

# ENVIRONMENTAL IMPACT ASSESSMENT REPORT

## International chapter

25 June 2026

PAKS NUCLEAR POWER PLANT  
SUBSEQUENT SERVICE LIFE EXTENSION



Paks NPP

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## 1. Introduction

### 1.1. Background

The MVM Paks Atomerőmű Zrt. plans a further 20-year extension of the operating lifetime of Units 1-4 of the Paks Nuclear Power Plant (Paks NPP), which are currently under its operation. The objective of the subsequent service life extension (SSLE) is to maintain the commercial electricity generation currently performed by MVM Paks Atomerőmű Zrt. through the continued operation of the plant's existing four reactor units for an additional 20 years.

The currently valid environmental license for the NPP was issued separately for each unit, with expiry dates between 2032 and 2037. The application for an environmental license related to the planned SSLE covers all four units of the NPP and their continued operation until 2052-2057.

In the summer of 2022, the Government of Hungary decided to initiate preparations for a further extension of the operating lifetime of the Paks NPP. Prior to commencing activities related to the SSLE, the Government informed the National Assembly. By Resolution 56/2022. (XII. 8.) OGY of the National Assembly concerning the further extension of the operating lifetime of the existing units of the Paks NPP, the National Assembly overwhelmingly approved and acknowledged the SSLE of the NPP, recognizing its contribution to Hungary's energy independence, climate protection objectives, and security of electricity supply.

Pursuant to Article 41 of Chapter 4 of the Euratom Treaty concerning investments, the lifetime extension project is subject to notification to the European Commission. Following consultations involving the Hungarian Atomic Energy Authority and the Ministry of Energy, a project description document was submitted on 26<sup>th</sup> October 2023 to the European Commission Directorate-General for Energy, Unit ENER D.2 – Nuclear Energy, Nuclear Waste and Decommissioning. Accordingly, the official notification of the SSLE of the Paks NPP to the European Commission was completed.

In January 2025, the Commission submitted supplementary questions concerning the project, to which responses were provided on 9<sup>th</sup> April 2025. The procedure will conclude with the issuance of the Commission's final opinion.

According to Government Decree 314/2005. (XII. 25.) on environmental impact assessment and integrated environmental use licensing procedure<sup>1</sup> the extension of the operating lifetime of a NPP constitutes an activity subject to environmental impact assessment and may only be carried out on the basis of an environmental license issued by the competent environmental authority. The results of the environmental impact assessment must be presented by the applicant in an Environmental Impact Assessment Report (EIAR).

In the case of the SSLE of the NPP, Hungarian legislation provides the applicant with the opportunity to conduct a so-called preliminary consultation prior to the environmental licensing procedure in order to obtain the opinions of the environmental authority and the relevant administrative bodies, as well as comments from the public. The affected public also includes the public of those countries notified during the preliminary consultation in accordance with Government Decree 148/1999. (X. 13.), promulgating the convention on environmental impact assessment in a transboundary context, signed in Espoo (Finland) on 26<sup>th</sup> February 1991.

On 26<sup>th</sup> September 2024, MVM Paks Atomerőmű Zrt. initiated a preliminary consultation with the competent environmental authority, the Baranya County Government Office (BCGO), regarding the further 20-year lifetime extension of Units 1-4 of the Paks NPP by submitting documentation (Preliminary Consultation Document) prepared in accordance with the content requirements set out in Annex 4 of Government Decree 314/2005. (XII. 25.).

In its opinion issued on 24<sup>th</sup> October 2024 under reference number 383-100/2024, concluding the preliminary consultation process, the BCGO established that no environmental licensing obstacle emerged during the preliminary consultation concerning the SSLE of Units 1-4 of the Paks NPP.

<sup>1</sup> The Decree, together with Act LIII of 1995 on the general rules of environmental protection, serves to ensure compliance with Directive 2011/92/EU of the European Parliament and of the Council of 13<sup>th</sup> December 2011 on the assessment of the impacts of certain public and private projects on the environment.

The environmental authority further determined that, pursuant to section 31 of Annex 1 of Government Decree 314/2005. (XII. 25.) (*“Nuclear power plants, nuclear reactors, the extension of the operating lifetime of nuclear power plants and nuclear reactors, as well as their decommissioning, i.e., the final removal of nuclear fuel and other radioactive components of the installation contaminated by radioactive substances, irrespective of size”*), the SSLE constitutes an activity subject to environmental impact assessment and may only be commenced or continued with a valid environmental license. The application for the environmental impact assessment procedure must be accompanied by an EIAR prepared in accordance with Annexes 6 and 7 of the Government Decree, taking into account the requirements specified in the BCGO’s opinion concluding the preliminary consultation.

Since the NPP is listed in Appendix I of the Espoo Convention promulgated by Government Decree 148/1999. (X. 13.) among activities likely to cause significant adverse transboundary impacts, and in accordance with the provisions of Government Decree 314/2005. (XII. 25.) relating to international environmental impact assessment procedures, potentially affected foreign parties were notified to provide them with the opportunity to participate in the consultation process.

The BCGO informed the Ministry of Energy, responsible for environmental protection matters, of the initiation of the preliminary consultation procedure, thereby enabling interested foreign parties to participate. On 30<sup>th</sup> October 2024, taking into account the countries notified during the transboundary environmental impact assessment procedure conducted for the Paks II NPP project, and extending well beyond Hungary’s neighbouring countries regardless of the limited nature of potential transboundary impacts, the Ministry of Energy notified 31 foreign parties (all neighbouring countries of Hungary, all member states of the European Union, as well as the United Kingdom, Norway, and Switzerland). Comments were received from the notified countries until 22<sup>nd</sup> January 2025, with feedback provided by eight countries. Austria, Latvia, Romania, and Croatia indicated their preliminary intention to participate in the environmental impact assessment procedure, while Finland, Poland, and the Czech Republic requested information on the results of the environmental impact assessment.

The EIAR for the SSLE of the Paks NPP was prepared during 2025-2026 through the coordinated work of an extensive team of experts from various disciplines (including engineering, environmental protection, nature conservation, radiation protection, meteorology, hydrology, and others), reflecting the broad scope of investigations and analyses required. For the implementation of the tasks, a dedicated project organization was established under the supervision of the environmental licensing working group operating within the Paks NPP SSLE Priority Project. The project organization was managed by MVM ERBE Zrt. as the main contractor, with the involvement of the energy engineering firms AFRY SOM System Kft. and AFRY ERŐTERV Zrt. Additional expert organizations and scientific institutions possessing the necessary references, authorizations, analytical tools, and professional expertise were engaged to perform the investigations and analyses related to the various disciplines and to prepare the respective sections of the EIAR.

The documentation supporting the environmental licensing procedure for the SSLE of the Paks NPP consists of the EIAR and its annexes, the Public summary, and the present International chapter. The International chapter of the EIAR is intended to inform interested foreign parties by presenting the results of analyses concerning the potential for transboundary environmental impacts and by providing responses to comments and questions raised by foreign parties during the preliminary consultation process.

## 1.2. Purpose and scope of the International chapter

The purpose of this International chapter is to present, in connection with the EIAR describing the results of the environmental impact assessment for the SSLE of the Paks NPP, the detailed results of the assessment of potential transboundary environmental impacts. In addition, this chapter contains a summary of the comments and questions submitted by the countries notified during the preliminary consultation process, together with the responses provided.

The assessment of direct and indirect impacts, including the determination of their spatial extent, formed an integral part of all specialist investigations conducted within the environmental impact assessment process. This included the identification of impacts extending to national borders. *Chapter 8.* of the EIAR presents the assessment of transboundary impacts for both radiological disciplines and conventional (non-radiological) environmental disciplines. An overview of this scope is also provided in *Chapter 2.* of the present International chapter.

Due to the location of the Paks NPP at a considerable distance from national borders (at least 63 km in a straight line and 94 km downstream along the Danube River) impacts reaching a national border may only occur in relation to the thermal loading of the Danube and, in the case of the NPP, under design extension conditions (events exceeding the plant's design basis). None of these impacts can be classified as significant.

Following the presentation of the assessment of impacts reaching national borders, this International chapter reviews the comments and questions submitted by the notified countries concerning the Preliminary Consultation Document and presents the corresponding responses. The countries participating in the environmental impact assessment procedure raised, in part, specific issues of particular interest or concern and, in part, observations related to individual specialist disciplines within broader review documents. Consequently, certain comments and questions were raised repeatedly, either as detailed discussions within a given specialist field or as part of the summary sections of the review documents.

Accordingly, the responses to the comments and questions are presented in this document either individually, where specific questions were raised, or in grouped form for issues relating to particular specialist disciplines. In the latter case as well, particular emphasis was placed on ensuring that every comment and question submitted received an appropriate response.

## 2. Presentation of transboundary impacts

### 2.1. Aspects for the assessment of transboundary impacts

#### 2.1.1. International and national requirements applicable to the impact assessment

The operation of NPPs falls within the scope of the Espoo Convention on environmental impact assessment in a transboundary context and Directive 2011/92/EU of the European Parliament and of the Council of 13<sup>th</sup> December 2011 on the assessment of the effects of certain public and private projects on the environment, as amended by Directive 2014/52/EU of 16<sup>th</sup> April 2014. The mandatory application of the Espoo Convention in Hungary is prescribed by Government Decree 148/1999. (X. 13.), promulgating the convention on environmental impact assessment in a transboundary context, signed in Espoo (Finland) on 26<sup>th</sup> February 1991.

A transboundary impact is defined as an impact whose area of influence extends beyond a national border and causes significant permanent changes or long-term environmental deterioration. In the case of activities falling under the scope of the Convention, countries considering themselves affected may request the conduct of a transboundary environmental impact assessment procedure regardless of whether the impact area, according to the analyses performed, actually extends to their territory.

The detailed rules governing transboundary environmental impact assessment procedures required for activities covered by the Espoo Convention are established by Government Decree 314/2005. (XII. 25.) on environmental impact assessment and the integrated environmental use licensing procedure. Under the provisions of the decree, coordination of the transboundary environmental impact assessment procedure and communication with interested parties are the

responsibility of the ministry headed by the minister responsible for environmental protection, which during the preliminary consultation process was the Ministry of Energy. Where significant transboundary environmental impacts are considered likely during the preliminary consultation process, the environmental authority informs the competent Ministry by forwarding the preliminary consultation documentation. The Ministry then notifies the foreign parties by transmitting the English-language version of the Preliminary Consultation Document. If a notified party indicates in its response, that it intends to participate in the environmental impact assessment procedure, the procedure shall continue in accordance with the provisions of Government Decree 314/2005. (XII. 25.) governing transboundary environmental impact assessment procedures, taking into account the comments submitted by the affected party.

Upon commencement of the preliminary consultation process, the BCGO, acting as the competent environmental authority, informed the Ministry of Energy by submitting the application and the English-language version of the Preliminary Consultation Document. On 30<sup>th</sup> October 2024, taking into consideration the countries notified during the transboundary environmental impact assessment procedure for the Paks II NPP project, the Ministry of Energy notified 31 foreign parties, including Hungary's neighbouring countries, all Member States of the European Union, as well as the United Kingdom, Norway, and Switzerland.

Comments from the notified countries were received until 22<sup>nd</sup> January 2025, with feedback received from eight countries. Austria, Latvia, Romania, and Croatia indicated their preliminary intention to participate in the environmental impact assessment procedure, while Finland, Poland, and the Czech Republic requested information regarding the results of the environmental impact assessment.

The Ministry informs the foreign parties by transmitting the translation of the Public summary of the EIAR into the language of the affected party or into English; the International chapter containing a review of the feedback received from foreign parties and the responses provided; and the EIAR prepared taking into account both the authority's opinion concluding the preliminary consultation and the comments received from foreign parties. The Ministry also initiates the consultation process based on these documents. Comments received during consultations with foreign parties, as well as comments submitted by the public of the affected party, are evaluated by the environmental authority with the involvement of the relevant competent authorities and are taken into account during decision-making within the environmental licensing procedure.

### **2.1.2. Environmental impacts, operating conditions, and events assessed from the perspective of potential transboundary impacts**

As part of the investigations and analyses performed to support the EIAR for the proposed SSLE of the Paks NPP, the potential for transboundary environmental impacts and the significance of any potentially transboundary impacts were assessed for all identified conventional and radiological impacts, taking into account impact pathways and the sensitivity of affected areas. For each environmental impact factor, impacts potentially reaching national borders were evaluated with respect to air quality, surface water and groundwater, geological medium, flora and fauna and ecosystems, noise and vibration conditions, and environmental radiation conditions.

No significant transboundary impacts were identified under normal operating conditions of the Paks NPP, either in relation to conventional environmental impacts or radiological impacts resulting from gaseous and liquid discharges. Owing to the central location of the NPP within Hungary and the fact that the nearest national border is located more than 60 km away, no significant transboundary impacts were identified even for incidents or accidents deviating from normal operation.

In accordance with internationally accepted practice for impact assessments relating to nuclear facilities, the assessment of transboundary impacts included not only operational occurrences and design-basis accidents but also the analysis of events classified under nuclear safety requirements as design extension conditions, which, in Hungarian terminology, are categorized

as complex or severe accidents. These analyses were also carried out as part of the transboundary impact assessment.

Power plants are extremely stringent and ensure that accidents are expected to occur only with an extremely low probability. This is further reinforced by the fact that analyses of accidents that have occurred during the history of nuclear energy utilization have led to continuous improvements in both technology and the regulatory requirements governing the operation of nuclear facilities. As part of these improvements, numerous upgrades and safety enhancement measures have been implemented at the Paks NPP. As a result, the four-unit NPP commissioned in the 1980s continues to comply with modern nuclear safety requirements that are aligned with current international standards and regulations. The periodic modernization of regulatory requirements, together with the obligation to comply with them, ensures that the applicable safety requirements can continue to be met throughout the period of the proposed SSLE. Compliance with these requirements ensures that radiation exposure to the public remains below the prescribed criteria during normal operation as well as during anticipated operational occurrences and design basis accidents.

Unlike the requirements applicable to normal operation and design basis accidents, the regulatory provisions concerning design extension conditions and accident analyses do not specify dose limits. Instead, they require the implementation of protective measures, where necessary, to reduce radiation exposure to the public. Accordingly, the primary objective of the requirements relating to design extension conditions is to ensure that NPP operators and the organizations and authorities involved in emergency response are adequately prepared for the possible occurrence of low-probability events with potentially severe consequences.

In order to demonstrate the potential transboundary impacts of accidents, analyses were performed not only for normal operating conditions and design basis accidents, but also for design extension conditions that could result in significant radiological releases.

## 2.2. Conventional environmental impacts and impacts related to radiation exposure of wildlife

The analyses and impact assessments conducted in support of the EIAR for the SSLE of the Paks NPP did not identify any significant transboundary impacts associated with conventional environmental impacts and impacts related to radiation exposure of wildlife. The findings regarding the spatial extent of the impacts can be summarized as follows:

- **Impacts on air quality:** The areas affected by air pollutant emissions are limited to the NPP site and its immediate surroundings. Environmental impacts associated with transportation activities related to the operation of the NPP occur primarily along the immediate vicinity of Main Road No. 6 between Paks and Dunaszentgyörgy. The assessment results confirmed that no impacts approaching national borders can be identified, regardless of whether only the existing four units of the Paks NPP or the combined impacts of the existing units and the two new units of the Paks II NPP are considered.
- **Impacts on groundwater:** Based on monitoring data from bank-filtered water resources, the national groundwater monitoring network, and the on-site monitoring system of the Paks NPP, as well as on the results of regional and local hydrodynamic and heat transport models, it can be concluded that no transboundary environmental impacts can be identified. The impacts are local in nature both for the operation of the Paks NPP alone and for the combined operation of the Paks and the Paks II NPP.
- **Impacts on noise and vibration conditions:** No transboundary environmental impacts are expected as a result of either the independent operation of the Paks NPP or the combined noise emissions of the Paks NPP and the Paks II NPP, since the boundary of the affected area is confined to a few kilometres around the NPP site.

