

# **ENVIRONMENTAL IMPACT ASSESSMENT REPORT**

**EXTENSION OF KRŠKO NPP'S OPERATIONAL  
LIFETIME FROM 40 TO 60 YEARS – NUKLEARNA  
ELEKTRARNA KRŠKO D.O.O.**

**NON-TECHNICAL SUMMARY OF THE REPORT**

**Št.: 100820-dn**

**Ljubljana, January 2022**



## NON-TECHNICAL SUMMARY OF THE REPORT

### Developer information:

The developer, Nuklearna elektrarna Krško, d.o.o., operates on the basis of the operating licence, which relates directly to the NEK Updated Safety Analyses Report (USAR), and contains the conditions and limitations for the power plant's safe operation. NEK has a valid open-ended operating licence and is technically capable of operating until 2043, provided that, in accordance with the applicable legislation, it performs a Periodic Safety Review (PSR) every 10 years. NEK is obliged to ensure all aspects of the power plant's safe operation.

NEK is equipped with Westinghouse's pressurised light-water reactor with thermal power of 1994 MW. Its net electrical output is 696 MW. The power plant is connected to the 400 kV network that supplies electricity to consumers in Slovenia and Croatia. It annually produces over 5 billion kWh of electrical energy, which is approximately 38% of the total electricity produced in Slovenia, half of which is exported to Croatia.

### Type and main characteristics of the activity:

The operator intends to extend NEK's operational lifetime from 40 to 60 years, i.e. from 2023 to 2043.

The extension of NEK's operational lifetime means that the facility's operational lifetime is extended by 20 years, from 40 to 60 years. This:

- **does not change** the position or location of NEK;
- **does not change** the dimensions and technical design of NEK;
- **does not change** the production capacity of NEK and its operation mode.

The scope of the intended activity is the continued operation of NEK with the existing operating characteristics after 2023 and does not foresee the construction of new structures or facilities that would change the physical characteristics of NEK.

No new activities are required for the extension of NEK's operational lifetime. The spent fuel dry storage (functional connection), which has a building permit, and for which an environmental impact assessment has also been carried out, is under construction and will be completed in the first half of 2023. The dry storage building will already be in operation at the beginning of NEK's extended operational lifetime in 2023, while the environmental impacts of dry storage are discussed in this report, as an impact of the activity.

No other activities were carried out to extend the plant's operational lifetime. Safety upgrades, which are not covered by the assessment, were carried out irrespective of the extension of NEK's operational lifetime on the basis of Slovenia's Post-Fukushima Action Plan following EU stress testing.

NEK has in the past already performed all the necessary analyses and safety updates, and acquired all the permits necessary for them and the agreement of the Slovenian Nuclear Safety Administration. NEK has thus replaced all key equipment to ensure further uninterrupted, safe, reliable and environmentally compliant production of electricity. The above actions have already established the technical preconditions necessary for the extension of the operational lifetime.

By the end of the operational lifetime that will be extended from 40 to 60 years until 2043, NEK will have operated as to date, i.e. safely and in keeping with the limits on emissions into the environment. Safety culture and the proficiency of employees and their responsibility are a core element of the organisational and business structure of NEK, and will continue to be the guiding principle and assurance of the continued safe and environmentally-friendly operation of NEK. As before, the necessary safety and other improvements will be introduced regularly and on time.

NEK will regularly maintain all its technical systems, especially those connected with safety, and will regularly upgrade them in compliance with operating experience in Slovenia and globally.

All risks connected with NEK's operation have been significantly mitigated through a comprehensive upgrade of safety systems in accordance with Slovenia's nuclear legislation.

The extension of NEK's operational lifetime from 40 to 60 years until 2043 does not change NEK's existing environmental permit. NEK's existing water permits will also not require changes.

The crucial document for the operation of NEK is the operating licence, which relates directly to the NEK Updated Safety Analyses Report (USAR), and contains the conditions and limitations for the power plant's safe operation.

NEK operates in accordance with the following: Approval to Commence NEK Operation, Decision by the Energy Inspectorate of RS No. 31-04/83-5 of 6 February 1984, Amendment to NEK Operating Licence, Decision by the Slovenian Nuclear Safety Administration (referred to as: URSJV) No. 3570-8/2012/5 of 22 April 2013, and NEK Updated Safety Analyses Report (USAR).

NEK – as it is now and after its operational lifetime is extended – is not classified as an activity or installation that can cause large-scale environmental pollution as defined in the Decree on the types of activity and installation that could cause large-scale environmental pollution (Official Gazette of RS, No. 57/15).

NEK – as it is now and after its operational lifetime is extended – is not classified as an installation with a high or low risk for the environment as defined in the Decree on the prevention of major accidents and mitigation of their consequences (Official Gazette of RS, No. 22/16).

#### Alternative solutions and reasons to choose the proposed solution:

Energy, system, environment protection and economic studies have shown that the extension of NEK's operational lifetime constitutes the most favourable alternative to all other technologies that are suitable for the production of electricity in the base-load mode and will have matured for commercial use by 2023.

Its advantages are particularly significant in terms of:

- assuming the role of a support point for the 400 kV network in normal operating conditions and in the event of disruptions;
- the positive impact on Slovenia's international obligations regarding CO<sub>2</sub> emissions, as it produces minimal CO<sub>2</sub> emissions, whereas other technologies that use fossil fuels would put Slovenia far off from fulfilling the demands of the Kyoto Protocol;
- land use, as it does not require any new spatial developments; and
- economics, as its operating costs are considerably lower than any of the alternative technologies, or the purchasing of energy on the market.

The non-extension of the operational lifetime of NEK would threaten Slovenia's energy independence. The deficit in energy would have to be produced using other sources or by purchasing electricity from other countries. The consequences would be economical, political and ecological.

The consequences of the zero variant are described in detail in the study Energy, Systemic, Economic and Ecological Aspects of the Operational Lifetime Extension of the Krško NPP, EIMV, Ljubljana, July 2021.

