REPUBLIC OF SLOVENIA
MINISTRY OF THE ENVIRONMENT AND SPATIAL PLANNING

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Pursuant to Article 38a of the State Administration Act (Official Gazette of RS, Nos. 113/05 [official consolidated version], 89/07 [Constitutional Court decision], 126/07 [ZUP-E], 48/09, 8/10 [ZUP-G], 8/12 [ZVRS-F], 21/12, 47/13, 12/14, 90/14, 51/16, 36/21, 82/21, 189/21 and 153/22), the second paragraph of Article 61 of the Environmental Protection Act (Official Gazette of RS, Nos. 39/06 [UPB], 49/06 [ZMetD], 66/06 [Constitutional Court decision], 33/07 [ZPNačrt], 57/08 [ZFO-1A], 70/08, 108/09, 108/09 [ZPNačrt-A], 48/12, 57/12, 92/13, 56/15, 102/15, 30/16, 61/17 [GZ], 21/18 [ZNOrg], 84/18 [ZIURKOE], 158/20 and 44/22 [ZVO-2]) and the seventh paragraph of Article 105 of the Nature Conservation Act (Official Gazette of RS, Nos. 96/04 [UPB], 61/06[ZDru-1], 8/10 [ZSKZ-B], 46/14, 21/18 [ZNOrg], 31/18, 82/20, 3/22 [ZDeb] and 105/22 [ZZNŠPP]), and the first paragraph of Article 6 of the Act Ratifying the Convention on Environmental Impact Assessment in a Transboundary Context (Official Gazette of RS [Mednarodne pogodbe] No. 11/98), the Ministry of the Environment and Spatial Planning hereby issues, in the administrative matter of the granting of an environmental protection consent for the extension of Krško nuclear power plant’s operational lifetime from 40 to 60 years, to the developer, Nuklearna elektrarna Krško, d.o.o., Vrbina 12, 8370 Krško, represented by President of the Management Board Stane Rožman and Member of the Management Board Saša Medaković, the following

ENVIRONMENTAL PROTECTION CONSENT

I. An environmental protection consent for the following activity is granted to the developer, Nuklearna elektrarna Krško, d.o.o., Vrbina 12, 8370 Krško: the extension of Krško nuclear power plant’s operational lifetime from 40 to 60 years on land in the cadastral municipality of 1321 Leskovec, land parcel nos. 1197/44, 1204/192, 1197/397, 1246/2, 1197/398 (partial), 1204/206, 1204/209, 1246/6, 1249/1, 1246/33, 1195/107, 1195/109 and 1195/111.

II. This environmental protection consent is issued under the following conditions:

1. <u>Conditions applying to the protection of surface waters, groundwater and the natural environment, including from the standpoint of climate change:</u>
   1. continuous measurements of the Sava flow rate upstream of the offtake of Sava water for Krško NPP must be carried out, or data on the flow rate upstream of that offtake obtained from Krško HPP, and records kept of the measurement results. Measurements of the Sava flow rate must be continuous and consistent, with data recorded at least once an hour and the results entered in the Slovenian Environment Agency’s online database;
   2. when the Krško NPP dam is functioning, continuous measurements of the Sava flow rate at the dam must be carried out and records kept of the measurement results. Measurements of the Sava flow rate at the Krško NPP dam must be continuous and consistent, with data recorded at least once an hour and the results entered in the Slovenian Environment Agency’s online database;