- **Impacts on wildlife, and ecosystems:** As part of the assessment of impacts on wildlife and ecosystems, no adverse impacts could be demonstrated for the terrestrial habitats and biological communities examined within distances of 3 km and 10 km from the NPP. Consequently, no such impacts can be expected at greater distances, including beyond national borders.
- **Radiation exposure of wildlife:** Historical monitoring data reviewed as part of the assessment of radiation exposure to biota, together with the most recent measurement results, confirmed that only negligible activity concentrations can be detected even in the immediate vicinity of the NPP. Radioactivity released to the environment is subject to substantial dilution with increasing distance, therefore, radiation exposure of biota attributable to the NPP becomes even more negligible at greater distances. Consequently, no transboundary impacts are expected with respect to radiation exposure of biota, regardless of whether the Paks NPP operates stand-alone or together with the six-unit configuration comprising the Paks and the Paks II NPP.

### 2.3. Impacts of the expected Danube heat load during the period of the SSLE

The quantification of potential transboundary impacts was carried out using a multi-stage modelling methodology consisting of interconnected models, which enabled not only the assessment of current conditions but also the projection of future scenarios. As part of the investigations, projections were prepared for the entire Danube catchment based on two climate scenarios (RCP4.5 and RCP8.5). For each scenario, the results of fourteen relevant global and regional climate models were considered, allowing future meteorological conditions to be estimated through the combined evaluation of multiple climate models.

Building upon the climate model outputs, a catchment-scale hydrological model was developed for the entire Danube river system. Calibration and validation of the model were performed using approximately 30 years of international hydrological data, with calibration carried out separately for individual sub-catchments. This ensured that the simulations reliably reflected the hydrological characteristics of the Danube. The model was used to forecast how climate change may affect the river discharge of the Danube at the Paks cross-section. The results of the hydrological calculations served as the basis for subsequent investigations, particularly for water temperature and thermal load modelling.

Considering river discharge data and meteorological conditions, projections of future Danube water temperatures were also developed. For this purpose, a temperature model calibrated using several decades of measured data was applied. Based on the outputs of the hydrological and temperature models, hydrologically representative conditions of particular importance for both the operation of the power plants and the receiving river were identified. These included average-flow conditions and biologically critical low-flow conditions. Detailed three-dimensional hydrodynamic and thermodynamic modelling was then used to determine the Danube water temperatures under which the cooling water discharges of the power plants would not yet require output restrictions due to exceedance of regulatory temperature limits.

For the detailed assessment of transboundary impacts, a depth-averaged two-dimensional (2D) hydrodynamic model was developed for the relevant section of the Danube. Calibration of the hydrodynamic model was performed using water level measurements for both low-flow and average-flow conditions. Remote sensing-derived water temperature data were also incorporated into the modelling of mixing and heat transport processes. This enabled the model to realistically describe the propagation of the thermal plume and the spatial distribution of water temperature.

The model was used not only to assess current hydrological and temperature conditions, but also to simulate future scenarios. These simulations incorporated the effects of climate change, including the projected reduction of low-flow discharges from approximately 910 m<sup>3</sup>/s at present to around 790 m<sup>3</sup>/s. In addition, the impacts associated with the commissioning of the Paks II NPP were specifically assessed, representing the scenario in which the Paks and the Paks II NPP operate simultaneously.

The modelling also accounted for heat exchange between the water surface and the atmosphere, a process that becomes particularly significant under elevated water temperature conditions. This mechanism results in gradual cooling of the river water downstream, thereby mitigating the effects of the thermal plume.

The two-dimensional hydrodynamic model was further used to investigate the longitudinal propagation of the thermal plume generated by the discharge of warmed cooling water. The calculations indicated that transverse mixing of the warmed water becomes nearly complete across the full river cross-section after approximately 70 river kilometres. Under current conditions, thermal discharges from Paks cause an increase in water temperature at the national border of approximately 0.4°C under average-flow conditions and approximately 0.9°C under low-flow conditions. In the future scenario involving the simultaneous operation of the existing Paks units and Paks II NPP, this effect may nearly double, reaching approximately 0.7°C under average-flow conditions and approximately 1.8°C under low-flow conditions at the national border.

The assessment of the potential transboundary impacts of warmed cooling water discharges from the Paks NPP during the period of the SSLE was based on the analysis and evaluation of archived chemical and biological datasets from 2000-2023, as well as monitoring surveys conducted in 2024 and 2025. Hydrological and heat load models developed for various climate scenarios provided the necessary background information for the ecological interpretation of long-term impacts associated with climate change and different power plant operating conditions, as well as for the delineation of the impact area.

The discharge of warmed cooling water through the warm-water channel into the Danube at river kilometre 1526.2 on the right bank, together with treated non-radioactive technological and municipal wastewater, has been shown to cause hydromorphological alterations, elevated water temperatures, and additional local water quality changes in the River Danube.

Ecological assessments performed at both water-body scale and finer spatial resolution demonstrated that the temperature increase associated with cooling water discharge and the resulting hydromorphological changes have measurable effects on community structure. However, the minor changes detected in individual chemical parameters do not produce measurable effects on the ecological structure of aquatic communities. Accordingly, both under current conditions and during the period of the SSLE, the actual environmental impact factors are the hydromorphological impacts of water abstraction, the heat load associated with the discharge of warmed cooling water, and the hydromorphological impacts of warmed cooling water discharge. Among these, thermal loading represents the most significant impact factor. Ecological investigations also confirmed that the actual receptors of these impacts are benthic diatoms (phytobenthos), aquatic macroinvertebrates (macrozoobenthos), and fish communities. In contrast, no measurable changes were detected in the ecological structure of planktonic organisms (phytoplankton and zooplankton), and therefore these groups cannot be considered impact receptors. The ecological assessment based on the available input data concluded that the strongest impacts and the largest impact area during the period of the SSLE are expected during the simultaneous operation of the Paks NPP and the Paks II NPP.

The results of the high-resolution ecological analyses indicated that, as an immediate short-term impacts, water temperatures of  $t_{\max} \geq 36^{\circ}\text{C}$  downstream of the discharge cause fish to avoid the affected area. Based on hydrological modelling for the year 2060 under low-flow conditions (790 m<sup>3</sup>/s), the extent of this area does not exceed approximately 200 m downstream along the right-bank section of the Danube affected by the thermal plume.

At the same time, it was established that the modification of the structure of receptor communities is primarily caused by the continuous long-term exposure to thermal loading, representing the most extensive impact in terms of spatial extent. The analyses demonstrated that, up to a temperature increase of  $\Delta t = +1\text{-}2^{\circ}\text{C}$ , community structure remains similar to the upstream reference condition and no direct effects on receptor groups can be detected. This finding is consistent with practical observations, as temperature differences of this magnitude may naturally occur within the Danube ecosystem.

Detectable changes in community structure begin to occur at sustained temperature increases of approximately +2-3°C. The ecological threshold identified for the receptor organisms was determined to be  $\Delta t \geq 2.5^\circ\text{C}$ .

Based on the hydrological models, it was determined that, during the simultaneous operation of the Paks and the Paks II NPP, the maximum impact area calculated for the projected low-flow conditions of 2060 extends no more than approximately 18 km downstream from the discharge point. Consequently, it can be clearly concluded that the Danube discharges from the Paks NPP do not result in transboundary impacts for any biological quality element.

## 2.4. Expected radiological impacts during the period of the SSLE

### 2.4.1. Assessment methodology and input data

In the assessment of radiological impacts, direct and indirect radiological impacts can be distinguished. Direct radiological impacts are those that affect members of the public directly as external radiation exposure resulting from the operation of the NPP, such as the transport of fresh and spent nuclear fuel, radioactive waste shipments, or the movement of equipment and radiation sources containing radionuclides on their surfaces within the plant site. Indirect radiological effects arise from the gaseous and liquid radioactive discharges of the NPP.

The direct radiological impact associated with the operation of the Paks NPP (i.e., direct exposure from scattered radiation) is already extremely low in the vicinity of the plant, and no impacts can be detected beyond national borders. Consequently, the assessment of potentially transboundary radiological impacts focuses on indirect effects, including the determination of environmental radiation conditions and public radiation doses resulting from radioactive discharges.

The assessment of transboundary radiological impacts was carried out both through a review of previous analyses and through new calculations using the most recent available data. The evaluation also examined how potential changes during the SSLE period, such as changes in meteorological and hydrological conditions or in the lifestyle and consumption habits of local populations, could affect transboundary radiological impacts. The assessment of radiological impacts potentially extending beyond national borders during the continued operation of the NPP was based on the normal operational gaseous and liquid discharges, design basis accidents, and potential gaseous releases associated with severe accidents.

The input data used in the models for determining environmental radiation conditions and public doses included the source term of the release, meteorological and hydrological conditions, and lifestyle and consumption habits of the exposed population. For each operating condition, the applicable assessment tools, source terms, release characteristics, meteorological and hydrological input data, as well as population lifestyle and consumption parameters, were defined. Relevant exposure pathways, receptor locations, and dose quantities to be determined were also identified.

Direct liquid discharges into the Danube may occur only during normal operation. Design basis accidents include leakage or malfunction of the liquid radioactive waste management system and hypothetical releases from liquid storage tanks. However, in such cases the leakage would occur within a plant building, from which radioactive material could only reach the environment through evaporation and release via ventilation systems. The associated activity would be several orders of magnitude lower than that considered for the atmospheric release scenarios assessed. Therefore, no liquid radioactive discharge into the Danube is expected under these accident conditions.

For design basis accidents and severe accidents, the assessment of transboundary impacts associated with aquatic transport was performed assuming that approximately 20% of the total activity released to the atmosphere during gaseous release events is washed out into the Danube by precipitation processes (excluding noble gases).

The difference between the design basis accident analyses and the severe accident analyses lies only in the source terms and release characteristics used. Severe accident analyses were performed for two scenarios involving significant environmental releases and considered

representative in terms of both occurrence frequency and event progression. In one severe accident scenario, direct environmental release occurs through a damaged reactor building wall, therefore, the analyses were performed assuming an effective release height of 40 m. In the second severe accident scenario, the release occurs through the ventilation stack, accordingly, the analyses were performed assuming an effective release height of 120 m.

For atmospheric dispersion modelling of gaseous releases, receptor points outside Hungary were defined as the nearest settlements to the NPP site located close to the national borders of neighbouring countries, together with Vienna (Austria). Distances from the plant were determined with an accuracy of approximately 1 km based on the nearest point of each settlement relative to the NPP site.

The receptor locations were assigned to one of sixteen directional sectors around the site. The selected receptor settlements and their characteristics are as follows:

- Slovenia: Pince (~179 km, sector 13, West),
- Croatia: Duboševica (~77 km, sector 9, South),
- Serbia: Riđica (~67 km, sector 8, South-Southeast),
- Romania: Beba Veche (~122 km, sector 6, East-Southeast),
- Ukraine: Solomonovo (~327 km, sector 3, Northeast),
- Slovakia: Obid (~138 km, sector 1, North),
- Austria: Luising (~187 km, sector 14, West-Northwest) and Vienna (~267 km, sector 15, Northwest).

For the assessment of potentially transboundary impacts associated with radioactive discharges to the Danube, the receptor point was selected as the location where the Danube leaves Hungary and reaches the first populated settlement. This location is Batina, Croatia, situated at river kilometre 1428, approximately 98 km downstream from the liquid discharge point of the NPP at river kilometre 1526.

## 2.4.2. Transboundary radiological impacts of the independent operation of the Paks NPP

### 2.4.2.1. Normal operating conditions

For normal operating conditions, annual doses presented in *Table 2.4.2.1-1* were calculated using the actual gaseous discharge data from 2022, representing the most conservative year for assessment purposes. The results were determined for representative adult individuals and one-year-old children at the selected receptor points outside Hungary. The highest dose was calculated for Duboševica, Croatia, located approximately 77 km south of the NPP. The annual committed effective dose for the representative adult individual was 0.042 nSv, while the corresponding value for a one-year-old child was 0.022 nSv.

The reported values represent the sum of doses arising from all exposure pathways considered in the assessment. As an example, the contribution of individual exposure pathways for Duboševica is presented in *Table 2.4.2.1-2*.

Among the various exposure pathways, the food-chain pathway contributes the largest share of the total committed effective dose for adults, accounting for approximately 52% of the total dose. For adults, approximately 35% of the dose originates from external exposure to radionuclides deposited on the ground surface. The inhalation pathway contributes approximately 12% of the adult dose. For one-year-old children, the largest contribution originates from ground deposition exposure, accounting for approximately 50% of the total dose. Inhalation and food-chain pathways contribute approximately 27% and 22%, respectively, to the total dose received by one-year-old children. Cloud-shine exposure contributes less than 1% of the total dose for both age groups.

**Table 2.4.2.1-1. Committed effective doses determined from actual gaseous releases in 2022 under normal operating conditions for representative adult Individuals and one-year-old children**

| Receptor point      | Distance and direction from release point | Committed effective dose [nSv] |                      |
|---------------------|-------------------------------------------|--------------------------------|----------------------|
|                     |                                           | Adult                          | One-year-old child   |
| Pince, Slovenia     | 179 km, West                              | $9.97 \cdot 10^{-3}$           | $5.14 \cdot 10^{-3}$ |
| Duboševica, Croatia | 77 km, South                              | $4.20 \cdot 10^{-2}$           | $2.20 \cdot 10^{-2}$ |
| Ridica, Serbia      | 67 km, South, Southeast                   | $3.57 \cdot 10^{-2}$           | $1.86 \cdot 10^{-2}$ |
| Beba Veche, Romania | 122 km, East, Southeast                   | $1.54 \cdot 10^{-2}$           | $7.98 \cdot 10^{-3}$ |
| Solomonovo, Ukraine | 327 km, Northeast                         | $7.89 \cdot 10^{-3}$           | $3.97 \cdot 10^{-3}$ |
| Obid, Slovakia      | 138 km, North                             | $3.61 \cdot 10^{-2}$           | $1.87 \cdot 10^{-2}$ |
| Lusing, Austria     | 187 km, West, Northwest                   | $1.21 \cdot 10^{-2}$           | $6.21 \cdot 10^{-3}$ |
| Vienna, Austria     | 267 km, Northwest                         | $1.04 \cdot 10^{-2}$           | $5.38 \cdot 10^{-3}$ |

**Table 2.4.2.1-2. Committed effective doses determined from actual gaseous releases in 2022 under normal operating conditions for representative adult Individuals and one-year-old children in Duboševica (Croatia), by exposure pathway**

| Exposure pathway | Committed effective dose [nSv] |                      |
|------------------|--------------------------------|----------------------|
|                  | Adult                          | One-year-old child   |
| Total            | $4.20 \cdot 10^{-2}$           | $2.20 \cdot 10^{-2}$ |
| Cloudshine dose  | $1.48 \cdot 10^{-4}$           | $1.20 \cdot 10^{-4}$ |
| Groundshine dose | $1.48 \cdot 10^{-2}$           | $1.10 \cdot 10^{-2}$ |
| Inhalation dose  | $5.09 \cdot 10^{-3}$           | $5.99 \cdot 10^{-3}$ |
| Food-chain dose  | $2.20 \cdot 10^{-2}$           | $4.94 \cdot 10^{-3}$ |

For the assessment of normal operational liquid discharges, calculations were performed using the actual liquid discharge data from 2021, considered the most conservative year for assessment purposes. The discharge was assumed to be continuous and represented as a point source located near the riverbank. *Table 2.4.2.1-3.* presents the calculated committed effective doses for representative adult individuals and one-year-old children at Batina, Croatia, located approximately 98 km downstream of the NPP. The dose resulting from the actual liquid discharges of the NPP in 2021 was dominated by the contribution of  $^{14}\text{C}$ , accounting for more than 90% of the total dose for both representative adults and one-year-old children. The total dose was dominated by internal exposure resulting from fish consumption. Due to differences in consumption rates, the internal and total doses calculated for adults were slightly higher than those calculated for one-year-old children.

