of enforcing them in the activities of the authorities
Decree of the Minister of Economic Development 1/2022. (V. 26.)	on the designation of persons exercising all the ownership rights and obligations of the state over certain state-owned companies

HAEA Decrees

HAEA Decree 1/2022. (IV. 29.)	on the nuclear safety requirements of nuclear facilities and the related regulatory activities
HAEA Decree 2/2022. (IV. 29.)	on the protection against ionizing radiation and the corresponding licensing, reporting and inspection system
HAEA Decree 10/2022. (XII. 29.)	on the special professional training and advanced training of workers employed in a nuclear facility, and on the scope of persons authorized to conduct activities in relation with the application of atomic energy
HAEA Decree 1/2024. (IV. 8.)	on the register of independent inspection organisations authorised on the basis of legislation and on the requirements to be applied during accreditation

II. Ageing management

Basics of aging management

MVM Paks NPP Ltd.'s ageing management concept is in line with:

- international and domestic experience in the field of ageing management and lifetime management;
- nuclear safety considerations;
- the continuous development of scientific and technical knowledge.

MVM Paks NPP Ltd. carries out systematic life cycle management activities for components classified in safety classes 1-3 and for components classified in non-safety class 4 that endanger the operation of safety functions (hereinafter: SC 1-3+). Within this,

- for components performing active functions, the maintenance of the technical condition required for the required safety level is ensured by means of an efficiency monitoring system;
- environmental qualification is carried out for electrical and control system components operating in hostile operating environments and the qualified status is continuously maintained;
- systematic ageing management shall be carried out for passive components:
  - individually for components subject to special treatment,
  - for non-high-priority components, by grouping the system components (system component groups).

Systematic ageing management for components with passive functions includes the following:

- identification of likely deterioration processes and structural locations sensitive to aging;
- the application of measures to mitigate and prevent aging processes;
- determination of parameters to be monitored for aging;
- timely detection of ageing effects through operational and in-service condition monitoring (e.g. technical safety review, non-destructive material testing, operational tests, etc.);
- monitoring of the aged condition (aging monitoring system), evaluation of the condition;
- developing acceptance criteria for assessing the status;
- developing corrective measures in case of non-compliance and implementing them (e.g., repair, replacement, administrative measures);
- increasing the effectiveness of the component aging management programme (feedback of status information to the programme);
- the possibility of administrative control of ageing management (quality control, coordination, documentation);
- utilizing operational experience.

This activity is carried out in accordance with approximately 150 ageing management programmes, the technical aspects and content of which, in addition to Hungarian requirements, are also in line with international practice [NUREG 1801, IAEA Specific Safety Guide SSG-48, IAEA SRS 82 (IGALL), and the results of international research and development in this field (e.g. EPRI, NUGENIA)].

Representatives of the Paks Nuclear Power Plant actively participate in the IAEA International Generic Ageing Lessons Learned (IGALL) programme, as a result of which they obtain first-hand information on documents related to ageing management and lifetime extension within the framework of both IGALL and other activities. This means that the Paks Nuclear Power Plant also complies with international expectations and the provisions of the documents, and implements them in its daily practice as quickly as possible. Accordingly, in the case of SSG-48, published in December 2018, there is a high degree of consistency between the plant's practices and the recommendations contained in the document, which was confirmed by the OSART review in autumn 2024. The ageing management programmes of the Paks Nuclear Power Plant also follow the structure and content of the publicly available ageing management programmes developed under the IGALL programme, which were based on the experience of more than twenty countries participating in the IGALL programme.

Selection of system components for special attention in ageing management

The components covered by the ageing management programme were selected primarily on the basis of a review of the equipment playing the most important role in the cooling and safe shutdown of the reactor, as well as the structures preventing the escape of radioactive media (principle of defense in depth). In addition to the relevant legislation, the IAEA publication Technical Reports Series 338, "Methodology for the Management of Ageing of Nuclear Power Plant Components Important to Safety," was also taken into account in the selection process.