3. continuous measurements of the flow rate of the offtake of Sava water for Krško NPP must be taken at the measuring point at coordinates e = 539923 and n = 88683 (D96/TM system) in cadastral municipality 1321 Leskovec, land parcel no. 1249/4, and records kept of the measurement results. Measurements of the flow rate of the Sava water offtake must be continuous and consistent, with data recorded at least once an hour and the results entered in the Slovenian Environment Agency's online database;
4. continuous measurements of the temperature of the Sava must be taken at the measuring point at coordinates e = 539851 and n = 88685 (D96/TM system) in cadastral municipality 1321 Leskovec, land parcel no. 1249/4, at the Krško NPP offtake point, and records kept of the measurement results. Measurements of the temperature of the Sava must be continuous and consistent, with data recorded at least once an hour and the results entered in the Slovenian Environment Agency's online database;
5. continuous measurements must be taken of the temperature and flow rate of wastewater from Krško NPP, i.e. for at least wastewater from the SW cooling system, wastewater from the CT surge tank into the Sava and wastewater from the CW cooling system into the Sava, and records kept of the measurement results; Measurements of the temperature and flow rate of wastewater must be continuous and consistent, with data recorded at least once an hour and the results entered in the Slovenian Environment Agency's online database;
6. continuous measurements must be taken of the flow rate and temperature at the time wastewater is sampled (performed as part of operational monitoring), where these measurements must be performed by an authorised operational wastewater monitoring contractor;
7. measuring points for the implementation of operational wastewater monitoring must be set up;
8. if the total annual quantities of wastewater from discharges V2 (flushing of the rotating rakes), V3 (discharge from fire protection pumps), V4 (essential service water), V5 (flushing of the travelling screens) and V6 (pumping during an outage) into the Sava exceeds 100,000 m^3, continuous measurements of industrial wastewater must be taken at the discharge with the highest annual quantity of released wastewater, and records kept of the measurement results. Measurements of the flow rate of wastewater must be continuous and consistent, with data recorded at least once an hour and the results entered in the Slovenian Environment Agency's online database;
9. at the point of complete mixing of the Sava and wastewater from Krško NPP, which is located in the stilling basin of Brežice HPP, a measuring point must be set up at the location of the downstream side wall on the left bank (coordinates e = 545686.070 and n = 84534.008, D96/TM system) in cadastral municipality 1301 Krška Vas, land parcel no. 6631, continuous measurements taken of the temperature of the Sava, and records kept of the measurement results. Measurements of the temperature of the Sava must be continuous and consistent, with data recorded at least once an hour and the results entered in the Slovenian Environment Agency's online database;
10. steps must be taken to ensure that the average daily waste heat emission ratio (WHER) from Krško NPP at the point of complete mixing of the Sava and wastewater from the plant (with due regard to the cumulative figure for all wastewater discharges from the plant), calculated for the daily average of all actual flow rates (watercourse and wastewater), does not exceed the limit WHER, which is 1;
11. steps must be taken to ensure that the average daily temperature of the Sava at the point of complete mixing does not exceed 28°C and that the Sava does not, at that point, get warmer by more than 3°C above its natural temperature as measured at the offtake of Sava water for Krško NPP;
12. the cooling towers must be activated in order for the requirements referred to in the two preceding points to be met, and Krško NPP must keep its own records of cooling tower operation;

13. if the requirements referred to in points 10 and 11 cannot be met by activating the cooling towers, electricity generation at Krško NPP must be reduced;
14. whenever concentrations of undissolved substances and sedimentary matter in the river are elevated as a result of a high flow rate, 24-hour sampling of Sava water at the offtake for Krško NPP must be carried out and an analysis performed of the parameters of undissolved substances and sedimentary matter at the measuring point at coordinates e = 539923 and n = 88683 (D96/TM system) in cadastral municipality 1321 Leskovec, land parcel no. 1249/4. The sampling of the Sava must, for the purpose of determining the presence of undissolved substances and sedimentary matter, be performed at the same time as the sampling of wastewater at measuring points MM1, MM3 and MM4 from the environmental protection permit;
15. prior to discharge into the Sava, Krško NPP must take its own measurements of boron in wastewater in which boron can appear, and keep records of the measurement results;
16. in the event of a declared higher degree of risk to energy supply and a demonstrable need for uninterrupted energy supply, the temperature of the Sava between 1 October and 30 April may be 3.5 K higher at the point of complete mixing than the temperature of the Sava at the offtake of Sava water for Krško NPP (average daily temperature rise = ΔT), where the temperature of the Sava at the point of complete mixing may not exceed 28°C. The average daily temperature rise of the Sava is calculated as the difference between the average daily temperatures of the Sava measured at the point of complete mixing and the average daily temperatures of the Sava measured at the offtake of Sava water for Krško NPP;
17. extreme weather events must be monitored constantly and analysed in detail. If the effects of extreme weather events exceed the design bases of the plant's structures, systems or components (SSCs), those SSCs must be upgraded on the basis of an analysis, or protected against the effects of such extreme events. In periods not longer than the interval between two consecutive Periodic Safety Reviews, the cumulative impact of extreme weather events, including combinations of such events, must be subjected to an in-depth analysis;
18. Krško NPP must draft an action plan for the third Periodic Safety Review (PSR3*) that includes an update of the PSHA for the Krško NPP site, submit it for approval to the SNSA no later than by the end of 2023 and, on this basis, carry out any additional measures required to increase the nuclear safety of the plant;
19. the PSHA and the measures must be communicated to the countries involved in the transboundary procedure as part of the status monitoring. The existing bilateral nuclear safety commissions, in which the responsible ministries for environmental impact assessments participate, should be used for this purpose;
20. Krško NPP must draft a final Krško NPP Decommissioning Programme, containing an Environmental Impact Assessment (EIA) Report for the decommissioning process, and commence an EIA no later than three years prior to the termination of operation of the plant.

III. An environmental protection consent is being granted instead of a nature protection consent because an EIA procedure is being carried out for the extension of Krško NPP's operational lifetime from 40 to 60 years.

IV. This environmental protection consent shall cease to be valid if the developer does not begin the project within five years of its entry into force.