**Table 2.4.2.1-3. Committed effective doses determined from actual liquid releases in 2021 under normal operating conditions for representative adult Individuals and one-year-old children in Batina (Croatia), by exposure pathway**

| Exposure pathway                                              | Committed effective dose [nSv] |                    |
|---------------------------------------------------------------|--------------------------------|--------------------|
|                                                               | Adult                          | One-year-old child |
| Total                                                         | $1.13 \cdot 10^1$              | $1.01 \cdot 10^1$  |
| Swimming – external skin dose from beta radiation             | $1.79 \cdot 10^{-5}$           |                    |
| Swimming – external dose from gamma radiation                 | $1.54 \cdot 10^{-5}$           |                    |
| Water-related activities – external dose from gamma radiation | $3.16 \cdot 10^{-2}$           |                    |
| Fish consumption – internal dose                              | $1.12 \cdot 10^1$              | $1.01 \cdot 10^1$  |

Based on the results, the radiological impacts beyond the national border arising from normal operational gaseous and liquid discharges can be classified as neutral impacts, remaining substantially below both the dose constraint of 90  $\mu\text{Sv}/\text{year}$  and the upper threshold established for neutral radiological impacts.

#### 2.4.2.2. Design basis accidents

For design basis accidents, the scenarios considered were identical to those used in *Chapter 5.3.* of the EIAR for the assessment of public radiation exposure. The highest doses resulting from atmospheric releases were obtained for release scenario No. 3 (break of a 90 mm nominal diameter pressurizer injection line at 1485 MW thermal power under the assumption of total loss of off-site and on-site power supply).

The doses calculated for this design basis accident scenario are summarized in *Table 2.4.2.2-1.* for representative adults and one-year-old children at the investigated receptor locations. The highest values were obtained for Ridica, Serbia, located approximately 67 km south-southeast of the NPP, and Duboševica, Croatia, located approximately 77 km south of the plant. The calculated committed effective dose for the representative adult individual was 7.57 nSv, while the corresponding value for a one-year-old child was 5.88 nSv.

**Table 2.4.2.2-1. Committed effective doses determined for release scenario No. 3 of the design-basis accident, for representative adult Individuals and one-year-old children**

| Receptor point      | Distance and direction from release point | Committed effective dose [nSv] |                    |
|---------------------|-------------------------------------------|--------------------------------|--------------------|
|                     |                                           | Adult                          | One-year-old child |
| Pince, Slovenia     | 179 km, West                              | 2.93                           | 2.25               |
| Duboševica, Croatia | 77 km, South                              | 7.56                           | 5.88               |
| Ridica, Serbia      | 67 km, South, Southeast                   | 7.57                           | 5.87               |
| Beba Veche, Romania | 122 km, East, Southeast                   | 4.94                           | 3.79               |
| Solomonovo, Ukraine | 327 km, Northeast                         | 1.81                           | 1.38               |
| Obid, Slovakia      | 138 km, North                             | 4.70                           | 3.61               |
| Lusing, Austria     | 187 km, West, Northwest                   | 2.35                           | 1.82               |
| Vienna, Austria     | 267 km, Northwest                         | 1.57                           | 1.22               |

The analyses demonstrate that even the committed effective dose associated with the design basis accident scenarios resulting in the highest public exposure does not exceed 90  $\mu\text{Sv}$ . Consequently, transboundary impacts associated with design basis accidents remain more than one order of magnitude below the upper limit established for neutral impacts.

No direct liquid radioactive discharge to the Danube occurs during design basis accidents. Therefore, the assessment of transboundary impacts associated with aquatic transport was based on the assumption that approximately 19,1% of the total activity released to the atmosphere during design basis accident scenarios is washed out into the Danube through atmospheric deposition processes (excluding noble gases). The washout fraction was determined based on the proportion of the released contamination deposited onto a hypothetical area of 700×700 m during the time required for the radioactive plume to pass over the area at the relevant wind speed. The deposited fraction of the atmospheric source term was then used as the source term for the aquatic transport calculations. For aquatic exposure pathways, the highest doses were again obtained for scenario No. 3 (break of a 90 mm nominal diameter pressurizer injection line at 1485 MW thermal power under total station blackout conditions).

*Table 2.4.2.2-2.* presents the calculated committed effective doses for representative adults and one-year-old children at Batina, Croatia, located 98 km downstream of the NPP, for the design basis accident scenario considered. Exposure duration was determined based on the time required for the radioactive contamination to pass through the river section, weighted according to the annual occupancy factor. During this period, the higher of the two external aquatic exposure pathways – swimming (immersion in water) and water-related activities (such as staying on the

riverbank, boating, or fishing) – was considered. In this case, the dominant pathway was water-related activities. Among the radionuclides released to the atmosphere and subsequently washed into the river, cesium and iodine isotopes provided the largest contribution to the dose, accounting for approximately 70-80% of the total dose for both adults and one-year-old children. The dose conversion factors used for calculating internal exposure from fish consumption are higher for one-year-old children than for adults for these radionuclides, resulting in correspondingly higher internal doses for the younger age group.

**Table 2.4.2.2-2. Committed effective doses determined for representative adult individuals and one-year-old children in Batina (Croatia), resulting from washout of atmospheric releases to the Danube in design basis accident scenario No. 3, by exposure pathway**

| Release scenario                               | Design-basis accident scenario No. 3 |                    |
|------------------------------------------------|--------------------------------------|--------------------|
| Exposure pathway                               | Committed effective dose [μSv]       |                    |
|                                                | Adult                                | One-year-old child |
| Total                                          | 14.2                                 | 14.4               |
| Water-related activities – external gamma dose | 13.1                                 |                    |
| Fish consumption – internal dose               | 1.06                                 | 1.26               |

The doses calculated for aquatic exposure pathways were higher than those calculated for atmospheric exposure pathways for the same accident scenario. The primary reason is that atmospheric dispersion occurs within a much larger volume, allowing the radioactive plume to spread and dilute significantly before reaching distant receptor locations. In contrast, aquatic transport is confined within the river channel, where dilution occurs within a substantially smaller volume of water.

The calculations demonstrate that, even under the highly conservative assumptions applied in the assessment scenario, the doses determined for design basis accidents remain well below the upper threshold of 90 μSv established for neutral impacts.

The calculation results obtained for aquatic exposure pathways resulting from the washout of atmospheric releases into the Danube cannot be directly added to the doses calculated for atmospheric exposure pathways based on the same gaseous release, as the simultaneous occurrence of the two scenarios is not physically possible. If radioactive material is washed out from the atmospheric plume into the Danube to such a significant extent, less activity remains in the atmosphere, resulting in lower doses associated with atmospheric dispersion pathways.

#### **2.4.2.3. Impacts of potential changes during the SSLE period**

The assessment also included an evaluation of how potential changes in factors influencing public radiation exposure during the SSLE period could affect potential transboundary environmental impacts and public radiation doses.

For the dose consequences of gaseous releases, sensitivity analyses were performed regarding changes in meteorological parameters affecting atmospheric dispersion calculations; population lifestyle characteristics affecting dose assessments; and consumption rates of locally produced foodstuffs. For liquid releases and their consequences via aquatic transport pathways, the assessment examined how changes in hydrological parameters, particularly variations in Danube discharge and river gradient, as well as changes in the duration of water-related activities and consumption rates of potentially contaminated fish caught in the Danube, could affect the calculated doses.

The sensitivity analyses of meteorological parameters demonstrated that, at transboundary distances, extreme deviations from the most common meteorological conditions, such as increased precipitation intensity, increased wind speed, or shifts toward more unstable atmospheric stability classes, result in reduced doses. For example, under a representative

meteorological scenario, increasing precipitation intensity from an average value of 0.06 mm/h to 2.2 mm/h reduced the 50-year committed effective dose at the nearest receptor locations beyond the national border by approximately 35-55% for both design basis accidents and severe accidents. This occurs because more intense precipitation enhances washout of radioactive material from the plume near the release point, thereby reducing the amount of activity remaining airborne and available for transport to more distant locations. Changes in population lifestyle and consumption habits may lead to increases in doses resulting from gaseous releases. However, even the plausible future magnitude of such changes would not result in particularly significant increases (i.e. exceeding approximately 40%). Therefore, it is not expected that future changes in lifestyle and consumption habits would materially alter the conclusions of the assessment or the significance of the identified impacts.

The washout of airborne contamination into the Danube is already treated in a highly conservative manner within the analyses. The sensitivity studies demonstrated that further variations in washout rates arising from changes in meteorological conditions would not result in changes exceeding 13% in the committed effective doses calculated for aquatic exposure pathways. Consequently, no significant increase in potentially transboundary radiological impacts is expected as a result of changes in washout processes.

The aquatic transport analyses demonstrated that a substantial decrease in river discharge (from average-flow to low-flow conditions) could increase the committed effective dose resulting from normal operational liquid releases by less than a factor of three. However, even under such conditions, the resulting radiation exposure remains well below both the dose constraint of 90  $\mu$ Sv/year and the upper threshold for neutral radiological impacts. For normal operational liquid releases, almost the entire dose (approximately 99%) originates from internal exposure due to fish consumption. Consequently, among the relevant lifestyle parameters, only changes in fish consumption rates can significantly affect the total committed effective dose. Changes in other aquatic exposure pathways have negligible influence; for example, even doubling the annual duration of water-related activities would increase the total dose by less than 1%.

#### 2.4.2.4. Severe accidents

The assessment of severe accidents was performed for the following two representative scenarios involving significant environmental releases, selected as characteristic cases for evaluating severe accident consequences:

- Case 1: Station blackout with the reactor and containment remaining intact, at nominal power.
- Case 2: A 233 mm large-break loss-of-coolant accident combined with failure of the sump isolation valves and unsuccessful containment isolation.

The release source term was defined by concentrating the significant environmental release into the first 48 hours following the accident. Accordingly, atmospheric dispersion modelling was performed for a time-dependent release lasting 48 hours. Of the two scenarios, severe accident scenario No. 2 resulted in the higher doses, therefore, the results presented below correspond to this case.

*Table 2.4.2.4-1.* summarizes the doses calculated for representative adults and one-year-old children at the investigated receptor locations. Among the exposure pathways the external exposure from the radioactive cloud, the external exposure from deposited activity on the ground, the internal exposure due to inhalation, and the internal exposure via the food chain were determined. For cloud immersion and inhalation pathways, the exposure duration corresponds to the passage time of the radioactive plume. For ground deposition and food-chain pathways, the assessment considers lifetime exposure periods (50 years for adults and 70 years for one-year-old children). The highest value was calculated for Duboševica, Croatia, located approximately 77 km south of the NPP. The calculated committed effective dose for the representative adult individual was 5.4 mSv, while the corresponding value for a one-year-old child was 2.0 mSv.

**Table 2.4.2.4-1. Committed effective doses determined for severe accident release scenario No. 2 for representative adult individuals and one-year-old children**

| Receptor point      | Distance and direction from release point | Committed effective dose [nSv] |                    |
|---------------------|-------------------------------------------|--------------------------------|--------------------|
|                     |                                           | Adult                          | One-year-old child |
| Pince, Slovenia     | 179 km, W                                 | $1.23 \cdot 10^3$              | $4.34 \cdot 10^2$  |
| Duboševica, Croatia | 77 km, S                                  | $5.35 \cdot 10^3$              | $2.00 \cdot 10^3$  |
| Ridica, Serbia      | 67 km, S, SE                              | $4.94 \cdot 10^3$              | $1.82 \cdot 10^3$  |
| Beba Veche, Romania | 122 km, E, SE                             | $2.04 \cdot 10^3$              | $7.04 \cdot 10^2$  |
| Solomonovo, Ukraine | 327 km, NE                                | $7.23 \cdot 10^2$              | $2.36 \cdot 10^2$  |
| Obid, Slovakia      | 138 km, N                                 | $3.21 \cdot 10^3$              | $1.14 \cdot 10^3$  |
| Lusing, Austria     | 187 km, W, NW                             | $1.02 \cdot 10^3$              | $3.62 \cdot 10^2$  |
| Vienna, Austria     | 267 km, NW                                | $9.10 \cdot 10^2$              | $3.25 \cdot 10^2$  |

In the event of a severe accident, it can reasonably be assumed that emergency protective actions (primarily sheltering or food consumption restrictions) would be implemented in those areas where the Hungarian National Nuclear Emergency Response Plan (OBEIT) requires such measures based on the projected doses calculated without the application of protective actions. It can further be assumed that the emergency response plans of Hungary's neighbouring countries contain similar procedures, as they are also developed in accordance with the requirements of the International Atomic Energy Agency's (IAEA) General Safety Requirements Part 7 (Preparedness and Response for a Nuclear or Radiological Emergency, IAEA, Vienna, 2015), and that the competent authorities of those countries would cooperate with the Hungarian emergency response organizations during an accident. If food consumption restrictions are successfully implemented, i.e., assuming that consumption of contaminated food is reduced to zero, and only external exposure and inhalation pathways are considered, the resulting doses are typically reduced to approximately one-third of their original values at all receptor locations.

For sheltering, the dose calculations assumed that residents remain indoors throughout the passage of the radioactive plume and engage only in low-activity indoor behaviour. Under these assumptions, sheltering reduces cloudshine and groundshine doses by approximately 20-30%, while inhalation doses are reduced by nearly 70% for adults. Nevertheless, because the dominant contribution to the total dose arises from food-chain exposure, the total dose is reduced by only approximately 10% compared with the case without sheltering.

The severe accident doses expected when both food consumption restrictions and sheltering are implemented are presented in *Table 2.4.2.4-2*. It can be seen that the introduction of these protective actions reduces the total committed effective dose by approximately 50-80% (for example, at Duboševica, the maximum dose is reduced by 48% for one-year-old children and by 83% for adults).

**Table 2.4.2.4-2. Committed effective doses determined for severe accident release scenario No. 2 for representative adult individuals and one-year-old children assuming food consumption restrictions and sheltering**

| Receptor point      | Distance and direction from release point | Committed effective dose [ $\mu$ Sv] |                    |
|---------------------|-------------------------------------------|--------------------------------------|--------------------|
|                     |                                           | Adult                                | One-year-old child |
| Pince, Slovenia     | 179 km, West                              | $1.03 \cdot 10^2$                    | $1.55 \cdot 10^2$  |
| Duboševica, Croatia | 77 km, South                              | $4.93 \cdot 10^2$                    | $7.65 \cdot 10^2$  |
| Ridica, Serbia      | 67 km, South, Southeast                   | $4.49 \cdot 10^2$                    | $6.86 \cdot 10^2$  |
| Beba Veche, Romania | 122 km, East, Southeast                   | $1.68 \cdot 10^2$                    | $2.45 \cdot 10^2$  |
| Solomonovo, Ukraine | 327 km, Northwest                         | $5.73 \cdot 10^1$                    | $7.79 \cdot 10^1$  |
| Obid, Slovakia      | 138 km, North                             | $2.73 \cdot 10^2$                    | $4.12 \cdot 10^2$  |
| Lusing, Austria     | 187 km, West, Northwest                   | $8.55 \cdot 10^1$                    | $1.30 \cdot 10^2$  |
| Vienna, Austria     | 267 km, Northwest                         | $7.61 \cdot 10^1$                    | $1.16 \cdot 10^2$  |

The assessment of potentially transboundary radiological impacts associated with aquatic transport of radioactive contaminants was performed by considering the washout of airborne releases from severe accidents into the Danube. The washout fraction was assumed to be 19,1%, consistent with the methodology applied for design basis accidents. Accordingly, the deposited fraction of the atmospheric source term was used as the source term for the aquatic transport modelling.