Taking the above criteria into account, the nuclear power plant carries out systematic ageing management for passive components classified as SC 1-3+ (approx. 25,000 items/unit). The components involved in ageing management are classified according to two criteria:

- Elements classified as priority in the *NUCLEAR SAFETY DECREE*, which are subject to individual ageing management: "priority components".
- Components managed at the component group level: several components with similar ageing characteristics are managed in an ageing management programme.

The list of "priority components " also includes components which, due to their specific characteristics, require long-term life management activities or whose replacement would pose a serious financial and technical challenge. The important components are as follows:

- reactor vessel and reactor vessel support structure;
- structures inside the reactor vessel;
- main coolant pipe and connecting pipe stubs;
- pressurizer;
- steam generators;
- main shut-off valves;
- main coolant pumps.

The ageing management programme for all highlighted components also includes the ageing management of the earthquake protection reinforcements of the main equipment concerned.

In the case of other mechanical equipment and architectural structures, the nuclear power plant may decide whether to carry out ageing management by forming groups or under a separate programme. In the case of electrical and control system components operating in hostile environments, the power plant shall carry out environmental qualification.

Procedures

MVM Paks NPP Ltd. implements comprehensive ageing management in accordance with the requirements of the *NUCLEAR SAFETY DECREE*. The investigation of technical problems related to the ageing of systems and components, and the assignment and implementation of tasks related to ageing management are carried out in accordance with the procedures entitled "Comprehensive ageing management process" and "Operation of ageing management programmes". The procedures define and coordinate the tasks of the organizational units responsible for ageing management.

Current status of ageing management

Ageing management at the Paks Nuclear Power Plant is carried out in four professional areas, taking into account the specific characteristics of each profession: mechanical engineering, electrical engineering, instrumentation and control engineering and civil engineering. Systematic and coordinated activities are ensured by the relevant procedures.

Based on the requirements of the *NUCLEAR SAFETY DECREE*, the Paks Nuclear Power Plant reviews and updates its comprehensive ageing management programme annually. On this basis, it submits an annual report to the HAEA, detailing the activities carried out in the field of ageing management during the past year, the condition of the most important equipment and whether the individual ageing management programmes have yielded any experiences that require action. It should also be noted that a comprehensive review of the aging management of the power plant is carried out every 10 years within the framework of the PSR, in accordance with the recommendations of the IAEA and WENRA.

Domestic legislation also ensures consistency between the ageing management and the planned periodic inspection programme. Accordingly, from the authority's point of view, the evaluation of the ageing management programme is linked to the evaluation of the periodic inspection programmes. At the beginning of each calendar year, the licensee of the Paks Nuclear Power Plant submits the annual periodic inspection programme plan to the authority, which reviews it to assess whether non-conformities or the progression of aging mechanisms are in line with the periodic inspection plans. Based on this information, the authority prepares its annual inspection plan for both comprehensive and ad hoc inspections.

This shows that Hungary complies with Principle 2 of the Vienna Declaration, as the aging management programme is reviewed regularly and systematically, both annually (in the short term) and in the longer term within the framework of the PSR.

System-specific aging management programmes have been developed in each area of expertise, which form the basis for comprehensive aging management. The exception is the electrical field, where aging management in accordance with specific aging management programmes for cables is only a supplement to the equipment environmental qualification. The condition assessment programmes used in the past

and their results were also used in the development of the specific ageing management programmes.

The results of aging management are of decisive importance for determining the technical and safety reserves of equipment deemed important for the subsequent service life extension, and thus for the development and operation of a life cycle management strategy. Aging management utilizes the results of domestic and international best practices. New, previously unknown deterioration processes may arise during the work, and targeted research and development activities are well suited to understanding these.