#### The existing state of the environment where the activity will be carried out:

The site of the activity is in the Municipality of Krško, in the southern part of the Vrbina settlement, at the address Vrbina 12, Krško. This is an area of long-term energy use on the left bank of the Sava. It

is located south-west of the town of Krško. According to the valid spatial planning document the site is located in an area of building land intended for **E** – energy infrastructure, in spatial planning unit (EUP) **KRŠ 025**.

The nearest residential areas are located northeast (buildings in Spodnji Stari Grad), at a distance of approximately 500 m, north (buildings in Spodnja Libna) at a distance of approximately 550 m and approximately 1.4 km west (Žadovinek) from the site of the planned activity.

An industrial road leads up to the power plant and connects to the regional road R1 Krško – Spodnja Pohanca. The plant also has an industrial railway track, which connects it to Krško railway station.

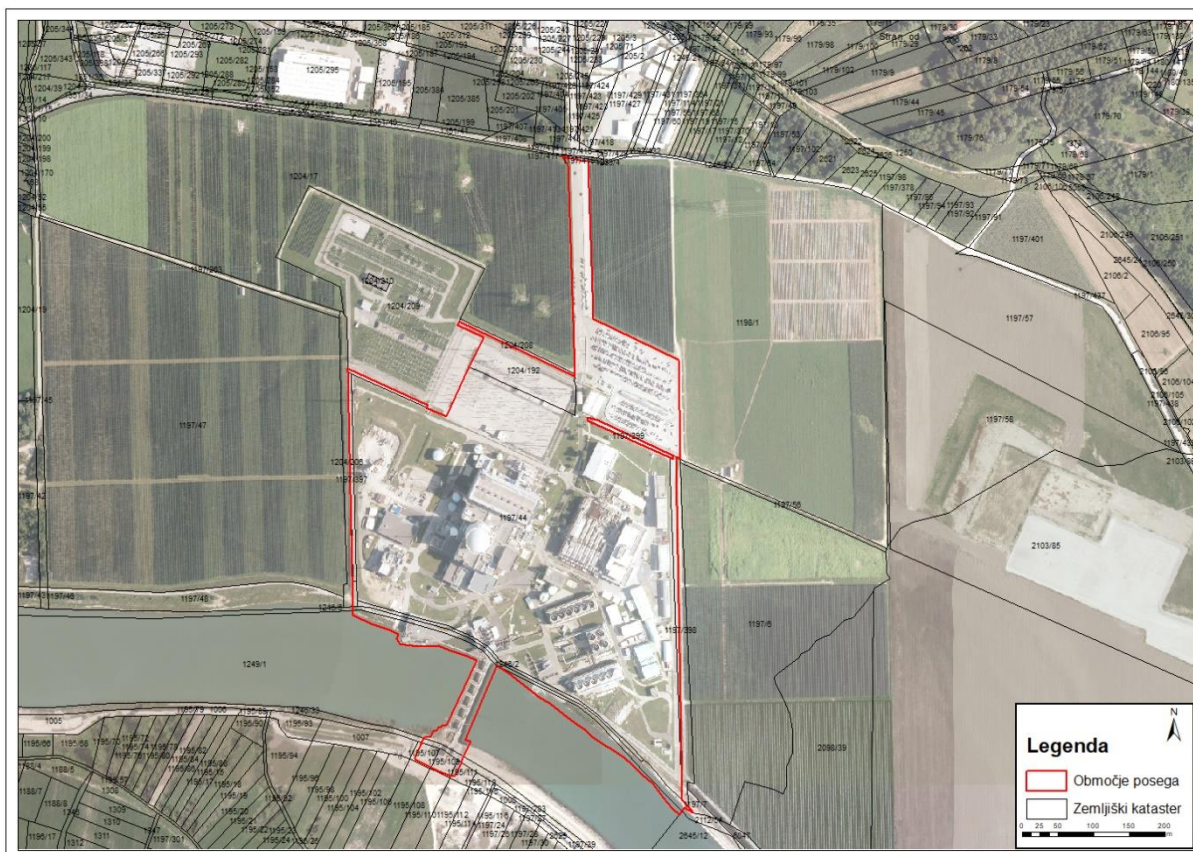


Figure 1: Aerial photograph showing the spatial characteristics of the activity and its location in the environment

Legenda	Key
Območje posega	Area of the activity
Zemljiški kataster	Cadastral register

The site is located away from areas that are at risk from flooding and erosion, and away from areas protected by regulations governing nature preservation and the conservation of cultural heritage, and areas where it could affect them. The far southern part encroaches on the second water protection zone on the right bank.

The quality of groundwater and surface water in the broader area is good.

For the Vrbina industrial zone, the spatial planning document determines level IV noise protection, while the nearby residential areas have level III noise protection. Noise measurements in 2020 showed that NEK does not cause excessive noise for the nearby residential estate.

For the industrial zone, the spatial planning document determines level II protection from electromagnetic radiation, while the nearby residential areas have level I protection from electromagnetic radiation, which requires additional protection from radiation. The last measurements

taken in 2021 showed that due to the presence of low frequency sources of electromagnetic radiation from NEK's operations, the area is not overloaded with radiation and due to its distance there is also no effect on the nearby residential areas.

When operating, the emissions from NEK's ventilation system release radioactive materials into the air. The dose resulting from the total annual activity of emitted noble gases for 2020 amounts to approximately 0.012% of the annual limit, which is similar to 2019 and to previous years.

The chemical state of the Sava at the WB Sava Krško–Vrbina measuring point was evaluated as good in the 2014–2019 period, while the level of confidence was also high. Analyses of the chemical status parameter in biota were also carried out at this measuring point. The status was assessed as poor. The reason for the poor chemical status was the increased presence of mercury.

NEK does not overburden the environment with the discharge of industrial wastewater because annual quantities of adsorbable organic halogens (AOX) are not exceeded and because the plant as a whole does not exceed thermal emission limits.

The average concentrations of active strontium in other Slovenian rivers are similar or higher than those measured in the Sava near NEK.