The doses for aquatic exposure pathways are presented for severe accident scenario No. 2, which resulted in the higher calculated doses. *Table 2.4.2.4-3.* presents the calculated committed effective doses for representative adults and one-year-old children at Batina, Croatia, located approximately 98 km downstream of the NPP. Among the aquatic exposure pathways, only the pathway resulting in the higher dose was considered. Of the radionuclides released into the atmosphere and subsequently washed into the river, isotopes of cesium ( $^{134}\text{Cs}$ ,  $^{136}\text{Cs}$ ,  $^{137}\text{Cs}$ ) and iodine ( $^{131}\text{I}$ ,  $^{133}\text{I}$ ,  $^{135}\text{I}$ ) were the dominant contributors, accounting for approximately 70% of the external gamma dose. The calculation of internal exposure from fish consumption was based on the conservative assumption that residents consume their entire annual quantity of fish containing radioactive contamination immediately after the release event.

**Table 2.4.2.4-3. Committed effective doses determined for representative adult Individuals and one-year-old children at Batina (Croatia), assuming washout of atmospheric releases into the Danube for severe accident scenario No. 2, by exposure pathway**

| Release scenario                               | Severe accident scenario No. 2              |                    |
|------------------------------------------------|---------------------------------------------|--------------------|
| Exposure pathway                               | Committed effective dose [ $\mu\text{Sv}$ ] |                    |
|                                                | Adult                                       | One-year-old child |
| Total                                          | $5.34 \cdot 10^3$                           | $5.02 \cdot 10^3$  |
| Water-related activities – external gamma dose | $4.06 \cdot 10^3$                           |                    |
| Fish consumption – internal dose               | $1.28 \cdot 10^3$                           | $9.64 \cdot 10^2$  |

Under these highly conservative assumptions, the committed effective dose calculated for Batina in severe accident scenario No. 2 amounts to 5.3 mSv for adults and 5.0 mSv for one-year-old children, assuming one year of fish consumption exposure and exposure to water-related activities for the duration of the passage of the contamination plume. For comparison, the worldwide average annual natural background radiation dose is approximately 2.4 mSv<sup>2</sup>. The contribution of the external gamma dose from water-related activities to the total dose is approximately 76% for adults and 81% for one-year-old children, while fish consumption contributes approximately 24% and 19%, respectively. For aquatic exposure pathways, emergency protective actions may also be implemented, including restrictions on water-related activities and fish consumption. The implementation of such measures can substantially reduce the committed effective dose, effectively to near-zero levels.

The dose values calculated for aquatic exposure pathways resulting from washout of atmospheric releases cannot be added to the dose values determined for atmospheric exposure pathways arising from the same airborne release, since the simultaneous occurrence of these two scenarios is not physically possible.

### 2.4.3. Transboundary radiological impacts of the combined operation of the Paks NPP and the Paks II NPP

The cumulative public dose, resulting from the normal operation of the Paks NPP, the Paks II NPP, and the Spent Fuel Interim Storage Facility (SFISF) remains significantly below the dose constraint of 90  $\mu\text{Sv}/\text{year}$  established separately for the Paks NPP and the Paks II NPP,

<sup>2</sup> United Nations Scientific Committee on the Effects of Atomic Radiation, Sources and effects of ionizing radiation. UNSCEAR 2008 Report, Volume I: SOURCES, Report to the General Assembly Scientific Annexes A and B, ISBN 978-92-1-142274-0.

even within a 30 km radius of the site. Accordingly, it can be concluded that no potential transboundary radiological impacts are expected from the combined normal operation of these three facilities (the Paks NPP, the Paks II NPP, and the SFISF). Provided that the applicable dose constraints are complied with, the impacts at receptor locations beyond Hungary's borders remain within the neutral impact category.

In the event of an accident, or severe accident postulated separately for any of the currently operating, or future nuclear facilities at the site, the impacts originating from the other two facilities – assumed to remain in normal operation during the event – would not materially influence the results of the analyses, either in terms of environmental releases or resulting public radiation exposure. The analyses do not require the assumption that accidents, or severe accidents occur simultaneously at multiple nuclear facilities currently operating or planned at the site. This is because, accident consequences associated with the SFISF, or the Paks II NPP would be significantly lower than those calculated for a comparably severe accident at the Paks NPP. Furthermore, even in the unlikely event of simultaneous incidents, no interactions between the facilities are expected that would result in increased radiation doses. Moreover, although the probability of simultaneous accidents is extremely low, even in such a theoretically conceivable case the temporal progression of the individual events would not be identical, and therefore the timing of radioactive releases would differ. As a consequence, the resulting radioactive plumes would most likely be dispersed under different meteorological conditions and would propagate in different directions. While this could potentially increase the overall geographical area affected, the maximum doses calculated separately for each accident scenario could not simply be added together. Similarly, the assessment did not consider scenarios involving simultaneous accidents occurring in multiple reactor units of the Paks NPP. The analyses were performed using conservative and best-estimate approaches, focusing on safety-relevant scenarios above a defined probability threshold. Therefore, they do not include theoretically possible, but extremely low-probability events, such as simultaneous accidents affecting multiple nuclear facilities or multiple reactor units.

### 3. Responses to comments received during the preliminary consultation

#### 3.1. Comments received on the Preliminary Consultation Document

Upon initiation of the preliminary consultation procedure, the BCGO, acting as the competent environmental authority, informed the Ministry of Energy, responsible for environmental protection matters during the preliminary consultation process, by transmitting the application and the English-language version of the Preliminary Consultation Document. On 30<sup>th</sup> October 2024, taking into account the countries notified during the transboundary environmental impact assessment procedure conducted for the Paks II NPP project, the Ministry notified 31 foreign parties (Hungary's neighbouring countries, all member states of the European Union, as well as the United Kingdom, Norway, and Switzerland).

Comments from the notified countries were received until 22<sup>nd</sup> January 2025. Responses were received from a total of eight countries. Austria, Latvia, Romania, and Croatia indicated their intention to participate in the environmental impact assessment procedure. Finland, Poland, and the Czech Republic requested information on the results of the environmental impact assessment. The documents received from foreign parties in response to the Ministry's notification, together with the responses provided, are summarized in *Table 3.1-1*.

**Table 3.1-1. Responses received from the notified countries**

| No. | Date        | Country, organization                                                                                                        | Response / title of document, reference number                                                                                                                                                        | Summary of response                                                                                                                                                                                                                                                                                                                                                                                                 |
|-----|-------------|------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.  | 06.12.2024. | Sweden<br>Swedish Environmental Protection Agency (SEPA)                                                                     | –<br>(e-mail response)                                                                                                                                                                                | Based on consultations with the relevant Swedish authorities, SEPA concluded that the project is not expected to result in transboundary environmental impacts affecting Sweden. Therefore, Sweden does not intend to participate in the Espoo Convention procedure as an affected Party.                                                                                                                           |
| 2.  | 11.12.2024. | Finland<br>Finnish Environment Institute (Syke)                                                                              | Finland's response to the notification in accordance with the Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention) for the "Paks NPP SSLE" KMF/16182-1/2024-EM | Finland does not intend to participate in the environmental impact assessment procedure for the SSLE of the Paks NPP. However, the Finnish Environment Institute requested information on the project through the provision of the English-language version of the EIAR.                                                                                                                                            |
| 3.  | 16.12.2024. | Austria<br>Republic of Austria Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology | Espoo Convention, Paks NPP (subsequent service life extension), Scoping; Statements<br>2024-0.911.417                                                                                                 | Austria intends to participate in the transboundary environmental impact assessment procedure, as significant environmental impacts affecting Austrian territory cannot be excluded. Comments submitted by Austrian authorities and the public are contained in separate documents. Austria requested the submission of the EIAR and information regarding opportunities for public participation in the procedure. |
|     |             |                                                                                                                              | Environmental Impact Assessment NPP Paks 1-4, 2 <sup>nd</sup> extension of the Lifetime Scoping (Expert statement) Report REP-0949                                                                    | Austrian Environment Agency GmbH (UBA), acting as Austria's coordinator in the transboundary environmental impact assessment procedure, prepared an expert report identifying issues that Austria considers should be addressed in the EIAR.                                                                                                                                                                        |
|     |             |                                                                                                                              | Statement Submitted within the Framework of the Transboundary Environmental Impact Assessment Procedure for the Lifetime Extension of the Paks NPP (Statement – Upper Austria)                        | The opinion submitted by Upper Austria identifies issues that, in its view, should be assessed in the EIAR.                                                                                                                                                                                                                                                                                                         |
|     |             |                                                                                                                              | Statement of the Vienna Environmental Ombudsman                                                                                                                                                       | The statement of the Vienna Environmental Ombudsman contains topics recommended for assessment during the environmental impact assessment procedure.                                                                                                                                                                                                                                                                |
| 4.  | 16.12.2024. | Latvia<br>The Environment State Bureau of                                                                                    | ESB letter dated 16.01.2025. No. 5-05/74/2025                                                                                                                                                         | Latvia intends to participate as an affected Party in the environmental impact assessment procedure and in consultations concerning                                                                                                                                                                                                                                                                                 |

| No. | Date        | Country, organization                                                | Response / title of document, reference number               | Summary of response                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-----|-------------|----------------------------------------------------------------------|--------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|     |             | The Republic of Latvia (ESB)                                         |                                                              | transboundary impacts. The Latvian authorities involved in the procedure did not submit specific expert comments regarding the scope of the EIAR.                                                                                                                                                                                                                                                                                                                                                                                       |
| 5.  | 19.12.2024. | Romania<br>Ministry of Environment, Waters and Forests               | Letter answer dated 19.12.2024.<br>DGEICPSC/43187/19.12.2024 | Romania intends to participate in the environmental impact assessment procedure in accordance with the requirements of the Espoo Convention and Directive 2011/92/EU. No comments were received from the Romanian public regarding the Preliminary Consultation Document. The response letter contains observations from the competent authorities, institutions, and potentially affected local environmental agencies.                                                                                                                |
| 6.  | 20.12.2024. | Poland<br>General Directorate for Environmental Protection           | Letter dated 20.12.2024.<br>DOOŚ-WST.442.25.2024.ZM.4        | Taking into account the characteristics of the project and the distance to the Polish border, Poland does not intend to participate as an affected Party in the transboundary environmental impact assessment procedure. However, Poland requested the results of the updated transboundary impact analyses and the EIAR in order to confirm that transboundary impacts on Polish territory can be conclusively excluded.                                                                                                               |
| 7.  | 17.01.2025. | Czech Republic<br>Ministry of the Environment                        | Letter dated 17.01.2025.<br>MZP/2025/710/100                 | The response includes opinions from the affected municipality, competent authorities, the Ministry of the Environment, and comments submitted by an association. Based on the statements of the competent authorities, significant transboundary impacts affecting the Czech Republic are not anticipated; therefore, the Czech Republic does not intend to participate in the transboundary environmental impact assessment procedure. Nevertheless, it requested that the issues raised by the association be considered in the EIAR. |
| 8.  | 20.01.2025. | Croatia<br>Ministry of Environmental Protection and Green Transition | Letter dated 20.01.2025.<br>Reg.No.: 517 -04-t-25-12         | No comments on the Preliminary Consultation Document were received from the Croatian public. The response letter contains issues proposed by the competent authorities for assessment within the EIAR.                                                                                                                                                                                                                                                                                                                                  |

Based on the review of the documents listed in *Table 3.1-1*, containing comments received from potentially affected foreign parties, comments, recommendations regarding topics to be addressed in the EIAR, and specific questions concerning the Preliminary Consultation Document were submitted by Austria, Romania, the Czech Republic, and Croatia.

For those general topics proposed for assessment that were raised by more than one foreign party, the responses of the Hungarian side are provided in *Chapters 2.*, *3.2.*, and *3.3.1. – 3.3.4.* The results of the assessment of conventional and radiological transboundary impacts are summarized in *Chapter 2*. The licensing process for the SSLE, the assessment of nuclear safety issues during the licensing procedure, and activities related to ageing management are presented in *Chapter 3.2*. *Chapters 3.3.1. – 3.3.4.* contain responses to questions concerning the geological investigations of the site, the thermal loading of the Danube, and the analysis of design extension condition accidents.

Responses to specific questions raised by the commenting foreign parties that do not fall within the above thematic categories are presented in tabular form in *Chapter 3.3.5*.

## 3.2. Licensing of the SSLE

### 3.2.1. Principal licensing procedures

In addition to the environmental licensing procedure, the SSLE of the NPP requires the completion of a nuclear safety licensing procedure under the authority of the Hungarian Atomic Energy Authority (HAEA), as well as an application to extend the validity period of the power plant's electricity generation operating licence before the Hungarian Energy and Public Utility Regulatory Authority (MEKH). An overview of the entire licensing process and its regulatory framework is provided in *Figure 3.2.1-1*.

Pursuant to section 68 of Act LIII of 1995 on the general rules of environmental protection, activities that have, or are expected to have, significant environmental impacts may only be commenced after an environmental impact assessment has been carried out and an environmental license has been obtained from the competent environmental authority.

The scope of such activities, as well as the procedures, phases, and content requirements of the environmental licensing process and the documentation to be submitted to the environmental authority, are specified in Government Decree 314/2005. (XII. 25.) on environmental impact assessment and the integrated environmental use licensing procedure. According to the Government Decree, environmental impact assessments apply not only to new facilities but also to modifications and changes to existing facilities specified in the decree, including the lifetime extension of NPPs.

For activities subject to environmental impact assessment, section 67 of Act LIII of 1995 allows the environmental user (applicant) to initiate a preliminary consultation with the environmental authority. Pursuant to section 5/A (2) of Government Decree 314/2005. (XII. 25.), the purpose of the preliminary consultation is to enable the environmental user to obtain a written opinion from the environmental authority regarding the content requirements of the EIAR, covering environmental and nature conservation issues as well as the other specialist matters specified in Annex 12 of the Government Decree. A further objective of the preliminary consultation is to provide the public, through the publication of the relevant documentation, with an opportunity to express comments and observations regarding the proposed activity.

The environmental impact assessment procedure following the preliminary consultation is initiated by the environmental authority upon application by the environmental user. The application must be accompanied by the EIAR prepared in accordance with the opinion issued by the authority during the preliminary consultation, and the general content requirements set out in Annex 6 of Government Decree 314/2005. (XII. 25.).