III. Implementation of measures decided in Hungary based on the lessons learned from the Fukushima accident

Following the accident at the Fukushima Daiichi Nuclear Power Plant, on 25 March 2011, the Council of the European Union concluded that nuclear power plants in the European Union should undergo a comprehensive safety review, assessing the risks of their operation and making the entire process public. The review is commonly referred to as a "stress test," and its official name in Hungary is "Targeted Safety Reassessment" (TSR). The review was first carried out by the organizations operating the power plants, then the national nuclear authorities of each country evaluated the results of the review and compiled national reports. The national reports were then evaluated by a group of international experts. The expert review consisted of three steps: first, the reports of the national authorities were reviewed, followed by a detailed assessment of the three main areas of the review (external hazards, electrical power supply and loss of ultimate heat sink, and accident management), involving the authors of the reports, during which the representatives of the countries were able to answer the reviewers' questions. In the third phase, the expert groups also carried out on-site reviews, visiting the authorities of all 17 countries concerned and one nuclear power plant site in each country. The reports on each country were finalized in this phase.

Based on the TSR assessment, the licensee proposed a number of corrective measures to increase safety margins. HAEA reviewed the proposed measures and, agreeing with them, ordered their implementation and the preparation of a detailed action plan, together with a few additional measures it considered important. At the end of 2012, the authority prescribed the implementation of the measures formulated to enhance safety, which included 46 tasks.

The HAEA reviewed the implementation of the action plan on an annual basis. In addition, during the third PSR in 2017, the Paks Nuclear Power Plant checked the status of the TSR measures and analyzed the extra safety risks arising from the delays. During the review, six uncompleted tasks were rescheduled in the final PSR decision of the authority, taking into account the time required for their implementation. Measures and modifications resulting from deviations identified during the TSR that posed a greater safety risk were completed by the end of 2018.

The tasks completed by the end of 2021 are presented in the annex to the *Ninth National Report*, while those for the period 2022-2024 are presented below.

III.1. Completed TSR tasks

By the end of 2024, 45 of the 46 tasks will have been completed.

The licensee's analysis confirmed that the remaining task poses an acceptable safety risk and that the delay does not significantly increase the safety risk arising from the lack of action.

Tasks completed in 2022-2024

In 2024, two 2 MW net electrical power emergency generators were completed, which are resistant to earthquakes with a frequency of occurrence of 10^{-5}/year, and are capable of operating under extreme environmental parameters, with 168 hours of

operating time and a fuel tank sufficient for independent operation from the nuclear power plant's other water and power supply systems.

By the end of 2024, a cooling system that manages the slow build-up of pressure in the containment and prevents the formation of pressures significantly exceeding the design pressure has been installed in all units. This system does not require cooling water for its operation, so it can perform its task even if the essential service water system fails.

A Backup Command Centre equivalent to the Protected Command Centre has been established. The Backup Command Centre is a 2,000 m2 building complex that can withstand earthquakes with a frequency of occurrence of 10^{-5}/year and can be operated even under extreme environmental conditions.

The amendment to Government Decree 346/2010. (XII. 28.) on government networks, effective as of April 2017, made it mandatory for licensees to use the Unified Digital Radio System for wireless communication, which ensures wireless communication in all operating states of the unit (including design basis and design basis extension conditions). The system was established in 2022.

III.2. TSR tasks in progress

With the reinforcement of the fire station building the safety of personnel and equipment in the event of an earthquake must be ensured. Based on the technical survey, the original objective of reinforcing the old fire station was replaced by the construction of a new fire station. The technical specifications for the design and the construction plans for the new station were completed in 2022. In 2023, the seismicity values for the site were revised, which meant that the plans had to be reviewed to ensure that the structure was compliant, resulting in a delay in construction. Further delays in construction were caused by the temporary replacement of electrical cables uncovered in the excavation pit, which was completed by the end of 2024.

Planned completion date: 31 July 2026.

IV. Activities related to the planned Paks II Nuclear Power Plant

In January 2014, the Government of Hungary and the Government of the Russian Federation signed an agreement on cooperation in the peaceful use of nuclear energy, which was promulgated by *ACT II OF 2014* and covers, among other things, cooperation on new nuclear power plant units.