The natural radionuclides of uranium (U-238, Ra-226 and Pb-210) and thorium (Ra-228 and Th-228) that decay were regularly detected in all water samples. The values were similar to those measured in other Slovenian rivers.

In 2020 all the radioactive effects of NEK on the NEK fence (the estimate is approximately valid also at a distance of 500 m from the middle of the reactor) and 350 m downstream from the NEK dam were estimated to be less than 0.071  $\mu$ Sv annually on the nearby population.

The estimated value is small in comparison with the authorised dose limit for the population in the vicinity of NEK (the effective dose of 50  $\mu$ Sv annually at a distance of 500 m and more for contributions via all pathways).

The estimated value of the radioactive impacts from NEK along the NEK perimeter fence is approximately 0.0029% of the typical, unavoidable natural background. The estimate also approximately applies at a distance of 500 m from the reactor shaft.

#### Possible effects of the activity on the environment and burdens on the environment:

The planned activity at the foreseen site will not affect the odours and cultural heritage in the broader surroundings, so the effects on these factors are not dealt with in more detail in the report.

The following is a summary of possible effects of the activity on the environment and the health of people, as found in the report based on an analysis of possible direct and indirect effects during the extended operational lifetime, bearing in mind the sensitivity of the environment where the activity is being carried out.

- **Soil**

The dry storage building will have already been built by the beginning of the extended operational lifetime in 2023. There will be no construction work, so there will also be no activities in or on the soil. The way wastewater is discharged will not change with the extension of NEK's operational lifetime. There will be no emission of pollutants into the soil during operation, as all wastewater is already being disposed of properly.

All waste, including radioactive waste, on the NEK site is appropriately stored and does not present a danger for soil contamination.

- **Waters**

The source of the greatest potential effect on the Sava are the cooling waters that are discharged in large quantities. While their composition occasionally exceeds the permitted concentrations of suspended solids and sediments, the power plant itself does not pollute the water, as the substances enter into the system with the water from the Sava. The fact that these effluents depend on the composition of the river water is shown by the monitoring of COD (chemical oxygen demand) and BOD5 (biochemical oxygen demand) values at three locations in and around the NEK site, where it is evident that the water contains certain components of these parameters before it enters the power plant.

Dry storage of the spent fuel does not emit anything into the water and is designed to be flood-proof with water-proof canisters for the waste and also containers that are resistant to breaking, water and other possible threats. In comparison with the current state, the extension of NEK's operational lifetime will not cause changes in wastewater effluents, even if there is a probability that the quantity of cooling water released through the cooling towers will increase. Considering that the state of the water body into which NEK wastewater is discharged is presently good, it is estimated that the effect will be insignificant and that the good state of waters in this area will not deteriorate.

NEK does not release harmful materials or polluted water directly into the ground, thereby potentially polluting the groundwater. The only way is indirect pollution via discharges into the Sava and by means of infiltration into the groundwater. The discharge of materials by NEK into the Sava is within prescribed limits and will remain so in the power plant's extended operation.

Extending NEK's operational lifetime will not have any effect on the flood safety of the buildings either. Protection against floods was already implemented during the planning of the power plant and through the construction of embankments along the Sava, upstream and downstream of the power plant. The entrances and openings in the buildings are built above the altitude of anticipated 10,000-year floods. The power plant is safe in the event of a design basis flood, even without the protective embankment.

- **Air**

The emissions of NEK into the air are negligible, the only emissions come from the auxiliary boiler room and the emergency diesel generator (three generators). These sources operate for short periods of time during outages and equipment testing. During the extended operation of the power plant there will be no new emissions of SO<sub>2</sub>, NO<sub>x</sub> and PM<sub>10</sub> or others, and the current level of emissions will not increase. The impact on air quality is negligible, which was verified by the modelling of dispersion in the atmosphere. The power plant has an indirect positive effect on air quality because its production of electricity means it did not have to be produced in fossil-fuel burning power plants. EU Member States have agreed to reduce air pollution emissions in their territories (LRTAP convention and NEC Directive), and NEK is contributing to this goal.

The operation of the cooling towers releases heat into the air, together with droplets and damp air, which in certain conditions forms a visible plume of steam. The effect of the cooling towers depends to a large extent on the weather conditions around the tower and the effect is local in nature. Due to climate change, the power plant will in future probably use the cooling towers even more to keep the thermal load on the Sava within  $\Delta T$  3°C. The magnitude of the effect will remain within the existing limits, the only difference could be that the impact may last longer.

- **Impact on the climate and resilience to climate change**

The increased concentration of greenhouse gases in the atmosphere is bringing about warming. In Slovenia in 2019 the electricity producing sector contributed 27% to the emission of greenhouse gases. The nuclear power plant emits no greenhouse gases and together with renewable energy sources is considered to be a low-carbon technology for electricity production. Thanks to the electricity produced by NEK, Slovenia contributes to the common goal of the EU, to reduce the emission of greenhouse gases and the goals of the Paris Agreement where the goal is to limit the rise in global temperature to

a maximum of 2.0°C, if possible only to 1.5°C. If the Slovenian share (50%) of electricity produced at NEK was produced by thermoelectric plants, the electricity producing sector would have 1.5 times greater greenhouse gas emissions annually, which would amount to around 2,500,000 tCO<sub>2</sub>-eq/year.

In 2019 the average global temperature was  $1.1 \pm 0.1$  °C higher than the preindustrial level. The year 2019 was likely the second warmest year since measurements started, while the previous decade 2010–2019 was the warmest decade on record. Each decade from the 1980s has been warmer than the decades that came before. The growth in average annual air temperatures in the period between 1961 and 2020 in Slovenia shows a rapid growth in temperatures at the end of the 20th and the beginning of the 21st century. In the years between 1961 and 2011 the average air temperature rose by 1.7°C. The amount of precipitation on an annual basis has fallen by around 15% in the western half of the country, and somewhat less (10%) in the eastern half of the country where the changes are not statistically significant. The water temperature grew by 0.2°C per decade for surface waters (1953–2015) and 0.3°C per decade for groundwater (1969–2015).