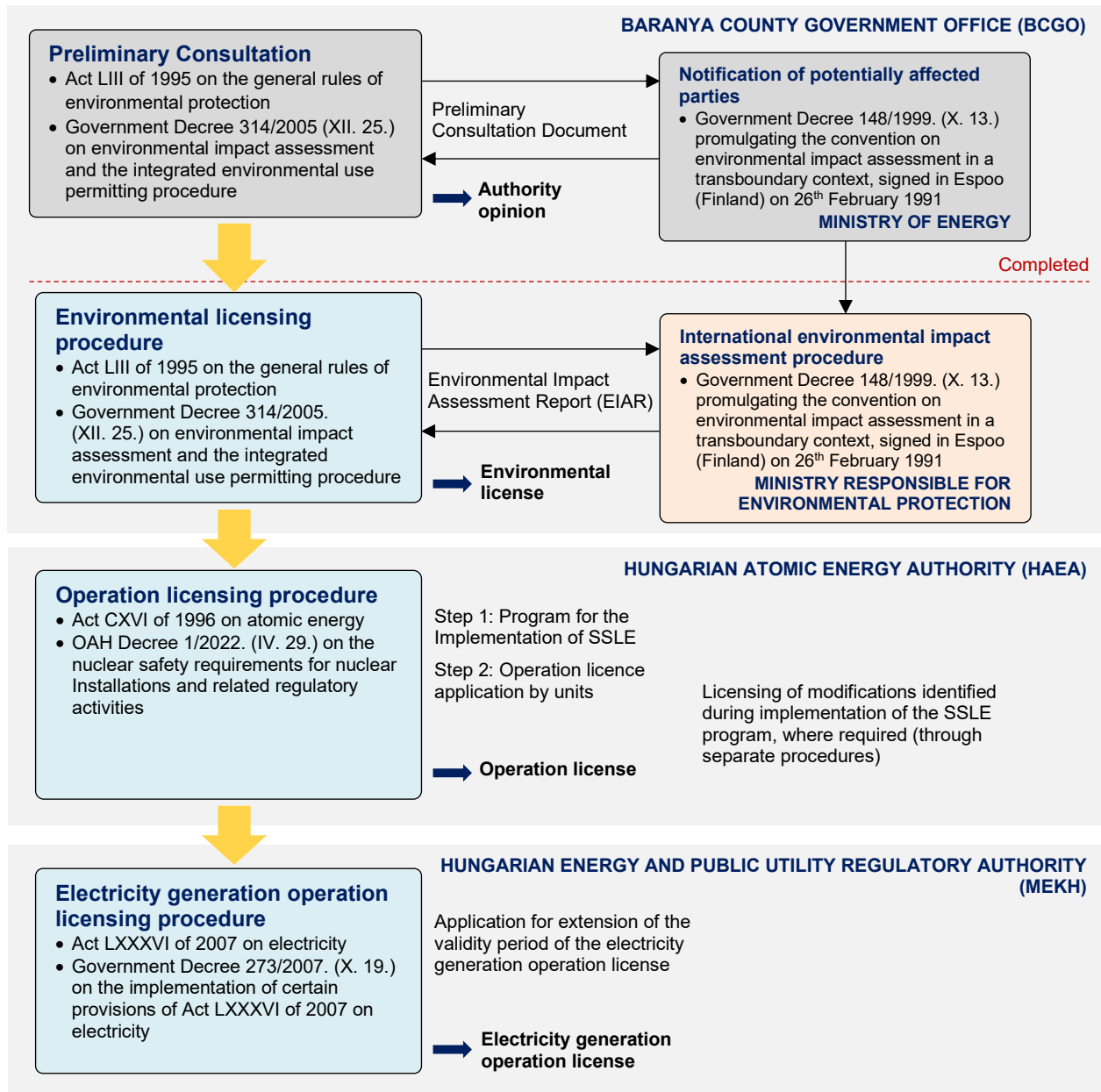


**Figure 3.2.1-1. Licensing process for the SSLE of the NPP**

The operation of NPPs is an activity falling within the scope of the convention on environmental impact assessment in a transboundary context, signed in Espoo (Finland) on 26<sup>th</sup> February 1991 and promulgated in Hungary by Government Decree 148/1999. (X. 13.). Pursuant to Appendix I of the convention, the operation of NPPs is an activity that may cause significant transboundary environmental impacts. Where significant transboundary environmental impacts are considered possible in connection with an activity assessed during the preliminary consultation process, the ministry responsible for environmental protection notifies potentially affected foreign parties of the proposed activity and of the ongoing environmental impact assessment procedure. If a foreign affected party indicates in its response that it wishes to participate in the environmental impact assessment procedure, the procedure must thereafter be continued in accordance with the provisions of the Espoo Convention as a transboundary environmental impact assessment procedure. Within the framework of this procedure, the EIAR and related documentation are transmitted to the affected parties, and consultations are conducted with the concerned foreign parties in order to provide information and obtain their views. In reaching its decision on the environmental license, the environmental authority takes into account the opinions and comments received from the affected foreign parties during the transboundary procedure.

In addition to the environmental licensing procedure, the SSLE of the NPP also requires the completion of nuclear safety licensing and electricity industry licensing procedures. Pursuant to section 17 (2) point 1 b) of Act CXVI of 1996 on atomic energy, the nuclear regulatory authority, namely the HAEA, is responsible for nuclear safety licensing related to the construction, expansion, commissioning, operation, operation beyond the original design lifetime, the further operation following operation beyond the design lifetime, which is the subject of the present assessment, as well as the decommissioning and termination of nuclear installations. According to section 18 (1) point e) of the OAH Decree 1/2022. (IV. 29.) on the nuclear safety requirements for nuclear installations and related regulatory activities, operation of a nuclear installation, operation beyond its design lifetime, and further operation following operation beyond the design lifetime require an operating licence issued by the nuclear safety authority, the HAEA. Obtaining a final environmental license is a prerequisite for the issuance of the nuclear safety operation licence required for the SSLE.

As the first stage of the nuclear safety licensing procedure, four years before the expiry of the operation licence of Unit 1, the implementation program for the SSLE of Units 1-4 of the Paks NPP will be submitted to the HAEA simultaneously with the official notification of the intention to pursue a SSLE. This implementation program defines all activities necessary to ensure that the safety of the NPP can be established, continuously maintained, and demonstrated, and that all licensing requirements can be satisfied. Provided that the implementation program complies with the requirements specified in the OAH Decree, the HAEA approves the program and supervises its implementation.

In the second stage of the procedure, one year before the expiry of the operation licence of the respective unit, separate applications for operating licences covering the SSLE period are submitted to the HAEA for each reactor unit individually.

The documentation supporting the licence application must include, inter alia, the following principal elements:

- review of the design basis of the reactor units,
- review of the comprehensive ageing management program of the Paks NPP, including the review / development of ageing management programs for specific systems, structures, and components, thereby ensuring continuous monitoring of the condition and safety functions of items within the scope of ageing management throughout the extended operating period,
- assessment of the technical condition of the NPP and demonstration of the suitability of systems, structures, and components for operation during the extended lifetime,
- establishment and implementation of a system for monitoring maintenance effectiveness, together with quarterly reporting of operating experience and results to the regulatory authority,
- environmental qualification of electrical and instrumentation and control systems and components,
- review and performance of time-limited ageing analyses and other lifetime-limiting assessments, together with the implementation of any measures required on the basis of the analysis results.

The above reviews and analyses are carried out continuously during the preparation period for the SSLE and in parallel with the environmental licensing procedure.

The HAEA authorizes further operation following operation beyond the original design lifetime through the issuance of a new operating licence upon application by the licensee. Applications for such licences must be submitted separately for each NPP unit no later than one year before the expiry of the valid operating licence. The detailed licensing requirements are specified in Volumes 1 and 4 of the Nuclear Safety Codes annexed to OAH Decree 1/2022. (IV. 29.).

Pursuant to section 74 (1) point b) of Act LXXXVI of 2007 on electricity, electricity generation by power plants with a nominal generating capacity of 50 MW or greater may only be carried out under a generation operation licence issued by the MEKH. According to section 75 (4) of the Act, the rules governing the issuance of a licence also apply to the extension of its validity period.

For NPPs, the validity period of the generation operation licence may be extended no earlier than five years before its expiry date. Applications for extension of the validity period of the generation operation licence must be submitted no later than 180 days before the licence expires. The detailed rules governing this licensing procedure are set out in Government Decree 273/2007. (X. 19.) on the implementation of certain provisions of Act LXXXVI of 2007 on electricity.

Although the lifetime extension of NPPs essentially concerns the continuation of an activity that has, in most cases, already been licensed and performed for several decades, from a licensing perspective it nevertheless requires a comprehensive review of all applicable requirements for the facility. This review must be carried out within the framework of both environmental licensing and nuclear safety licensing procedures, which constitute the most significant regulatory approval processes for the SSLE.

### 3.2.2. Assessments supporting the nuclear safety licensing

The operating licence is renewed by HAEA on the basis of a comprehensive safety assessment. Consequently, the licensing procedure covers all systems classified within nuclear safety classes that are required to perform their designated safety functions throughout the entire operating lifetime of the plant. The assessment must also include non-safety-related systems and components whose failure could impede, affect, or jeopardize the ability of safety-related systems and components to perform their intended functions.

To support the SSLE, it must be demonstrated that the condition of the systems, structures, and components allows continued operation. The condition monitoring of the NPP's systems and structures has been carried out continuously since commissioning. The associated inspection programs, pressure tests, structural examinations, and periodic inspections include both destructive and non-destructive testing methods. Over the years, the technical standard of these examinations has continuously improved in terms of both equipment and methodologies. Material examinations are conducted and qualified in accordance with the methods recommended by the European Network for Inspection Qualification.

In addition to routine condition monitoring and inspections performed in accordance with established NPP practice, special investigations will also be carried out, within a scope and using methodologies agreed with the regulatory authority, to assess the condition of all safety-significant systems, structures, and components. These investigations primarily focus on structural locations that are not included in periodic inspection programs but where one-time examinations are considered necessary based on analyses of ageing mechanisms that may limit service life. The investigations must demonstrate that the plant structures and equipment remain suitable for continued operation, are free from defects, and possess material properties exceeding the required acceptance criteria.

The licensed operating lifetime and the validity period of the operating licence are primarily limited by the technically and safety-defined functional lifetime demonstrated through Time-Limited Ageing Analyses (TLAA).

The scope of the required TLAA's was determined on the basis of analyses performed by the original designer, the Final Safety Analysis Report (FSAR) of Units 1-4 of the Paks NPP reflecting current safety expectations, and the international practice, including the review of similar analyses conducted at more than thirty NPPs worldwide, with particular consideration given to the specific characteristics and unique challenges of the Paks NPP. As part of the preparation for the SSLE, the performance of 32 TLAA's is planned:

- TLAA1 Low-cycle fatigue analysis of ABOS 1-2 (safety classification) mechanical systems and components.
- TLAA2 Environmental qualification of electrical and instrumentation and control systems and components.
- TLAA3 Pressurized Thermal Shock (PTS) analyses of reactor pressure vessels.
- TLAA4 Determination of pressure – temperature ( $p$ - $T$ ) curves for the primary circuit.
- TLAA5 Crack growth analyses.

- TLAA6 Thermal stratification analyses of ABOS 1-2 piping systems.
- TLAA7 Extension of high-energy pipe break analyses.
- TLAA8 High-cycle fatigue analysis of flow-induced vibration of reactor internals.
- TLAA9 High-cycle fatigue analysis of flow-induced vibration of steam generator tubes.
- TLAA10 Analysis of material property changes in reactor internal structures.
- TLAA11 Fatigue analyses of containment penetrations.
- TLAA12 Fatigue analyses of containment structure components (welds).
- TLAA13 Analysis of thermal ageing embrittlement of ABOS 1-2 mechanical systems and components.
- TLAA14 Fatigue analyses of cranes performing safety functions.
- TLAA15 Fatigue analysis of spent fuel pool liners.
- TLAA16 Analysis of material property changes in steam generator tubes.
- TLAA17 Analysis of material property changes in heavy concrete structures.
- TLAA18 Analysis of integrated leak-rate tests at elevated pressure.
- TLAA19 Analysis of corrosion wall-thickness allowances.
- TLAA20 Fatigue analysis of the main coolant pump flywheel.
- TLAA21 Analysis of building settlement and its consequences.
- TLAA22 Assessment of B10 depletion of spent fuel pool racks.
- TLAA23 Analysis of embedded flaws in the heat-affected zone of reactor vessel cladding.
- TLAA24 Analysis of material property changes in the ceramic thermal insulation of the upper block.
- TLAA25 Fatigue assessment of spent fuel storage racks.
- TLAA26 Fatigue assessment of the fuel handling machine.
- TLAA27 Fatigue assessment of containment airlocks.
- TLAA28 Fatigue assessment of diesel generators.
- TLAA29 High-cycle thermal fatigue analysis of cracks identified in the guide vane and discharge cover of the main coolant pump.
- TLAA30 Lifetime-limiting analysis of the steel thermal insulation support structure of the reactor shaft wall.
- TLAA31 Assessment of material degradation processes affecting the reactor pressure vessel support ledge and supporting steel components.
- TLAA32 Analysis of liner defects and leakage in the spent fuel pool and transfer pool.

The outcomes of these analyses may fall into one of two categories:

- In most cases, the extended or repeated analyses demonstrate that the examined structure will not reach the specified limits (for example, the allowable number of load cycles), and therefore the conclusions regarding operability remain valid throughout the extended operating period.
- If the extended or repeated analyses and examinations demonstrate operability for a period shorter than the proposed extended lifetime, a targeted ageing management program or other corrective measures (such as equipment replacement, refurbishment, or additional future inspections) must be implemented or planned to address the identified issue.

### 3.2.3. Review of ageing management programs

The Paks NPP has implemented ageing management programs capable of detecting ageing processes affecting structures, structural components, and systems in a timely manner; effectively preventing the adverse effects of ageing; mitigating degradation that may occur; and restoring degraded conditions where necessary. As part of the preparation for the SSLE, these programs are being reviewed and, where necessary, new programs are being developed.

The graded approach generally applied throughout the nuclear industry is used, taking into account the safety significance of the structure or component, and the extent to which the relevant ageing mechanism may limit plant lifetime. Accordingly, systems, structures, and components are classified into two categories:

- Safety-Significant Individual Components, which include components of outstanding importance to nuclear safety, such as the reactor pressure vessel and the main equipment of the reactor coolant system, i.e., structures classified in Safety Class 1 and certain structures classified in Safety Class 2. For these items, dedicated, component-specific ageing management programs have been developed.
- Ageing management groups comprise collections of systems, structures, and components that have similar designs and materials; operate in the same environmental conditions; and therefore, experience similar ageing mechanisms. As a result, they can be managed through common ageing management programs. Approximately 90 ageing management groups have been defined for mechanical systems and components, nearly 30 groups for civil structures, and 16 groups for electrical and instrumentation and control systems. Consequently, approximately 100,000 systems, structures, and components included within the scope of ageing management at the Paks NPP can be managed through approximately 150 ageing management programs.

The demonstration of the adequacy of these programs constitutes an important chapter of the licensing documentation required for the SSLE. As part of demonstrating the adequacy of the ageing management programs, a comprehensive review of previous ageing management practices is also performed, including the necessary modification of existing programs and, in certain cases, the development of new ones. The review is carried out in accordance with the recommendations of HAEA Regulatory Guide No. 4.12 concerning the structure and content of ageing management programs. These recommendations are consistent with both United States practice, as reflected in the Generic Aging Lessons Learned (GALL) Report (NUREG-1801), and the expectations of the International Atomic Energy Agency (IAEA Safety Standards Series No. NS-G-2.12, Ageing Management for Nuclear Power Plants).

For the Paks NPP as a complete four-unit facility, the overall service life is primarily determined by those structures and components that cannot be replaced, cannot be refurbished, or whose replacement would involve such extensive costs and outage durations that replacement would not be technically or economically reasonable. Examples include the reactor pressure vessel, steam generators, and the containment structure. One of the most important questions related to the SSLE is therefore whether the expected service life of these non-replaceable major technological components is sufficient to support an additional 20 years of operation.

Based on the material testing results, engineering analyses, and maintenance experience currently available, none of the most important safety-significant components (including the reactor pressure vessels, steam generators, hydro accumulators, pressurizers, main isolation valves, and primary coolant piping) are expected to encounter technical limitations or disproportionately high costs during the extended operating period of 50+20 years. All available technical information indicates that the safe operation of the NPP for a total service life of 70 years can most likely be demonstrated.

To ensure compliance with nuclear safety requirements, the conservative design philosophy of the plant, together with actual operational loads being lower than those assumed in the design basis and the introduction of 15-month operating cycles, has resulted in substantial lifetime margins for long-lived structures and equipment. These margins make it possible to extend the operating lifetime of key systems, structures, and components, and consequently the lifetime of the entire power plant, without reducing the mandatory safety margins incorporated into the original design through limiting criteria and safety factors beyond acceptable levels.