Within the framework of the intergovernmental agreement, on 9 December 2014, Paks II Ltd. and the Russian Joint-Stock Company Nizhny Novgorod Engineering Company Atomenergoproekt signed three implementation agreements for two new nuclear power plant units, each with a capacity of 1200 megawatts, to be built in Paks, namely

- a so-called main contractor agreement on the design, procurement and construction of the new units;
- an operation and maintenance contract;
- a contract detailing fuel supply and spent fuel management.

Following the signing of the contracts, preparatory work began on the construction of Units 5 and 6 of the Paks Nuclear Power Plant.

Site investigation and evaluation license

In April 2014, Paks II Ltd. submitted its application for a site investigation and assessment license and began preparations to fulfill the obligations and tasks arising from its role as a licensee. On 14 November 2014, the HAEA approved the site investigation and assessment programme, subject to certain conditions. The HAEA regularly checked compliance with the license conditions.

Preliminary Safety Information Report

On 1 September 2015, Paks II Ltd. submitted a Preliminary Safety Information Report (PSIR) to HAEA. The legal basis for the submission and evaluation of the PSIR is provided by the *ATOMIC ACT* and the *NUCLEAR SAFETY DECREE*. Accordingly, prior to the planned initiation of the licensing procedure for a nuclear facility, the licensee may inform the nuclear energy supervisory authority of the preliminary compliance of the planned nuclear facility with safety requirements by submitting a PSIR. The PSIR shall demonstrate the preliminary compliance of the planned nuclear power plant with domestic requirements, using information on operating or planned units of the same type as the planned nuclear power plant, and shall indicate any deviations from those requirements. The assessment of the PSIR does not constitute an official licensing procedure. Its main purpose is to enable the HAEA to familiarize itself with the main technological characteristics and technical solutions of the planned unit type and to assess whether the unit is preliminarily compatible with the national safety requirements, thereby enabling it to prepare for the assessment of the application for a construction license.

Following the assessment, the HAEA informed Paks II Ltd. of the results of the assessment so that it could prepare the PSAR to be submitted with the application for a construction license in accordance with the comments.

Site License

In 2015 and 2016, Paks II Ltd. carried out the activities of the Geological Survey Programme specified in the site investigation and assessment programme at the planned site and its surroundings.

On 26 October 2016, Paks II Ltd. submitted to the HAEA an application for a site license for the new nuclear power plant units, in which it had to prove that there were no site characteristics that would prevent construction. In addition, it had to demonstrate the implementation of the site investigation and assessment programme and provide planning data related to the site.

As part of the licensing procedure, the HAEA held a public hearing in Paks. At the public hearing, participants had the opportunity to ask questions and express their opinions on the site licensing procedure. In addition to the general public, representatives of social and political organizations also attended the event.

The site license necessary for the preparation of the facility was issued by HAEA on 20 March 2017. The permit contains a number of requirements, the implementation of which was regularly monitored by HAEA.

By its decision of 29 March 2022, the HAEA extended the validity of the site license by five years. The site license was valid until the construction license became final. The construction license was issued by the HAEA on 25 August 2022, which also stipulated that the conditions set out in the site license had been met.

Environmental license

The environmental impact assessment procedure for the construction of the two new nuclear power plant units was launched on 19 December 2014.

This included an assessment of significant transboundary environmental impacts in accordance with the provisions of the Espoo Convention. Eleven affected parties (Austria, the Czech Republic, Greece, Croatia, Malta, Germany, Romania, Serbia, Slovakia, Slovenia and Ukraine) registered for the international phase of this procedure and were granted the opportunities for participation required by the Espoo Convention. In Hungary, 41 public forums were held and a public hearing took place in Paks. The Secretariat of the UN Espoo Convention classified the environmental impact assessment procedure for the Paks II project as an example of best practice, and the International Atomic Energy Agency also described it as good practice.

On 29 September 2016, the first instance environmental authority issued the environmental license for the Paks II project, which was forwarded on 21 December 2016, to the parties involved in the procedure in accordance with the provisions of the Espoo Convention. The environmental license became final on 4 May 2017.