When planning investments in infrastructure and energy generation facilities, it is essential to analyse the resistance of the projects to climate change, whether they have sufficient integrated adjustment measures for the expected changes in climate variables (temperature, wind, storms, floods, hail and sleet, etc.). During the evaluation of impact it was found that NEK's production of electricity is sensitive to three climatic variables: access to water from the Sava, the temperature of the Sava and the extreme outdoor temperature. The power plant takes water from the Sava for the cooling of its condensers, the turbine cycle and the safety components. In periods of reduced flow of the Sava, the power plant uses its cooling towers to discharge some of its heat through the recirculation cycle. In this way the power plant maintains a temperature difference of no more than  $\Delta T$  3°C regardless of the state of the Sava, and this remains unchanged also in the power plant's future operation. In 2008, the nuclear power plant supplemented its cooling facilities with the construction of a third block of cooling towers. This has strengthened the plant's resistance to changes that could in the future be connected with a reduction in the river's flow and a rise in air and water temperatures. The construction of a system of hydroelectric power plants on the lower reaches of the Sava has moderated variations in the river's flow and temperature which favourably affects the stability of production.

An analysis of the impact of climate change on safety are analysed in accordance with legislation and the regulations governing nuclear safety and protection against ionising radiation. Extreme weather conditions in combination with other natural and other occurrences are an integral part of the safety analysis of power plants. The Periodic Safety Review (PSR), which is compulsory every ten years, includes an analysis of the effect of climate change and the Updated Safety Analyses Report (USAR) is constantly updated regarding all important safety aspects.

- **Noise**

No new noise sources are foreseen due to the extension of NEK's operational lifetime. NEK's production capacity also remains unchanged, and the power plant will continue to operate 24 hours a day, every day of the year, even after the extension of the operational lifetime. In the context of climate change, there could be an increase in the operation of cooling towers, but given the trend of climate variables, we estimate that the number of days that the cooling towers operate will not change significantly. The measured equivalent noise levels indicate that even if the cooling towers were to operate 365 days a year, the area of NEK and its immediate surroundings (the area of measuring points) would not be subject to excessive noise pollution.

Measurements and analyses of environmental noise in 2015 and 2020 (the results are described in report no. LFIZ – 201500001 – JJ/M and LOM – 20200588 – KR/M) have found that the sources in question did not exceed the limit values for environmental noise defined in the Decree on limit values for environmental noise indicators (Official Gazette of RS, Nos. 43/18 and 59/19) at any assessment point (in front of the most exposed buildings with safety premises) during the power plant's operation.



- **Electromagnetic radiation**

No new sources of electromagnetic radiation (EMR) (e.g. new transformer stations) are foreseen as a result of NEK's operational lifetime extension. Likewise, there are no plans to fit the existing transformer stations with new transformers or replace them with greater capacity transformers. On the basis of the above, we estimate that the burden from EMR will remain unchanged, i.e. as shown by the last EMR measurements in 2021.

The entire NEK site is classified as a Level II electromagnetic radiation protection area, while the nearby residential areas and other nearby radiation-sensitive areas constitute Level I electromagnetic radiation protection areas. The main sources of low frequency EMR on the NEK site are transformers and power lines. The developer operates several transformer stations. The 2020 report on measurements of low frequency electromagnetic fields shows that the limit values for Level II radiation protection were not exceeded on the NEK site and on the site's boundaries. All transformer stations are regularly checked and serviced, with appropriate records kept.

- **Vibrations**

The site of the activity covered by this report is at least 500 m away from the nearest residential building or other buildings that are sensitive to vibrations (e.g. cultural heritage structures, kindergartens, schools, etc.). Road transport in the scope of the activity flows along public regional and state roads, while local roads in densely populated areas are not used for the delivery of raw materials and ancillary materials, and the transport of products. The scope of road transport for operational needs is and will continue to be small, and will also flow along public regional roads outside densely populated areas. The production process inside NEK does not include machines, devices or activities that could be a significant source of vibrations in the environment.

- **Waste**

The types and annual quantities of waste (including radioactive) generated by NEK will not change substantially due to its extended operational lifetime. The rate at which waste is generated will remain the same.

The introduction of dry storage will change the technology of storing spent fuel from wet to dry. Dry storage is a safer way of storing spent fuel under the same environmental and radiation conditions as are prescribed in the existing operating licence. An environmental impact assessment was carried out for the dry storage of spent fuel and a building permit was acquired (building permit no. 35105-25/2020/57 of 23 December 2020).

Due to the extension of the operational lifetime from 2023 to 2043, there will be an extra 547 m<sup>3</sup> or 884 t of low- and intermediate-level radioactive waste.

The burden on the environment due to this extra spent fuel will be equal in size and form to the existing burden, i.e. the burden in the years before the operating period was extended.

If NEK operated until the end of 2023, a total of 1,553 elements of spent fuel would be produced. If NEK operates until the end of 2043, 2,281 spent fuel elements will be produced.

Due to the extension of the operational lifetime from 2023 to 2043, an extra 728 spent fuel elements will be generated.

There are around 36 existing types of waste (2020) that are generated in all production and support processes, of which 19 are hazardous types of waste (description in section. The total volume of waste generated in 2020 was around 2,302 tonnes, including 2,192 tonnes of construction waste from works performed in 2019. The hazardous waste amounted to approximately 12.3 tonnes. The extended operational lifetime will not change the rate at which waste is created.

All waste, except for radioactive waste, is handed over for treatment to a contractor. NEK does not treat the other waste.

- **Ionising radiation**

During NEK's operating period the emission of radioactive material into the environment will be equal to the existing rate. NEK is continuously upgrading and improving its safety and process systems, which means that the environmental burden is constantly decreasing. The estimated annual effective dose for an inhabitant most affected by NEK's impacts in 2020 was 0.071  $\mu\text{Sv}$ . Compared to the annual effective dose from natural background radiation, which amounts to 2500  $\mu\text{Sv}$  in Slovenia, the contribution of NEK is negligible.