The most important prerequisite for the SSLE is that systems, structures, components, buildings, and civil structures maintain the required technical condition and availability throughout the extended operating period. To achieve this objective, experts of the Paks NPP have developed a comprehensive refurbishment and modernization program based on the extension of the operating lifetime to 50+20 years, current condition information, and forecasts of the future condition of mechanical, electrical, instrumentation and control systems, structures, and buildings.

Implementation of the refurbishment program will primarily take place during planned major outages and during maintenance activities performed on safety systems while the plant remains in operation. Several large-scale refurbishment projects are also anticipated that will require

substantial dismantling of technological systems (e.g., replacement of the spent fuel pool liner, replacement of the transfer pool liner, and replacement of cable bundles within the containment). For such projects, the standard outage periods of 25-55 days and the associated technological conditions will not be sufficient. Consequently, preparation for the SSLE will require one extended outage of several months for each reactor unit.

### 3.3. Overview of comments received and presentation of their resolution

The responses to comments and questions submitted by foreign parties regarding the Preliminary Consultation Document are presented below, partly in thematic groups and partly in the form of itemized responses.

#### 3.3.1. Issues beyond the scope of the environmental licensing

Several comments submitted during the preliminary consultation concern matters that fall within the scope of nuclear safety licensing. *Chapter 3.2.* provides an overview of the principal activities associated with both environmental licensing and nuclear safety licensing. It is also important to note that the full implementation of the measures required to ensure compliance with nuclear safety requirements will take place after completion of the environmental impact assessment process. In some cases, it cannot be excluded that additional analyses or even further modifications may prove necessary, which could influence the scope considered in support of the environmental license application. Similarly, amendments to legislation introduced before the commencement of the SSLE could affect the analytical basis and scope of the licensing process in any area relevant to the authorization of the SSLE.

Nevertheless, it can reasonably be assumed that such developments will not significantly alter the scope underlying the EIAR, given that the project concerns the continuation of an activity whose environmental effects are already well understood in detail. Regardless of any modifications that may become necessary and the corresponding reviews required, the applicable regulatory framework provides an appropriate mechanism for the management and regulatory approval of such changes.

#### 3.3.2. Issues related to the geological, tectonic, seismological, and geotechnical characteristics of the site

*Chapter 2.1.6.* of the EIAR provides comprehensive responses to all questions raised during the preliminary consultation regarding geological, tectonic, seismological, and geotechnical matters, as the chapter was prepared taking these comments into account.

Geological investigations of the Paks site, together with associated scientific research aimed at improving the understanding of the geology of the Pannonian Basin, have been conducted for more than six decades. The targeted investigations carried out at the site and the related scientific studies have enabled a comprehensive understanding and evaluation of the site's geological, seismotectonic, and geotechnical characteristics in accordance with nuclear safety requirements. This knowledge forms the basis for the design, safety assessment, development, and regulatory licensing of the three nuclear facilities (Paks NPP, SFISF and Paks II NPP) located at the site.

The Paks site exhibits complex seismotectonic characteristics. The presence of a fault system in the vicinity of the site had been known well before site selection. However, the activity of these faults, which was a key issue in determining the seismic hazard of the site, was previously the subject of scientific debate. No direct empirical evidence of fault activity was available, and quaternary reactivation was indicated only by the 1911 Kecskemét earthquake.

As part of the site investigation program for the Paks II NPP, detailed mapping of the fault system was recently carried out. The investigations included analysis of geomorphological and paleoseismological indicators of quaternary activity, high-resolution geophysical surveys, microseismic monitoring, and space-geodetic deformation measurements. The exceptionally detailed Geological Investigation Program confirmed quaternary reactivation of the mapped

Dunaszentgyörgy-Harta fault structure. However, subsequent interpretations and analyses performed following completion of the program did not confirm the existence of significant surface displacement. At the same time, the investigations concluded that earthquakes of a magnitude capable of producing significant and permanent lateral surface displacement relevant to nuclear safety are unlikely to occur on this fault system.

### ***Seismicity of the site***

The seismicity of Hungary is characterized as diffuse intraplate seismicity. Earthquakes occurring within Hungary have been monitored since 1995 by a highly sensitive microseismic monitoring network with particular focus on the Paks region. The results of sensitive microseismic monitoring carried out over the past three decades demonstrate that no earthquake with a magnitude of  $ML \geq 1.0$  has occurred in the immediate vicinity of the Paks site. Consequently, recent activity of the local faults can increasingly be excluded with a high degree of confidence, meaning that no seismically active fault can be identified in the immediate vicinity of the Paks site. Other faults identified near the site on the basis of geophysical, geological, and geomorphological observations likewise show no seismic activity, even within the very low magnitude range of approximately 0.75-1.0.

Consistent with the microseismic monitoring results, analyses of space-geodetic and GPS measurements clearly indicate that there is currently no significant lateral displacement along the mapped faults in the area. The structural blocks do not exhibit significant relative movement, or such movement is less than 0.1 mm/year.

### ***Paleoseismological investigations***

The principal findings of the paleoseismological investigations can be summarized as follows:

- the identified deformations can be interpreted as earthquake-induced environmental effects, confirming late pleistocene tectonic activity.
- the age determination is considered reliable, however, the location of the fault associated with the observed earthquake-induced environmental effects remains highly uncertain,
- it is a logical, although not exclusive, assumption that the features observed in the trenches are the result of activity on a fault located beneath the trench; however, faulting beneath the trench is not a prerequisite for the occurrence of earthquake-induced liquefaction; the necessary conditions are the presence of water-saturated, cohesionless granular soils that can be affected by earthquake-induced ground shaking,
- according to recent research, late pleistocene paleoliquefaction features may have been caused not only by earthquakes of magnitude  $M_w \geq 5$ , but potentially also by earthquakes of approximately  $M_w \geq 4$ .

### ***Seismic hazard and soil liquefaction***

The seismic hazard of the NPP site was evaluated using a Probabilistic Seismic Hazard Assessment (PSHA) methodology. With regard to the maximum horizontal ground acceleration corresponding to the design basis annual exceedance probability of  $10^{-4}$ /year, the results obtained over the past thirty years using different models and software tools are essentially consistent and show no significant differences. Compared with earlier analyses, differences were identified only in the response spectrum of the vertical seismic component. This is attributable to the fact that, in light of current scientific knowledge, the vertical component was calculated taking into account that the site's seismic hazard is predominantly influenced by earthquakes occurring in nearby seismic source zones.

Regarding soil liquefaction, the calculated results indicate that no global liquefaction affecting the entire soil profile is expected at the  $10^{-4}$ /year probability level. However, localized liquefaction phenomena resulting in surface settlements of a few centimetres may occur.

### ***Hazard of permanent surface displacement***

According to IAEA SSR-1 and IAEA SSG-9 (Rev. 1), where quaternary activity indicates the possibility of surface fault displacement, a probabilistic fault displacement hazard analysis is required to determine whether the hazard is relevant from a nuclear safety perspective.

Such analyses are based on characterizing fault activity using a magnitude-frequency (recurrence) relationship. In the present case, the available data are insufficient to perform such an analysis. Even if extensive additional investigations were undertaken, the seismicity and geodynamic characteristics of the site suggest that the necessary data would most likely remain unavailable. Consequently, conventional Probabilistic Fault Displacement Hazard Analysis (PFDHA) methodologies cannot be applied to these faults, because no magnitude-frequency relationships have been established. The currently available paleoseismological data are insufficient not only for PFDHA purposes but also for the accurate determination of earthquake magnitudes. Likewise, historical and instrumental earthquake records provide no evidence supporting recent fault activity.

Nevertheless, following the conceptual approach of PFDHA, a fault-displacement hazard curve can be generated using the results of the Probabilistic Seismic Hazard Assessment (PSHA). Based on the resulting seismic hazard curve, the risk of permanent surface displacement is considered practically negligible. It is not significant even at a frequency level of  $10^{-7}$ /year, and the possibility of a cliff-edge effect can also be excluded.

#### **3.3.3. Issues related to the heat load of the Danube**

Responses to the questions raised regarding the heat load of the Danube that could potentially reach national borders as a result of the independent operation of the Paks NPP or its combined operation with the planned Paks II NPP are provided in *Chapter 2.3*.

#### **3.3.4. Issues related to the analysis of design extension condition accidents**

Several comments and questions were raised concerning design extension condition accidents, their analysis, and their potential transboundary impacts. Detailed responses to these questions are provided in *Chapter 2.4*.

#### **3.3.5. Itemized responses**

Questions that cannot be classified within the categories presented in the preceding chapters, together with the corresponding itemized responses, are provided in *Table 3.3.5-1*.

**Table 3.3.5-1. Itemized responses to questions submitted by foreign parties during the preliminary consultation**

| No.                                   | Comment submitted by the foreign party                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Response to the comment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|---------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Comments Received from Romania</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| R 1                                   | Regarding the biological quality elements, it was indicated that there was a local impact with a significant effect on the indicators on the structure of the organisms communities in the downstream sections of the water discharge used in the cooling process. It was also noted that affecting biological quality elements will not cause degradation at ecological class level of any of the biological elements assessed under the WFD, in the downstream sections of the water discharge used in the cooling process. However, in terms of indirect impact, the spread of invasive species caused by the water discharge used in the cooling process was indicated. In this respect, we mention that it is necessary to detail the information on the spread of invasive species and how they could affect the ecological status/potential status of water bodies, as well as the associated mitigation measures.                                                                                                                                                                                                                                                                                                                                                                                                             | The indirect impact mechanism has been described in detail. The discharge may contribute to the proliferation of invasive species insofar as their increased abundance within the affected river reach may enhance their reproductive potential. However, based on the results of the analyses performed, there is no evidence that this indirect effect is capable of causing a deterioration in the ecological status classification of the affected water body. Furthermore, it can be unequivocally stated that the operation of the NPP does not itself facilitate the introduction or direct spread of invasive species. |
| R 2                                   | The environmental impact assessment for life extension activities, in this case, must focus on whether the cumulative environmental impacts of extended operation of the plant will change due to the subsequent life extension of 20 years. It is also necessary to take into account the expected changes in the characteristics of the environment, with reference to climate change and the establishment of the adaptation measures needed to improve resilience (quantitative management of the Danube waters, forecasted changes in the hydrological characteristics of the Danube, population, human activities), as well as the impact on the evolution of flora and fauna in the area of influence of the project due to technological warm water discharges into the Danube. In this context, the environmental impact assessment study is expected to present in detail the situation of the potential impact on the environmental components, respectively on water resources and aquatic organisms, the monitoring of compliance to respect with the requirements of the European directives in the field of water, the risk situations, as well as the description of the difficulties. It is recommended that the EIA report comprehensively examines potential impacts on water usage and temperature changes in the | The detailed analyses performed took all of the above-mentioned factors into consideration. The assessment of impacts and the delineation of impact areas were based on modelling results projected for the year 2060, using the most conservative assumptions and input data available.                                                                                                                                                                                                                                                                                                                                       |

| No. | Comment submitted by the foreign party                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Response to the comment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|     | river, especially as related to cooling processes at Paks NPP. We request a continued commitment to collaborative water monitoring, ensuring that downstream impacts are mitigated effectively.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| R 3 | <p>Although the document transmitted mentions that:</p> <ul style="list-style-type: none"> <li>– “no significant transboundary impacts were expected for conventional pollutants and radioactive discharges, including events falling under the categories of normal operating and design basis accidents”</li> <li>– The Paks NPP site is located in the “interior” of the country, a considerable distance from the national borders. This means that, given its location, transboundary impacts can only be envisaged in exceptional cases”</li> </ul> <p>we believe it is necessary to take into account these exceptional cases, which involve the accidental pollution (especially of the Danube, taking into consideration that the propagation wave on the river is 1-2 days) and the assessment of the impact on the species and habitats on the Romanian territory susceptible to be affected.</p> | <p>The exceptional scenario raised in the comment, namely the propagation of contamination through the Danube, has been taken into account in the EIAR. During potential accident scenarios associated with the operation of the Paks NPP, the quantity of contaminants directly entering the water would be negligible, therefore, no transboundary impact is expected. Analyses were also performed assuming that radioactive atmospheric releases could enter the Danube through wet deposition caused by precipitation. Accordingly, the EIAR examined the possibility of accident-related atmospheric releases being washed into the Danube by precipitation and determined the expected radiation exposure at Batina, the first settlement beyond the national border along the Danube. Radiation doses associated with aquatic exposure pathways (swimming, shoreline activities, and fish consumption) were evaluated. The results of these analyses are presented in <i>Chapter 8.</i> of the EIAR.</p> |
| R 4 | Given Romania’s proximity, a robust environmental radiological monitoring program should be maintained and adapted for the extended operational period.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <p>Both under current operating conditions and throughout the proposed SSLE period, the NPP operates an emission monitoring and environmental monitoring system that complies with all applicable legal and regulatory requirements. A detailed description of this system is provided in <i>Chapter 2.4.2.</i> of the EIAR. The overall purpose of the system is to provide a sufficient quantity of reliable direct measurement data under all operating conditions of the NPP to enable the assessment of environmental impacts and, where necessary, support the implementation of appropriate measures. The monitoring regime is specified in the Emission Monitoring and Environmental Monitoring Regulations, approved by the environmental authority. The associated measurements and analyses are performed by the NPP’s Emission Monitoring Laboratory and Environmental Monitoring Laboratory.</p>                                                                                                    |
| R 5 | Given that the project will extend the life of four nuclear reactor units while also operating in proximity to the new units of the Paks II NPP, we encourage a detailed cumulative impact analysis. We believe this analysis should encompass potential safety, environmental, and public health impacts arising from the combined operation of both Paks NPP and Paks II both in normal conditions and in the most unfavorable scenarios (incidents, accidents). A dispersion study in                                                                                                                                                                                                                                                                                                                                                                                                                     | <p>The impacts of the combined operation of the Paks NPP and the Paks II NPP were considered and evaluated within the environmental impact assessment for both conventional and radiological effects, under normal operating conditions as well as abnormal and emergency scenarios. The detailed results of these assessments are presented in the annexes to the EIAR. Dispersion calculations relating to radioactive releases are presented in <i>Chapters 5.</i> and <i>8.,</i> as well as in <i>Annex 12.</i> of the EIAR.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

| No.                                   | Comment submitted by the foreign party                                                                                                                                                                                                                                                                                                             | Response to the comment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
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|                                       | which the radiation emissions in the two countries are analysed should also be provided.                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| R 6                                   | In this context, we recommend that the EIA report details emergency preparedness and response measures adapted for an extended operational timeframe. This includes updated emergency protocols to ensure efficient cross-border cooperation and communication in the event of an incident.                                                        | Emergency preparedness and response procedures, including the emergency protocols ensuring transboundary cooperation and communication referred to in the comment, are continuously updated by the Paks NPP. In doing so, both national and international operating experience, as well as the latest technical and technological developments, are taken into account.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Comments Received from Croatia</b> |                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| C 1                                   | When preparing the Environmental Report, it is proposed to draw up an analysis of electricity grid needs, both in Hungary and in the neighbouring countries.                                                                                                                                                                                       | Forecasts of future electricity demand and assessments of the availability of electricity generation capacities in Hungary formed the basis for the decision to proceed with the SSLE of the Paks NPP. The necessary analyses were carried out independently of, and prior to, the preparation of the EIAR.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| C 2                                   | The Environmental Report should address the transboundary impact on the environment, on human health and property in a normal situation as well as the transboundary impact in an emergency. A calculation of doses at certain distances should be made in the event of a project accident or an extended project accident at Paks NPP in Hungary. | Dose calculations were performed both for normal operating conditions and for abnormal operating conditions, incidents, and accident scenarios. The results of these calculations are presented in detail in <i>Chapters 5. and 8.</i> , as well as in <i>Annex 12.</i> of the EIAR.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| C 3                                   | As regards the methodology for assessing exposure to ionising radiation for biota (Chapter 6.9), it is advisable to specify for the purpose of validating the results which version of the ERICA Tool program will be used, in view of the significant changes and updates of the program in recent years.                                         | The version applied was specified as ERICA Tool 2.0, Build 2.0.230.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| C 4                                   | Furthermore, it has not been stated that the potential impact of climate change on the radiological status of biota, in particular in the Danube River, would be considered (e.g. the impact assessed of extremely low water levels of the Danube River, which could affect the increase of average radionuclide concentrations in the river).     | Persistently and exceptionally low water levels in the Danube would necessitate the shutdown of the power plant long before any radiological consequences could become relevant. Under current conditions, the measured and modelled exposures and risks in environmental media and biota remain many orders of magnitude below radiological levels that could pose any risk to living organisms, and variations in Danube water levels would not significantly alter this conclusion. Furthermore, under normal operating conditions, the upper limit of radiological impact is determined by the radioactivity of the warm-water channel, which represents a point-source discharge from the perspective of the Danube. The radioactivity levels typically present in the channel do not constitute a risk factor, even without considering the dilution effect of the Danube. |