Construction license

Paks II Ltd. submitted its application for a construction license for the 5th and 6th nuclear power plant units to be built, as well as for the designation of the safety zone boundaries, to the HAEA on 30 June 2020. The basic document for the construction license application is the Preliminary Safety Analysis Report, which confirms that the planned nuclear power plant, with the technical design, technological solutions and operating methods presented in the plans, meets nuclear safety requirements and can be safely constructed and operated.

On 25 August 2022, the HAEA issued the construction license for Units 5 and 6, specifying conditions and hold points, and also approved the preliminary Nuclear Emergency Response Plan. At the same time, the HAEA issued a separate decision designating the safety zone for Units 5 and 6. In accordance with the hold point provision specified in the construction license, Paks II Ltd. reviewed the Preliminary Safety Analysis Report submitted with its construction license application. Following the assessment of the revised PSAR, the HAEA lifted the hold point specified in the construction license in November 2024.

The HAEA imposed regular (monthly, then quarterly and annual) and ad hoc reporting obligations in the construction license.

Electricity industry establishment license

On 19 November 2020, the licensee obtained an electricity industry establishment license from the Hungarian Energy and Public Utility Regulatory Authority (HEPURA). Paks II Ltd. in compliance with its obligations under the Electricity Act, submitted its application for an electricity industry establishment license for the new units to HEPURA on 9 October 2020, which is intended to certify that the power plant will meet the relevant requirements, fit into the domestic electricity supply system, not adversely affect the continuous operation of the existing nuclear power plant, and contribute to the long-term security of supply of the Hungarian electricity system. In accordance with the conditions set out in this license, Paks II Ltd. shall provide HEPURA with regular half-yearly and ad hoc summaries on the current status and progress of the investment, within the scope of its competence.

Site preparation work

In the second half of 2021, the HAEA granted a building permit for the construction of the cut-off wall and soil improvement tests, as well as for the removal of soil above the groundwater level (minus five meters).

The licensee received the building permit for the construction of the cut-off wall in May 2022. As a result of the construction, 2705 m of cut-off wall were built.

Based on the building permit issued in June 2022, the soil improvement works under the nuclear island of Units 5 and 6 were completed in 2024, and the licensee submitted its application for an occupation permit for Unit 5 to the HAEA in December 2024.

The building permit for soil excavation down to the design level under units 5 and 6 was obtained by the licensee in November 2023. Soil excavation down to the design level in the area under the nuclear island of unit 5 began in September 2024.

Physical Protection License

On 25 August 2021, the HAEA granted a license for the Physical Protection System and Physical Protection Plan of Paks II Ltd.

Building permits for operational buildings

The Reactor Building (50UJA), Control Building (50UCB), Steam Cell (50UJE), Equipment Lock Trestle (50UJG), Auxiliary Building (50UKA), Safety Building (50UKD) and the Switching Chamber (50URS) building permit related to the nuclear island of unit 5 were issued by the HAEA in August 2022.

Paks II Ltd. submitted applications for building permits for four additional operational buildings to the HAEA in September 2024, as follows: Turbine building for Unit 5 (50UMA), Start-Up/Standby Electric Boiler House (90UTH), Emergency Oil Drain Tank (50UMW), Unit Demineralization Plant Building (50ULR).

Manufacturing permit

The HAEA issued manufacturing permit for the reactor vessels of the 5th and 6th nuclear power plant units to be constructed in August 2022. Raw material production began in September 2022.

The manufacturing permit for the for the core catcher was issued by the HAEA in June 2022, and the manufacturing of the core catcher for the 5th unit began in August 2022. In August 2024, the equipment was delivered to the Paks site.

Permitting of the construction support area

The construction support facility complex will consist of a total of 124 structures, including 88 buildings and 36 additional structures, divided into 15 functional groups.

The HAEA has issued building permits for all 71 structures requiring building permits in the construction support area.