V. No costs were incurred in the course of this procedure.

G r o u n d s

On 15 October 2021 the Environment Directorate at the Ministry of the Environment and Spatial Planning (hereinafter: the ministry) received an application from the developer, Nuklearna elektrarna Krško, d.o.o., Vrbina 12, 8370 Krško, represented by President of the Management Board Stane Rožman and Member of the Management Board Saša Medaković (hereinafter: developer) for an environmental protection consent for the extension of Krško NPP's operational lifetime from 40 to 60 years in the cadastral municipality of 1321 Leskovec, land parcel nos. 1197/44, 1204/192, 1197/397, 1246/2, 1197/398 (partial), 1204/206, 1204/209, 1246/6, 1249/1, 1246/33, 1195/107, 1195/109 and 1195/111.

The following were enclosed with the application:

- Project: Long-Term Operation of Krško Nuclear Power Plant (2023–2043), no. NEK ESD – RP – 205, Rev. 3, October 2021 (Nuklearna elektrarna Krško, d.o.o., Vrbina 12, 8270 Krško);
- Environmental Impact Assessment Report for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years – Nuklearna elektrarna Krško d.o.o. no. 100820-dn, October 2021 (E-NET OKOLJE d.o.o., Linhartova cesta 13, 1000 Ljubljana);
- Supplement Assessing the Acceptability of the Impacts on Protected Areas for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years – Nuklearna elektrarna Krško d.o.o., order no.: 1456-20 VO, October 2021 (AQUARIUS d.o.o. Ljubljana, cesta Andreja Bitenca 68, 1000 Ljubljana);
- Soil Status Report for the Site of the Planned Construction of an SFDS for Nuklearna elektrarna Krško d.o.o., no. 360/2020, 29 July 2020 (TALUM INŠTITUT, raziskava materialov in varstvo okolja, d.o.o., Tovarniška cesta 10, SI-2325 Kidričevo).

The following documentation was added to the application on 9 November 2021:

- Environmental Impact Assessment Report for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years – Nuklearna elektrarna Krško d.o.o. no. 100820-dn, October 2021, supplemented 8 November 2021 (E-NET OKOLJE d.o.o., Linhartova cesta 13, 1000 Ljubljana).

The following documentation was added to the application on 10 January 2022:

- Second Supplement to the Application for an Environmental Protection Consent for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years (letter), no. ING.DOV-007.22, 10 January 2022;
- Environmental Impact Assessment Report for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years – Nuklearna elektrarna Krško d.o.o. no. 100820-dn, October 2021, supplemented 8 November 2021 and 10 January 2022 (E-NET OKOLJE d.o.o., Linhartova cesta 13, 1000 Ljubljana);
- Supplement Assessing the Acceptability of the Impacts on Protected Areas for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years – Nuklearna elektrarna Krško d.o.o., order no.: 1456-20 VO, October 2021, supplemented January 2022 (AQUARIUS d.o.o. Ljubljana, cesta Andreja Bitenca 68, 1000 Ljubljana).

The following documentation was added to the application on 10 and 25 May 2022:

- Third Supplement to the Application for an Environmental Protection Consent for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years: presentation of evidence, no. ING.DOV-178.22, 6 May 2022, with four appendices;
- Supplemented Environmental Impact Assessment Report for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years – Nuklearna elektrarna Krško d.o.o. no. 100820-dn, October 2021, supplemented 8 November 2021, 10 January 2022 and 5 May 2022 – following public consultation (E-NET OKOLJE d.o.o., Linhartova cesta 13, 1000 Ljubljana, in printed and electronic form).

The following documentation was added to the application on 20 July 2022:

- Draft minutes of the oral hearing with third-party participants held on 28 June 2022, with minor suggestions for corrections (12 pages);
- Position of the developer, Nuklearna elektrarna Krško, d.o.o., Vrbina 12, 8370 Krško, on the comments and suggestions made by the Association of Ecological Movements of Slovenia (Zveza ekoloških gibanj Slovenije, ZEG), Cesta krških žrtev 53, 8270 Krško during the oral hearing held on 28 June 2022 (45 pages).

The following documentation was added to the application on 8 September 2022:

- Responses to additional comments made by ZEG as part of the comments on the draft minutes of the oral hearing, no. ING.DOV-345.22, 7 September 2022, with appendix ("Position of the developer NUKLEARNA ELEKTRARNA KRŠKO, d.o.o. on the comments and suggestions made by the Association of Ecological Movements of Slovenia (Zveza ekoloških gibanj Slovenije, ZEG) as part of comments on the draft minutes of the oral hearing in the administrative matter of the issuing of the environmental protection consent for the lifetime extension. Extension of Krško NPP's Operational Lifetime From 40 to 60 Years to NE Krško d.o.o., Vrbina (ZEG letter no. 71/22, 14 July 2022).