| No. | Comment submitted by the foreign party                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Response to the comment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
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| C 5 | It is also unclear from the presented methodology how the Environmental Report would separate the actual background radiation for biota from the one currently in the vicinity of Paks NPP, i.e. the contribution of Paks NPP to the increment dose rate.                                                                                                                                                                                                                                                                                          | In the vicinity of the Paks NPP, background radiation and the plant's contribution were determined using the results of long-term environmental radiation monitoring conducted at the site, supplemented by detailed atmospheric and aquatic dispersion modelling and dose assessments relating to normal operational gaseous and liquid discharges. The measurement and modelling results for the environment surrounding the NPP are presented in <i>Chapters 5.2. and 5.3.</i> of the EIAR. The assessment of potentially transboundary impacts arising from the normal operation of the Paks NPP was performed using actual operational gaseous and liquid discharge data, combined with detailed dispersion modelling and dose calculations. The results are presented in <i>Chapter 8.</i> of the EIAR. |
| C 6 | The Environmental Report should assess the potential impact of the operation and service life extension of the NPP on the water quality of the Danube River, with a particular focus on:<br>1. Hydrological aspects and transboundary impact on the Danube River <ul style="list-style-type: none"> <li>– Thermal energy emissions (thermal pollution) into the river</li> <li>– Potential release of contaminants (Chemicals, radioactive substances)</li> <li>– Impact on ecological balance and habitat quality of aquatic organisms</li> </ul> | These issues have been comprehensively assessed in the EIAR, partly in relation to emergency scenarios involving potential chemical contamination and partly in <i>Chapter 8.</i> concerning transboundary impacts, based on the results of hydrological modelling.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| C 7 | 2. Quality of groundwater and surface water <ul style="list-style-type: none"> <li>– Analyse potential risks to groundwater and surface water in the cross-border area, including potential pollution</li> <li>– Include data on water quality monitoring upstream and downstream from the NPP and propose measures for continuous cross-border monitoring</li> </ul>                                                                                                                                                                              | No transboundary impacts on either surface water or groundwater have been identified.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| C 8 | 3. Management of water resources and potential risks <ul style="list-style-type: none"> <li>– Assess potential cross-border risks of pollution from accidents or incidents at the plant</li> <li>– Consider capacities for emergency water protection measures in case of cross-border incidents</li> </ul>                                                                                                                                                                                                                                        | The potential propagation of contamination in the Danube has been taken into account in the EIAR. During potential accident scenarios associated with the operation of the Paks NPP, the quantity of contaminants directly entering the water would be negligible. Therefore, no transboundary impacts are expected. Analyses were also performed assuming that atmospheric releases could enter the Danube through wet deposition caused by precipitation. Accordingly, the EIAR examined the possibility of accident-related atmospheric releases being washed into the Danube by precipitation and determined the expected radiation exposure at Batina, the first settlement beyond the national border along the Danube, for aquatic exposure pathways (swimming, shoreline                              |

| No.  | Comment submitted by the foreign party                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Response to the comment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
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|      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | activities, and fish consumption). The results of these analyses are presented in <i>Chapter 8.</i> of the EIAR.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| C 9  | 4. Climate change and long-term impact on water resources<br>– Assess how climate change and potential changes in the flow of the Danube River can affect the safety of the NPP, with a particular focus on the availability of cooling water.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | The expected future hydrological conditions of the Danube are presented in detail in the EIAR for all scenarios, based on hydrological and climate modelling.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| C 10 | The Environmental Report should propose concrete measures to ensure transboundary protection of waters.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | No transboundary chemical or biological impacts have been identified.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| C 11 | Impacts in case of accidents and/or incidents, and bearing in mind the location of the project, which is situated around 75 km from the border with the Republic of Croatia, should be considered in relation to the biodiversity of border areas in the Republic of Croatia that could be adversely affected by the project, the Danube River and Natura 2000 ecological network areas, part of which are also protected areas in the Republic of Croatia in the category of nature park or regional park (Kopacki rit Nature Park, Mura-Drava Regional Park). Data on biodiversity, protected areas and the Natura 2000 ecological network in the Republic of Croatia is available through the Nature Protection Information System – Biportal; <a href="https://biportal.hr/">https://biportal.hr/</a> and <a href="https://biportal.hrleis/j">https://biportal.hrleis/j</a> . | The direct and indirect ecological impact areas associated with the preparation of the SSLE were determined on the basis of comparative evaluations of the 2024-2025 biological surveys conducted for the EIAR, historical surveys from previous operating periods, and supplementary scientific literature data. The assessment also examined the cumulative impacts of the combined operation of the Paks NPP and the Paks II NPP. The identified ecological impact areas do not extend beyond a distance of 3 km from the site boundary, either across terrestrial areas or along the Danube, and therefore do not approach the national border in any direction. Consequently, under normal operating conditions during the period of the SSLE, transboundary impacts on biodiversity can be excluded, both for the stand-alone operation of the Paks NPP and for its combined operation with the Paks II NPP. The investigations also assessed the expected impacts on biota resulting from accident scenarios whose probability of occurrence remains credible when taking into account the plant's safety systems. A significant ecological impact area could arise in the event of an accident involving water contamination via the warm-water discharge channel, whereby pollutants could enter the receiving waters of the Danube and affect aquatic ecosystems. The direct ecological impact area of such an event would typically be confined to the right-bank riparian and mid-channel sections of the Danube downstream of the warm-water channel outlet. Its downstream extent would depend on the toxicity, degradation characteristics, and duration of the pollutant release. Taking into account the NPP's emergency response arrangements, it is not considered likely that a water-contamination accident of sufficient magnitude would occur to result in an ecological impact area reaching the national border. |

| No.  | Comment submitted by the foreign party                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Response to the comment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
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| C 12 | General air quality protection measures are listed in the background document: the operating time of the safety diesel generators shall be < 0.05 m/m% and the limit values for pollutant emissions into the air shall be determined by standardised measurements carried out every five years by an accredited measurement organisation. It is proposed to define the limit values for pollutant emissions into the air for safety aggregates in the Environmental Report while the measurements will confirm their compliance with the limit values.                                                                                                       | Air pollutant emission limit values, the results of environmental monitoring measurements, and the general air quality protection measures were taken into account during the preparation of the EIAR.                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| C 13 | The Environmental Report shall cover the following air quality impacts: emissions of radioactive substances into the atmosphere during normal operation, conventional air pollutant emissions (power plant and transport) during normal operation, thermal emissions into the atmosphere (normal operation) and air pollution due to accidents, with additional consideration and an overview of the potential impact of transboundary pollution.                                                                                                                                                                                                            | Analyses were performed regarding the transboundary impacts of radioactive airborne releases. Public dose assessments were carried out for settlements located near the borders of neighbouring countries for both normal operating conditions and accident scenarios. The results are presented in <i>Chapter 8.</i> of the EIAR. The impacts of conventional air pollutant emissions were also assessed for the various scenarios considered during the preparation of the EIAR, including the installation of the peak cooling system, normal operation, operational disturbances, combined operation, transportation-related impacts, and potential transboundary impacts. |
| C 14 | In order to determine the level of air pollution at and near the site, measurements have been carried out between 16 January 2024 and January 2025, the results of which (we suggest that they be a part of the Environmental Report) will be used as basic data on air pollution for the environmental impact assessment.                                                                                                                                                                                                                                                                                                                                   | The results of the measurements performed within the monitoring program were used as baseline data for the assessment of the impacts of air pollutant emissions during the preparation of the EIAR.                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| C 15 | With regard to soil pollution and transboundary impact, protection measures should be considered and listed in case of accidents and incidents such as accidents related to waste management and discharge of pollutants (e.g. hazardous substances stored on site).                                                                                                                                                                                                                                                                                                                                                                                         | No transboundary impacts arising from waste management activities or pollutant releases were identified.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| C 16 | Climate change poses a growing threat to society, the economy and the environment and places the resolution of the climate crisis at the very heart of EU policies, including in Croatia. The European Commission developed <i>Technical guidance on the climate proofing of infrastructure in the period 2021-2027</i> (OJ C, C/373, 16.09.2021, p. 1). The purpose is to integrate climate aspects into future investments and the development of infrastructure projects, from buildings and network infrastructure to a range of built Systems and assets. This should also be applied in detail and extensively in the respective Environmental Report. | The assessments referred to in the comment are also required by the applicable Hungarian legislation governing environmental impact assessments and are addressed in the relevant annex of the EIAR.                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

| No.                                              | Comment submitted by the foreign party                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Response to the comment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
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| <b>Comments received from the Czech Republic</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| CZ 1                                             | <p><i>Association of South Bohemian Mothers of 25<sup>th</sup> December 2024</i></p> <p>The Association requires the further documentation to assess the impacts of a major accident, including their possible transboundary impact (concerns about a possible military attack with catastrophic effects on the surrounding area). The association believes that the EIA process should evaluate the long-term management of spent nuclear fuel (where and how it will be stored) and the impacts of long-term storage of this hazardous waste on environment and humans as well. In this context, it also calls for an assessment of the risks and impacts of an accident at the spent fuel intermediate storage facility, which is very vulnerable to external influences due to its construction (a hall). The documentation is to be supplemented by studies assessing the incidence of potentially ionising radiation-related diseases in the population living within a 30 km radius of the plant. The Association requests the assessment of the project in the transboundary EIA process because of the possible impacts of a possible over-project accident on the territory of the Czech Republic and supplementing the documentation with the above information.</p> | <p>Of the issues listed, those relating to the NPP are fully addressed in the relevant chapters of the EIAR. The issue concerning the SFISF falls outside the scope of the EIAR prepared for the SSLE and will be addressed in the EIAR prepared specifically for the SFISF.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Comments received from Austria</b>            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| A 1                                              | <p>When deciding on the lifetime extension of existing NPPs, it must be considered that the spectrum of hazards that might impact safety may change during the period of extended operation. This applies in particular to the risk posed by extreme weather events and expected effects of climate change. It is recommended that the EIA documents how hazards and hazard combinations applies to the Paks site. The EIA should describe how Design Extension Conditions (DEC) are analysed in the LTE process in accordance with WENRA Issues T6 and TU6. The EIA Report is expected to show how the overall goal formulated by WENRA, i.e., to identify reasonably practicable improvements to increase the robustness and resilience of a plant that can be implemented for the prevention of severe accidents, will be achieved in the LTE process.</p>                                                                                                                                                                                                                                                                                                                                                                                                                   | <p>In order to provide a comprehensive assessment of the potential risks associated with the operation of the Paks NPP, the analyses of transboundary impacts in the EIAR separately evaluated both design basis conditions (DBA) and design extension conditions (DEC). In addition, sensitivity analyses were performed to assess the potential effects of climate change. These analyses assumed extreme meteorological conditions (e.g., extreme winds and intense precipitation) in the atmospheric and aquatic dispersion models and in the dose calculations. This approach enabled the assessment of how changing climatic conditions could influence the environmental consequences of potential releases. The results of these analyses are presented in <i>Chapter 8</i> of the EIAR.</p> |
| A 2                                              | <p>The EIA report should provide detailed information on the scope and the schedules of relevant licensing processes at the level of the nuclear regulatory authority, including the timeline for the</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <p>The EIAR and the Public summary present the licensing procedures required for the SSLE of the NPP, including their principal scope and regulatory framework.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

| No. | Comment submitted by the foreign party                                                                                                                                                                                                                                                                                                                                                                                                     | Response to the comment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
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|     | development of relevant safety justification. It should describe, which information, mainly plant specific technical data at the date of the publication of the EIA Report – are assumptions and which data are based on the results of the analyses undertaken (including the date of its elaboration).                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| A 3 | The Preliminary consultation document (MVM 2024) also states that the dose constraints would not be exceeded with units experiencing „expected operational events“. The problem is that it remains undefined what are the “expected operational events”. Are those all design basis events (i.e., including the most critical DBA, like full guillotine break of the RCS piping) or only some of the DBA events, i.e. expected transients? | In accordance with the terminology used in nuclear safety analyses, “anticipated operational occurrences” correspond to the DBA2 category (Hungarian designation: TA2). The dose assessments cover events within the design basis (Design Basis Accidents /DBA/), including small-, medium-, and large-break loss-of-coolant accidents (SBLOCA, MBLOCA, and LBLOCA). The calculations also cover accident conditions associated with open-reactor states and accident involving the spent fuel storage pool. For the assessment of transboundary impacts, the following two Severe Accident (SA) scenarios were additionally analysed: Station Blackout (SBO) and a Large-Break Loss-of-Coolant Accident (LBLOCA) combined with Containment Isolation Failure (CIF). The results are presented in <i>Chapters 5.3. and 8. of the EIAR.</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| A 4 | The Preliminary consultation document (MVM 2024) does not say anything about possible interactions between multiple units at the site, including any planned assessment in relation with external impact. In particular, there is no discussion in relation with the man-made event that could possibly be critical when considering the risks to the environment and population.                                                          | A detailed assessment of the potential impacts of the operation of the Paks II NPP on the Paks NPP has been carried out. The results of this assessment are presented in the EIAR. Environmental impact assessments have also been performed for potential accidents associated with activities carried out at the Paks NPP site. These assessments, likewise presented in the EIAR, include analyses of the impacts of the operation of the Paks NPP on the Paks II NPP. Furthermore, the assessment program assumed that, as a common-cause event, an earthquake or extreme wind could simultaneously trigger accidents involving the release of hazardous substances at several neighbouring industrial facilities, including both the Paks NPP and the Paks II NPP. Additional analyses were conducted to determine whether such accidents could affect nuclear safety with a frequency exceeding the screening threshold. The results demonstrate that, due to the assumed accident locations and distances, as well as the differing effects of the various hazard sources, the vulnerability of the NPP does not change if accidents occur simultaneously at multiple facilities. Consequently, this hazard combination was not identified as requiring detailed analysis within the EIAR. It should also be emphasized that the two NPPs do not share any safety systems or operational personnel resources. Therefore, no such interactions are expected. |