All calculations of radiation levels show that the dose rates and doses of ionising radiation resulting from the dry storage of spent fuel will be within the very strict limits, which were set out in the technical specifications of the project for the construction of dry cask storage, and are lower than the permitted levels.

Likewise, the annual effective external radiation dose on the NEK perimeter fence from all contributors, including the dry storage of spent fuel, will not exceed, during operation, the radiation load that currently applies to the NEK perimeter fence, which is 200  $\mu\text{Sv}$ .

- **Light pollution**

As NEK's external lighting is an integral part of the technical systems for ensuring physical protection, NEK is not bound by the Decree on limit values for light pollution (Official Gazette of RS, Nos. 81/07, 109/07, 62/10, 46/13), but by the Rules on the physical protection of nuclear facilities and nuclear and radioactive materials, and the transport of nuclear materials (Official Gazette of RS, Nos. 17/13, 76/17 [ZVISJV-1]).

Nevertheless, NEK continuously strives to comply with requirements for reducing light pollution by, for example:

- using the appropriate, horizontally mounted lights with level glass;
- not turning lights upwards more than is foreseen in the project to achieve appropriate illumination levels; and
- upgrading lights with modern, energy efficient solutions such as LEDs, etc.

The extended operational lifetime **does not foresee** the installation of additional lights on the NEK site, so the illumination of the area and the light emitted to the surroundings will be **equal** to the existing state.

- **Landscape**

The appearance of the power plant will not change during the extended operating period. At the beginning of the extended operational lifetime, dry cask storage for spent fuel will have already been built, while no other construction works are foreseen. Due to the increasingly common occurrence of either high or low levels of the Sava, it is expected that the cooling towers will operate more often, accompanied by steam emissions that will be visible from larger distances. The occasional appearance of steam will not have a significant effect on NEK's visibility in the surroundings. The planting of a forest belt alongside the low- and intermediate-level radioactive waste depository will further reduce the power plant's visibility from the east and south-east.

- **Nature**

During its operation, NEK does not emit ionised radiation into the environment which could have a marked effect on the flora and fauna surrounding the power plant. NEK uses water from the Sava for

cooling the condensers and turbines and for cooling the safety components. The environmental permit stipulates that NEK must ensure that at no time of year, the synergetic action of the discharge of industrial cooling waters and other discharged wastewaters may cause the Sava to exceed its natural temperature by more than 3 K. NEK fulfils this condition. The ecological state of the Sava downstream from NEK is evaluated as being good. A sustained impact on the vegetation and types of habitat in the vicinity of NEK could occur in the event of a serious accident resulting in the discharge of radioactive substances into the environment. Numerous safety upgrades have been implemented at NEK. For this reason, the possibility of core damage is very small.

- **Land**

The site of the planned activity is located in an area of building land on which mainly industrial buildings classified E – energy infrastructure have been built (the intended use is presented in section. The planned change (expansion) does not reach outside the area presently occupied by NEK, and is in accordance with valid spatial planning documents, while the planned and actual land use do not change with the planned extension of NEK's operational lifetime.

In terms of wooded land, an opinion has been given by the Ministry of Agriculture, Forestry and Food (no. 3401-43/2020/4). On the basis of a review of materials, the aforementioned ministry finds that there is no wooded land on the NEK site. There will thus be no direct impact on wooded land. There will also be no indirect or remote impacts on the forest, as the wooded land is more than 450 m away from the site of the planned activity. No additional negative impact on wildlife is expected either.

In terms of agricultural land, an opinion has also been given by the Agriculture Directorate of the Ministry of Agriculture, Forestry and Food (no. 351-77/2020/5). The competent ministry believes that the planned extension of NEK's operational lifetime from 40 to 60 years will not have any particular impact on agricultural land.

- **Natural assets**

The direct use of natural resources in production encompasses the use of water from the public water network for sanitary needs and fire safety, and river water and groundwater, which is taken from wells and the Sava for technological needs on the basis of water permits. River water and groundwater is not used as a raw material (it is not incorporated into products), but is used in supportive cooling processes. Following use and appropriate treatment, all the water is returned into the environment, i.e. into the Sava. The water pumped from the three temporary wells returns directly into the Sava via the rainwater drainage system.

During the extended operational lifetime, the use of river water and groundwater will not change significantly and will remain similar to the current state.

- **Material assets**

The extension of NEK's operational lifetime will not have a significant impact in terms of increasing existing burdens on the environment. The state will remain unchanged. All activities that enable the extension of the operational lifetime will have been carried out before it begins. The annual effective external radiation dose on the NEK perimeter fence from all contributors, including the dry storage of spent fuel, will not exceed, during operation, the radiation load that currently applies to the NEK perimeter fence, which is 200  $\mu$ Sv.

In the period of NEK's extended operational lifetime, there will be no effect on material assets (land, buildings and cultural heritage) around the site of the activity.

- **Risks of environmental and other accidents**

Extending NEK's operational lifetime means prolonging its operation by 20 years (2023–2043) under the same environmental and radiation conditions as prescribed in the existing operating licence.

Although NEK was designed for a minimal operating period of 40 years, the power plant has carried out all the necessary analyses and upgrades from which it follows that it can operate for another 20 years. On the basis of a series of studies and analyses, the Slovenian Nuclear Safety Administration confirmed with its Decision no. 3570-6/2009/32 of 20 June 2012 that the state of the equipment at NEK is suitable, despite aging, and that all safety margins and operating functions are guaranteed.

The ability to extend the operational lifetime is based above all on the following facts:

- the power plant has built-in materials and equipment that provide sufficient safety reserves;
- all equipment that affects the reliability of operation has been replaced;
- the operation of the power plant is stable;
- a safety upgrade has been implemented in accordance with the demand of ZVISJV-1 and the lessons learnt from all past major nuclear accidents which is reflected in ENSREG (the national post-Fukushima plan);
- NEK has a comprehensive aging management programme (AMP) in place to monitor the aging of all passive structures and components (reactor pressure vessel, concrete, underground pipelines, steel structures, electrical cables, etc.).