| No. | Comment submitted by the foreign party                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Response to the comment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
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| A 5 | <p>The EIA Report should contain the following information on possible interactions among multiple units, including assessment of external impacts affecting all the units at the site (as well as the SNF interim store):</p> <ol style="list-style-type: none"> <li>1. Assessment of the severe weather conditions, including the Danube River/flooding while considering the effects of climate change;</li> <li>2. A summary of outcomes of the assessment of man-made external events like aircraft crashes, terrorism or sabotages, including insider events and terrorist attack;</li> <li>3. Assessment of a combination of external events, including consideration of interactions among multiple units on the site;</li> <li>4. Assessment of the cliff edge effects for individual and multiple unit;</li> <li>5. Investigation into interaction among the plants, including effects like turbine missiles;</li> <li>6. Thorough analysis of the possible events affecting multiple units on the site, with a view on establishing an enveloping radiological release source term;</li> <li>7. Assessment of the effects on the operation and safe shutdown of other units in a case where one or more units at the site have released radioactivity into the environment, making site access and/or communication difficult or impossible.</li> </ol> | <ol style="list-style-type: none"> <li>1. The effects of climate change and the assessment of extreme weather conditions are addressed in the EIAR.</li> <li>2. The investigations and assessments carried out for the EIAR cover all external human-made events that may arise from intentional but non-targeted actions or from unintentional on-site or off-site human activities. The effects of an aircraft crash are sufficiently localized that it is not reasonable to assume direct impacts simultaneously affecting both NPPs. The assessment results for the Paks NPP are included in the EIAR. Furthermore, the Paks II NPP has been designed to withstand aircraft impact, therefore, an aircraft striking one of the new units cannot cause significant effects on the safety systems of the Paks NPP.</li> <li>3. The assessment program assumed that, as a common-cause event, earthquakes or extreme winds could simultaneously cause accidents involving the release of hazardous substances at several neighbouring industrial facilities, including the Paks NPP and the Paks II NPP. Additional analyses were conducted to determine whether such events could affect plant safety with a frequency exceeding the screening threshold. The results indicate that the vulnerability of the NPP does not increase under such circumstances, therefore, this hazard combination was not considered to require detailed analysis within the EIAR. It should also be emphasized that the two NPPs do not share safety systems or personnel resources, and thus no such interaction is expected.</li> <li>4. For human-made hazards, frequency-based screening was not applied, with the exception of aircraft crashes. Instead, the maximum credible impact was considered in the analyses, therefore, cliff-edge effects can be excluded for these hazards. For aircraft crash scenarios, a screening frequency of <math>10^{-7}</math>/year was applied, below which even cliff-edge effects do not require assessment. Regarding hazard combinations, the analyses concluded that the level of protection is adequate. Accordingly, the plant is sufficiently protected even against hazards beyond the design basis, as demonstrated by the safety margins incorporated into the design and by the results of probabilistic safety assessments. A detailed discussion of these issues falls beyond the scope of the EIAR.</li> <li>5. A detailed assessment of all impacts of the operation of the Paks II NPP on the Paks NPP, including the effects of turbine missiles, has been completed. The results are presented in the EIAR.</li> </ol> |

| No. | Comment submitted by the foreign party                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Response to the comment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
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|     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <p>6. The relevant analyses and their results are presented in <i>Chapter 8.</i> of the EIAR.</p> <p>7. Events involving radioactive releases and their consequences are addressed in <i>Chapters 5.3. and 8.</i> of the EIAR.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| A 6 | <p>With respect to the general safety expectations, MVM 2024 (p. 70) states that “taking into account all design operating conditions and assumed initial events, except sabotage, the frequency of core damage leading to a severe accidental release shall not exceed 10<sup>-4</sup>/year.” This statement is clearly not in line with the WENRA (2021) Safety Reference Levels for Existing Reactors. WENRA (2014, Issue T5.; 2021, Issue TU5.) requires existing reactors being protected from design basis events. During design basis accidents, protection shall be sufficiently reliable to conservatively ensure that the plant is able to fulfil the fundamental safety functions. This is to be achieved by applying reasonable conservatism providing safety margins in the design (WENRA 2014; 2021, Issue E8.). Reactivity control is among the fundamental safety functions. Core damage in the design basis range is consequently not admissible.</p> | <p>The fact that the frequency criterion for events considered in the design basis corresponds numerically to the core damage frequency criterion does not constitute a contradiction. On the contrary, the same values are used in the regulatory frameworks of most countries operating Generation III. NPPs. Within the design basis, the intensity of each hazard (e.g., earthquake) corresponding to an occurrence frequency of 10<sup>-4</sup>/year must be considered (for individual hazards and hazard combinations separately), and adequate margins must be provided against such hazard intensities. By contrast, the probabilistic safety criterion relates to the aggregate risk arising from all external hazards combined, as well as all internal initiating events (e.g., transients and pipe breaks) and all internal hazards (e.g., fire and flooding). Furthermore, probabilistic safety assessments of external hazards include not only damage caused directly by the hazard but also additional random failures. Accordingly, the numerical equivalence of the two values does not represent an inconsistency.</p> |
| A 7 | <p>Multi hazard assessment in combination with seismic hazard is only briefly addressed in the EIA Scoping Document. While the non-causal combination of earthquake ground shaking with extreme (high or low) temperature is taken into account, the consequential hazard combination earthquake induced internal fire is not, although it is a rather likely hazard combination (e.g., the accident in the Kashiwazaki-Kariwa NPP, IAEA 2007). This aspect should be covered in the EIA.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <p>During implementation of the assessment program for combinations of external hazards, in addition to the combination of earthquakes with extreme high or low temperatures, it was assumed that earthquakes and extreme winds, acting as common-cause events, could simultaneously trigger accidents involving the release of hazardous substances at neighbouring industrial facilities. The assessment focused on combinations of external hazards. Technological transients or internal hazards induced by individual external hazards were not considered within this specific assessment because such events are addressed within the analyses of the respective individual external hazards themselves.</p>                                                                                                                                                                                                                                                                                                                                                                                                                        |
| A 8 | <p>Increases in thermal load from heated cooling water discharge into the Danube, especially in a parallel operation of Paks I and II, are discussed at large in the EIA Scoping Document. The highest temperature in the Danube was reported to be 27.03°C (MVM 2024, p. 126f.). In the heatwave of 2018, the Hungarian NGO Energiaklub conducted independent measures of the Danube water temperature at the Paks site and found temperatures upstream from the NPP of 25-26 °C; downstream, however, the temperature rose to above</p>                                                                                                                                                                                                                                                                                                                                                                                                                              | <p>Measurements are carried out by the operator of the NPP using measurement and evaluation methods approved by the competent authorities. The Paks NPP publishes the measurement results on the following website: <a href="https://atomeromu.mvm.hu/hu-HU/Rolunk/Vizhomerseklet">https://atomeromu.mvm.hu/hu-HU/Rolunk/Vizhomerseklet</a></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

| No.  | Comment submitted by the foreign party                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Response to the comment                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
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|      | <p>30°C at several points. For the Paks NPP, the cut-off was at this time 30°C. Shortly after Energiaklub published these findings and an accompanying video, MVM Paks Atomerőmű Zrt, published its official water temperature data. On the day Energiaklub had measured over 30°C, the official thermometer measured 28.42°C. The NPP registered the highest water temperature, 29.88°C, at the beginning of August 2018. This is only 0.12°C lower than the temperature at which the NPP must be shutdown to protect life in the river. (MÁTYÁS and MRAZ 2021) These discrepancies need to be clarified. What was the highest temperature measured at the Paks water canal outlet by MVM? On how many days have the measurements shown a temperature of 30°C or above? Where are the water measurement data published?</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| A 9  | <p>In the summer of 2024, the Hungarian government issued a decree to bypass the legal temperature limits set for the Danube River downstream of Hungary's Paks NPP, using the argument of security of energy supply. The Danube is an important European waterway and borders numerous Natura 2000 areas. (Parliamentary question to the EC by Jutta Paulus (Verts/ALE5)) It is not clear what effects this decree is having.</p>                                                                                                                                                                                                                                                                                                                                                                                           | <p>The EIAR was prepared in accordance with the applicable legal requirements in force at the time of the assessment.</p>                                                                                                                                                                                                                                                                                                                                                                     |
| A 10 | <p>Issues related to terrorist attacks and sabotage can and should be addressed without the disclosure of sensitive or security-related information.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <p>The Paks NPP maintains appropriate physical protection plans and practical response systems addressing terrorist attacks and acts of sabotage. All information relating to preparedness is classified. Nevertheless, MVM Paks Atomerőmű Zrt. has for many years participated in training and advanced training programs on these topics organized by the United States Department of Energy and coordinated by the HAEA.</p>                                                               |
| A 11 | <p>A comprehensive discussion of design-basis accidents (DBAs), design extension conditions (DECs), and severe accident management measures, including the results of safety analyses of design extension condition scenarios (initiating events, accident sequences, and source terms), is necessary to facilitate a more accurate assessment of the potential risk to the Austrian population.</p>                                                                                                                                                                                                                                                                                                                                                                                                                         | <p>Analyses have been performed for both design basis accident scenarios and severe accident scenarios of the Paks NPP with respect to Austrian territory, specifically for Lusing, the closest settlement to the plant near the Austrian border, and for Vienna. The EIAR provides a detailed presentation of the accident scenarios, release source terms, and the input parameters and assumptions applied in the analyses. The results are presented in <i>Chapter 8</i> of the EIAR.</p> |
| A 12 | <p>Climate Change Mitigation: The Paks NPP is dependent on the cooling function of the Danube. However, there are limitations to the allowed water intake and water temperature increase due to the power plant. These limitations are necessary to protect the local</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <p>The expected impacts of the combined operation of the Paks NPP and the Paks II NPP were determined in a dedicated chapter on the basis of climate and hydrological modelling. The impacts and impact areas were defined using the most conservative assumptions and methodologies available.</p>                                                                                                                                                                                           |

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|      | environment especially the limnology of the Danube. However, global warming is an ongoing process and it is planned that the Paks II NPP project additionally utilizes the Danube as heat sink. Therefore, it would be of interest to assess the local water quality and whether it has to be anticipated that the temperature threshold values of the Danube are met more frequently.                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| A 13 | Nuclear Waste: If the license of the four Paks I reactors is extended, more nuclear waste will be produced than originally anticipated. It would be of interest to understand how this affects the situation at the existing storage facilities.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | The management of spent nuclear fuel and radioactive waste is presented in the EIAR.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| A 14 | Public Participation: The city of Vienna appreciates the invitation to participate in this proceeding. According to the documents nearly all countries (if not all) in Europe were invited, which is commendable. However, according to media reports, in Hungary itself only the regions around the power plant were asked to participate in the EIA. If this is correct, it would be our suggestion to increase the opportunity for Cities and Regions in Hungary to participate as they are exposed the most regarding possible environmental impacts.                                                                                                                                                                         | In accordance with the applicable environmental legislation, the environmental authority published the Preliminary Consultation Document on its website following its submission and transmitted it to all municipalities located within the estimated impact area. Consequently, the documentation was available to the public and open for review and comment through municipal websites and/or municipal offices. MVM Paks Atomerőmű Zrt. also published press releases through numerous online channels both before and after the preliminary consultation. The process of public participation during the environmental impact assessment phase will be very similar. In addition to publication on the websites of the environmental authority and the affected municipalities, the documentation submitted in support of the environmental license application (the EIAR) will also be published on the website of the ministry responsible for the international environmental impact assessment procedure. Public hearing(s) will also be organized during this phase. Furthermore, MVM Paks Atomerőmű Zrt. intends to issue press releases prior to the submission of its environmental license application. |
| A 15 | Zero variant: It would be valuable to assess in detail the potential consequences if the zero variant is selected. For this analysis it would be necessary to estimate the total cost of the LTO process. For comparison it would be important to evaluate how much alternative installed capacity, particularly using renewable energy sources, could be established and what this would mean in terms of Euro/MWh output or CO <sub>2</sub> emissions over the total life cycle. Such an analysis is relevant, considering that in Hungary, it can be expected that the Paks II project will provide necessary baseload in the future. Renewables could be a cost-effective, carbon-neutral and safe way to provide peak loads. | Prior to launching the SSLE project, MVM Paks Atomerőmű Zrt. commissioned KPMG in 2023 to prepare a comprehensive financial model and economic feasibility assessment for the program. As part of the analysis, a Levelized Cost of Electricity (LCOE) benchmark study was conducted, comparing the SSLE project with alternative greenfield investment options, including potential solar and wind power plants. The study concluded that the SSLE project exhibited the lowest LCOE among all alternatives evaluated. The analysis also highlighted that the availability factors of renewable energy sources (typically ranging between 15-25%) are significantly lower than those achievable under the SSLE scenario. The calculations were based on cost information available in 2023. MVM Paks Atomerőmű Zrt. intends to update                                                                                                                                                                                                                                                                                                                                                                                 |

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|      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | the assessment using the most recent investment cost data, however, no significant change is expected in the overall LCOE conclusions. In addition, peak electricity demand in Hungary cannot be met solely through renewable energy generation without substantial development of energy storage capacities.                                                                                                                                                                                               |
| A 16 | Energy Independency: The provided documentation argues that nuclear energy in Hungary is necessary to maintain self-sufficient electricity production. In particular, the plan of EU to reduce dependency from Russian gas is mentioned. However, lots of goods and Services in the nuclear sector have to be imported from abroad. For this reason, it would be of interest to analyze in detail, which products, like fuel rods or their uranium, used at Paks I have to be imported. | Hungary is committed to the diversification of nuclear fuel supply sources. Since 2024, MVM Paksi Atomerőmű Zrt. has maintained a fuel supply contract with Framatome. In 2025, the NPP concluded an agreement with Westinghouse Electric Sweden for the manufacture of nuclear fuel assemblies. MVM Paksi Atomerőmű Zrt. also participates in a cooperation program aimed at the development of a fully European nuclear fuel supply chain together with Framatome, Slovenské Elektrárne, ČEZ, and Fortum. |

## Abbreviations

|             |                                                                          |
|-------------|--------------------------------------------------------------------------|
| ABOS        | Safety classification of nuclear power plant components                  |
| BCGO        | Baranya County Government Office                                         |
| CIF         | Containment Isolation Failure                                            |
| DBA         | Design Basis Accidents (state included in the design basis)              |
| DEC         | Design Extension Conditions                                              |
| EC          | European Commission                                                      |
| EIA         | Environmental Impact Assessment                                          |
| EIAR        | Environmental Impact Assessment Report                                   |
| ERICA       | Environmental Risk from Ionising Contaminants: Assessment and Management |
| ESB         | Environment State Bureau of The Republic of Latvia                       |
| EU          | European Union                                                           |
| FSAR        | Final Safety Analysis Report                                             |
| GALL        | Generic Aging Lessons Learned                                            |
| GPS         | Global Positioning System                                                |
| HAEA (OAH)  | Hungarian Atomic Energy Authority                                        |
| IAEA        | International Atomic Energy Agency                                       |
| LBLOCA      | Large Break Loss of Coolant Accident                                     |
| LCOE        | Levelized Cost of Electricity                                            |
| LTE         | Lifetime Extension                                                       |
| LTO         | Long-Term Operation                                                      |
| MBLOCA      | Medium Break Loss-of-Coolant Accident                                    |
| MEKH        | Hungarian Energy and Public Utility Regulatory Authority                 |
| NGO         | Non-Governmental Organization                                            |
| NPP         | Nuclear Power Plant                                                      |
| OBEIT       | National Nuclear Emergency Response Plan                                 |
| Paks NPP    | Paks Nuclear Power Plant                                                 |
| Paks II NPP | Paks II Nuclear Power Plant                                              |
| PFDA        | Probabilistic Fault Displacement Hazard Analysis                         |
| PSHA        | Probabilistic Seismic Hazard Assessment                                  |
| PTS         | Pressurized Thermal Shock                                                |
| RCS         | Reactor Coolant System                                                   |
| SA          | Severe Accident                                                          |
| SBLOCA      | Small Break Loss-of-Coolant Accident                                     |
| SBO         | Station Blackout                                                         |
| SEPA        | Swedish Environmental Protection Agency                                  |
| SFISF       | Spent Fuel Interim Storage Facility                                      |
| SNF         | Spent Nuclear Fuel                                                       |
| SSLE        | Subsequent Service Life Extension                                        |
| Syke        | Finnish Environment Institute                                            |
| TLAA        | Time-Limited Ageing Analyses                                             |
| UBA         | Umweltbundesamt GmbH – Austrian Environment Agency                       |
| WENRA       | Western European Nuclear Regulators Association                          |
| WFD         | Water Framework Directive                                                |