Safe and reliable operation in all conditions is NEK's top priority. Since it began operating, NEK has carried out a series of modernisations which have increased the site's safety and efficiency.

Extending the operational lifetime will not represent a risk for the environment or other possible accident, considering the foreseen solutions and safety functions are ensured.

- **Population and health protection**

As follows from the findings in previous chapters of this report, which deal with the impacts of lifetime expansion (LTE) on all relevant environmental factors it might affect, NEK's current level of production does not exceed the limit values for substance emissions and radiation into the environment. It is not expected that the limit values will be surpassed during the planned extension of operational lifetime of NEK either. The limit value is the prescribed level whose aim is to avoid, prevent or reduce harmful effects on human health or the environment as a whole. NEK implements, and will continue to implement after the changes, all the measures to reduce burdens and prevent pollution of the environment and the impact on human health, which stem from regulations. Regular monitoring is also carried out in keeping with applicable prescriptions and permits.

The change in the current activity (extension of the operational lifetime) will not cause changes to natural and other conditions of life and habitation near the site of the activity and further afield.

During the extended operational lifetime, there will be regular monitoring throughout NEK, which is already being carried out now - measurements of river water pumping for technological purposes, measurements and analyses of wastewater discharged into the sewage system, and measurements of radiation.

- **Transboundary impacts during normal operation**

NEK's current level of production does not surpass the limit values of substance emissions and radiation into the environment. It is not expected that the limit values will be surpassed during the planned extension of operational lifetime of NEK either. The area in which the activity causes an environmental burden, that can affect human health or property, will be limited to the narrower NEK site. Under normal operation, the foreseen activity will have no transboundary effects on factors dealt with in this report that would stem from individual influences or their mutual effects.

- **Transboundary impacts in the event of an emergency – accident**

The study "Calculation of doses at certain distances for Design Basis (DB) and Beyond Design Basis (BDB) accidents at NEK", FER-MEIS, 2021, dealt with the design basis Large-break Loss of Coolant Accident (LB LOCA) and the Design Extension Conditions (DEC-B). As evident from the results of the study, the effective 30-day dose at a distance of 10 km from the power plant is 1.16 mSv and therefore more than two times lower than the annual natural background dose, which is about 2.5 mSv in Slovenia. The thyroid gland dose (13.5 mSv) at a distance of 3 km from NEK is below the limit (50 mSv for 7 days) prescribed by law (Decree on dose limits, reference levels and radioactive contamination, Official Gazette of RS, No. 18/18) for iodine prophylaxis.

The distance of NEK from the closest borders of neighbouring countries is:

- 10 km from the border with Croatia;
- more than 75 km from the border with Austria;
- more than 129 km from the border with Italy;
- More than 100 km from the border with Hungary.

The results of the study show that in the event of a Large-break Loss of Coolant Accident (LB LOCA) and Design Extension Conditions (DEC-B), which also represent the worst possible accident scenarios, there will not be a significant transboundary impact on the environment and people's health and possessions.

Measures to prevent, reduce, and offset the identified significant adverse impacts on the environment – Operation

Described below are the mitigation measures required to prevent significant impacts on individual environmental components. These include mitigation measures that the developer is already implementing and will continue to implement during the extended operational lifetime. They are divided into measures prescribed by law, measures set out in the environmental permit, measures defined by the project, and additional measures.

**Waters, including thermal pollution**

- Compliance with the provisions of the Ordinance on NEK's development plan:
  - adequate quality of the water treated in the treatment plant;
  - monitoring the influence of NEK cooling water on the inflow of the Sava water into groundwater, the temperature of which must not exceed 15°C;
  - an independent meteorological station at NEK. The programme of measurements is defined by the Slovenian Nuclear Safety Administration.
- Compliance with the measures set out in the environmental permit regarding emissions into waters, the permitted quantities of water abstracted from the Sava, and on-site pumping of water from wells.
  - The limit emission value of transmitted heat in the 24-hour average for the removal of wastewater into the Sava – at any time during the year, the discharge of industrial cooling waters and other discharged wastewaters must not cause the Sava to exceed its natural temperature by more than 3 K. NEK must activate the cooling water recirculation system in a timely manner via the cooling towers so that the temperature of the Sava does not exceed its natural temperature by more than 3 K. If the combined cooling system is insufficient to fulfil this condition, the power of the power plant must be reduced accordingly.
- Compliance with the additional measures that the developer has implemented or is carrying out:
  - Expansion of the cooling tower system, which reduces the quantity of water abstracted from the Sava, reduces the heat load, and increases resilience to climate change. Four new cooling cells were installed, and all the electrical equipment of the cooling tower

system was replaced. The power of the cooling towers has increased by 36%. The emission value of transmitted heat in the 24-hour average is maintained below 1.

→ *Compliance with the limit values specified in the environmental permit, prevention of surface water and groundwater pollution.*

### **Climate change**

- Compliance with the provisions of the Decree on the use of fluorinated greenhouse gases and ozone-depleting substances:
  - Obligation of the operator to report stationary equipment, and the obligation of the operator, maintenance provider and authorised company to report the use, capture, and delivery of waste fluorinated greenhouse gases and waste ozone-depleting substances to the waste collector.
- Compliance with the measures set out in the environmental permit:
  - The structures, systems and components of the power plant are dimensioned to withstand extreme weather events and meteorological parameters by ensuring highly conservative margins, and by following best practices and technology development;
  - The periodic safety review (performed every 10 years) includes analysis of the impact of extreme weather events on the safety of the power plant;
  - Limitation of the heat load on the Sava through the use of the combined cooling system (flow system and cooling towers). The power plant maintains a temperature difference of no more than  $\Delta T$  3°C regardless of the state of the Sava;
  - Procedures in the event of hydrological conditions that may affect the operation of the power plant: activation of cooling towers at high water levels due to the risk of inflow of debris (branches, plastic, etc.);
  - Cooperation with other energy facilities on the Sava – agreement on measures and obligations to ensure unchanged, safe and uninterrupted operation of NEK during the operation of the hydroelectric power plants on the lower Sava by implementing additional monitoring on the Sava;
  - Measurement of meteorological parameters at the automatic station with an on-site meteorological tower and the use of SODAR for high-altitude atmospheric measurements. Annual reporting of the measurements.

→ *Compliance with the limit values specified in the environmental permit, prevention of surface water and groundwater pollution, and resilience to climate change.*

### **Waste**

- Compliance with the provisions of the Rules on radioactive waste and spent fuel management:
  - Management of radioactive waste and spent fuel is carried out in accordance with written procedures – the radioactive waste and spent fuel management programme;
  - Sorting of radioactive waste with regard to its aggregate state and by category and type;
  - The packaging of radioactive waste and spent fuel must ensure that the intended manner of handling the containers is safe at all times. The suitability of packaging for confinement and storage conditions is verified;
  - The radioactive waste and spent fuel containers are marked with a radiation hazard symbol and a container label identifying their contents;
  - Radioactive waste is stored in the radioactive waste storage facility, and spent fuel in the spent fuel storage facility. Spent fuel and high-level radioactive waste are stored in such a way as to prevent criticality and ensure the removal of residual heat;
  - Radiation activities are carried out in such a manner that the releases of liquid or gaseous radioactive waste into the environment do not exceed the approved limit values;
- NEK keeps up-to-date records on the confinement of radioactive waste and spent fuel, as well as on its processing in the technological process, storage or release, clearance,

- recycling or reuse, delivery to a public service provider, and temporary or permanent export or shipment abroad;
  - If the collected wastewater exceeds the clearance criteria, it is treated as secondary radioactive waste that is processed at NEK. If it does not exceed the clearance criteria, and if it meets the criteria for municipal wastewater, it is discharged into the internal water treatment plant. If the collected wastewater exceeds the criteria for discharge to the sewage system, it is dispatched for treatment to an authorised collector or processor of such waste.
  - Compliance with the measures defined by the dry storage project:
    - The work platform in front of the dry storage and the transfer facility in the storage area are equipped with drainage sumps. Any water collected will be removed using mobile devices. Sampling will be carried out before the pits are emptied. In the event that the limits for discharging this water are exceeded, a special container will be used to transport the wastewater to the technological section of the power plant, where it will be processed.
    - In the event of leakage from a transfer overpack, radiological and chemical monitoring of the collected water is performed before the water is pumped from the pit. If the collected wastewater exceeds the clearance criteria, it is treated as secondary radioactive waste that is processed at NEK. If the collected wastewater does not exceed the clearance criteria, and if it meets the criteria for municipal wastewater, it is discharged into the internal water treatment plant. If the collected wastewater exceeds the criteria for discharge to the sewage system, it is dispatched for treatment to an authorised collector or processor of such waste.
- *Prevention of soil, surface water and groundwater pollution, and prevention of uncontrolled releases of ionising radiation into the environment.*

## Nature

- Compliance with the provisions of the Decree on the emission of substances and heat in the discharge of wastewater into waters and the public sewage system with regard to the limit emission value of transmitted heat in the discharge of industrial wastewater.
  - Compliance with the measures set out in the environmental permit:
    - The limit emission value of transmitted heat in the 24-hour average for the removal of wastewater into the Sava – at any time during the year, the discharge of industrial cooling waters and other discharged wastewaters must not cause the Sava to exceed its natural temperature by more than 3 K. NEK must activate the cooling water recirculation system in a timely manner via the cooling towers so that the temperature of the Sava does not exceed its natural temperature by more than 3 K. If the combined cooling system is insufficient to fulfil this condition, the power of the power plant must be reduced accordingly.
  - Compliance with the additional measures that the developer has implemented or is carrying out:
    - If the flow rate of the Sava is lower than 100 m<sup>3</sup>/s, NEK activates the cooling towers, through which a portion of the condenser water is cooled via recirculation. Expansion of the cooling tower system – four new cooling cells (a new cooling tower – CT3) were installed, and all the electrical equipment of the cooling tower system was replaced.
- *Prevention of excessive thermal pollution of the Sava, prevention of adverse temperature conditions for organisms in the Sava.*

## Ionising radiation

- Compliance with the restrictions set out in NEK's operating licence:
  - The maximum permissible annual effective dose from emission of radioactive material at 500 m from the reactor centre : 50 µSv;
  - Limit on the annual activity of fission and activation products in liquid discharges: 100 GBq;

- Limit on the quarterly activity of fission and activation products in liquid discharges: 40 GBq;
  - Limit on the annual activity of H-3 in airborne discharges: 45 TBq;
  - Limit on the annual activity of iodine in gaseous discharges: 18.5 GBq;
  - Limit on the annual activity in dust particles: 18.5 GBq;
  - Limit on the annual dose of external radiation on the NEK perimeter fence: 200  $\mu$ Sv.
  - Compliance with the restrictions for the operation of the SF dry storage facility:
    - Permissible dose rate on the outside of the dry storage facility: 3  $\mu$ Sv/h;
    - Following the storing of SF in the dry storage facility, the annual effective external radiation dose at the NEK perimeter fence will not exceed the limit of 200  $\mu$ Sv;
    - The effective dose limit for exposed workers is 20 mSv per year.
  - Compliance with the measures defined by the SF dry storage project:
    - The thickness of the concrete walls of the dry storage facility is adequate to ensure protection against gamma radiation, and the walls are lined with neutron radiation protection material;
    - In order to monitor the impact of the dry storage facility on the radiation parameters at the NEK perimeter fence, radiation will be measured using dosimeters (7 dosimeters for gamma radiation and 7 dosimeters for neutron radiation). Passive dosimeters will also be installed in the storage area of the spent fuel dry storage building;
    - Dosimeters will be read and replaced at least once every 6 months;
    - During the transport of spent nuclear fuel from the fuel handling building to the dry storage building, a controlled area will be established along the transport routes, that is, the area will be cordoned off, marked, and unauthorised access will be prevented.
  - Compliance with the additional measures that the developer is already carrying out:
    - Filtration of liquid emissions;
    - Filtration of gaseous emissions;
    - Confinement of radioactive effluents in order to minimise radioactivity through radioactive decay;
    - Measures to ensure fuel integrity;
    - Design and implementation of structural protection (adequate wall thickness, labyrinth design of the rooms);
    - Installation of temporary shields for short term activities that result in locally increased levels of external radiation;
    - Storage of radioactive waste and spent fuel at the facilities intended for this purpose.
- *The implementation of these measures will ensure compliance with all radiological conditions and limits set out in the valid NEK operating licence and in the Ionising Radiation Protection and Nuclear Safety Act.*
- *Population health protection.*

### **Material assets**

- There are no special legislative measures covering material assets during operation. The measures taken into account are those listed for individual relevant factors (waters, waste, ionising radiation, risks of environmental and other accidents).
- All measures that the developer is already carrying out are listed in the previous sections (ionising radiation).

### **Risks of environmental and other accidents**

- Compliance with the provisions of the Ordinance on NEK's development plan:
  - Compliance with the provisions for the SF dry storage;
  - Implementation of solutions and measures applying to defence and to protection against natural and other disasters, including protection against fire;
  - The potential spread of fire to adjacent structures and land is restricted by the use of fire-resistant materials;



- Emergency exits from the facilities;
- Water for fire suppression is provided through the existing hydrant network and the NEK pumping station;
- Emergency access routes within the NEK complex provide access for firefighting vehicles;
- The use of hazardous substances (fuel for diesel motors, lubricants, paints, etc.) is restricted to areas equipped with oil traps to prevent spillage into the environment.
- Compliance with the measures set out for other environmental components (waters, climate change, waste, ionising radiation).

### **Population and health protection**

- There are no special legislative measures covering material assets during operation. The measures taken into account are those listed for individual relevant factors (waters, climate change, waste, ionising radiation).
- All additional measures implemented by the operator are those previously listed for environmental components (waters, waste, ionising radiation, risks of environmental and other accidents).

### Measures to prevent, reduce, and offset the identified significant adverse impacts on the environment – Termination of activity

#### **Radioactive waste and ionising radiation**

- Compliance with the measures that stem from regulations:
    - The decommissioned area will still have limited access, be marked out and dealt with as an area of radiation monitoring.
    - All activities associated with the termination of operation will be carried out in accordance with the requirements of regulations, the management system and written work procedures and instructions.
- *The implementation of these measures will prevent uncontrolled emission of ionising radiation into the environment.*

### Monitoring the status of impact mitigation factors and measures – Operation

#### **Waters**

In the event of leakage from the HI-TRAC transfer overpack (which also contains glycol in winter), sampling and analysis of wastewater collected in the CTF drain sump is performed in accordance with the Rules on initial measurements and operational monitoring of wastewater and the Decree on the emission of substances and heat in the discharge of wastewater into waters and the public sewage system.

Measurements of the quantities of water abstracted for process purposes are carried out at abstraction locations in accordance with the environmental permit. Measurements of pollution parameters and wastewater quantities are carried out at measuring points in accordance with the environmental permit.

It is recommended that the measurements of parameters are performed at the entrance to the system, if the conditions in the Sava at the time of sampling clearly indicate elevated concentrations of sedimentary matter and undissolved substances.

#### **Air**

Due to the possibility that the auxiliary boilerhouse may operate more than 300 hours per year, it is recommended that a one-off measurement of emissions is performed by an authorised laboratory (dust, smoke number, CO, NO<sub>x</sub>, SO<sub>2</sub>) in accordance with the Decree on the emission of substances into the atmosphere from medium-sized combustion plants, gas turbines and stationary engines.

## **Noise**

In accordance with the Rules on initial assessment and operational monitoring of sources of noise and conditions for the implementation of monitoring, an authorised contractor will carry out noise measurements once every three years.

## **Electromagnetic radiation**

In accordance with the Rules on initial measurements and operational monitoring of sources of electromagnetic radiation and conditions for the implementation of monitoring, an authorised contractor will carry out EMR measurements once every three years.

## **Ionising radiation**

NEK is carrying out extensive monitoring of radioactive emissions and immissions, which is defined in the Radiological Effluent Technical Specification (RETS). The document describes the systems for monitoring liquid and airborne emissions, locations, and frequency of monitoring. NEK monitors radioactive emissions in all systems where radioactivity might occur during operation.

Emission monitoring includes:

- measurements of liquid emissions in periodic and continuous discharges,
- measurements of gaseous emissions: periodic and continuous.

At the same time, extensive monitoring of radioactivity in immissions is carried out in the vicinity of NEK. The monitoring includes all transmission routes by which a person can receive a dose:

- the Sava (water, sediments, and aquatic biota);
- water supply network and boreholes;
- pumping stations and catchments;
- precipitation and depositions;
- air;
- external radiation;
- soil;
- food – milk, fruit, garden crops and field crops.

Immission measurements are performed by authorised environmental monitoring contractors in accordance with the Rules on the monitoring of radioactivity. A report on radioactivity monitoring in the vicinity of NEK, which includes dose estimations for reference population groups, is compiled every year.

The construction of the spent fuel dry storage building will require additional external radiation monitoring. Currently, NEK is measuring the dose rate of ionising radiation with six passive optically stimulated luminescence (OSL) dosimeters at measuring points on NEK fence. After the construction of the dry storage building, a total of six passive dosimeters will also be installed in the storage area. Additional passive dosimeters will be installed on the NEK perimeter fence.

During the transfer of spent fuel from the FHB to the DSB, a temporary controlled area will be established along the transfer route and measurements of radiation parameters will be carried out.

Since July 2017, NEK has been conducting additional radioactivity monitoring of the Sava to account for the impacts of the construction and operation of the Brežice HPP. In addition to the usual sampling locations, radioactivity is measured on both sides of the reservoir, at the Brežice HPP dam, in the replacement habitat, and in additional boreholes.