The developer added the following documentation to the application on 4 November 2022:

- Krško NPP's responses to the replies sent by the Association of Ecological Movements of Slovenia (Zveza ekoloških gibanj Slovenije, ZEG) to the written position of the developer Nuklearna elektrarna Krško, d.o.o., letter no. ING.DOV-345.22, 7 September 2022, no. ING.DOV-400.22/4557, 4 November 2022 with appendices:
    1. Position of the developer NUKLEARNA ELEKTRARNA KRŠKO, d.o.o. on the responses of the Association of Ecological Movements of Slovenia (Zveza ekoloških gibanj Slovenije, ZEG) to the written position of the developer Krško NPP on the comments and suggestions made by ZEG as part of comments on the draft minutes of the oral hearing in the administrative matter of the issuing of the environmental protection consent for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years to NE Krško d.o.o., Vrbina (ZEG letter no. 96/22, 26 September 2022).
    2. Record of the visit of the Association of Ecological Movements of Slovenia (Zveza ekoloških gibanj Slovenije, ZEG) to Krško NPP in the administrative procedure of the acquisition of an Environmental Protection Consent for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years, 27 October 2022.

The developer added the following document to the application on 28 December 2022:

- Statement from the developer, Krško NPP, on the findings of the Ministry of the Environment and Spatial Planning regarding the relevant facts given in MOP letter no. 35428-4/2021-2550-94, 19 December 2022, no. ING.DOV-460.22/5341, 23 December 2022.

Under Article 50 of the Environmental Protection Act (Official Gazette of RS, Nos. 39/06 [ZVO-1-UPB1], 49/06 [ZMetD], 66/06 [Constitutional Court Decision], 33/07 [ZPNačrt], 57/08 [ZFO-1A], 70/08, 108/09, 108/09 [ZPNačrt-A], 48/12, 57/12, 92/13, 56/15, 102/15, 30/16, 61/17 [GZ], 21/18 [ZNOrg], 84/18 [ZIURKOE] and 158/20, ZVO-1), an EIA must be carried out and an environmental protection consent obtained from the ministry before an activity that could have a significant impact on the environment can commence. The Environmental Protection Act (Official Gazette of RS, No. 44/22, ZVO-2) came into force on 13 April 2022. Article 303 of that act provides that any procedures relating to the issuing of an environmental protection consent or amendments thereto commenced under Articles 57 and 61a ZVO-1 shall be completed under the provisions of that earlier act. Accordingly, this procedure will continue and end in accordance with the ZVO-1.

The obligation to carry out this assessment is laid down in the Decree on activities affecting the environment for which an environmental impact assessment is mandatory (Official Gazette of RS, Nos. 51/14, 57/15, 26/17, 105/20 and 44/22 [ZVO-2]).

In accordance with point D Energy, D.III Renewable energy sources, D.II.1 Annex 1 to the Decree on activities affecting the environment, an environmental impact assessment is mandatory in the case of nuclear power plants and other nuclear reactors, including their decommissioning or removal.[13]
Footnote 13 states: “Nuclear power stations and other nuclear reactors cease to be such installations when all nuclear fuel and other radioactively contaminated elements have been removed permanently from the installation site.”

According to the second paragraph of Article 2 of the Decree on activities affecting the environment for which an environmental impact assessment is mandatory, an environmental impact assessment is also mandatory for a modification to an activity affecting the environment regardless of whether an environmental protection consent or decision has been obtained for the activity affecting the environment in a screening procedure prior to modification under the law governing environmental protection if it concerns a modification referred to in: the previous paragraph which, in itself, reaches or surpasses the threshold, or a multiplication of the threshold, set for this type of activity in Annex 1 to this Decree; Article 3 of this Decree, which reaches or surpasses the threshold or a multiplier of the threshold set for this type of activity in the description of the type of activity marked with an X in the column titled EIA in Annex 1 to the Decree.

According to the second paragraph of Article 3 of the Decree on activities affecting the environment for which an environmental impact assessment is mandatory, a screening procedure is carried out for a modification to an activity as referred to in the first paragraph of the previous article for which an environmental protection consent has been obtained prior to modification, if it concerns a modification that, in itself, reaches or surpasses the threshold, or a multiplication of the threshold, for which a screening procedure must be carried out for this type of activity under Annex 1 to this Decree, where the activity, together with the previous modifications will reach or surpass the threshold at which a screening procedure must be carried out for this type of activity under Annex 1 to the Decree, or a multiplication of the threshold.

According to the fourth paragraph of Article 3 of the Decree on activities affecting the environment for which an environmental impact assessment is mandatory, screening shall also be carried out for a modification to an activity as referred to in the first paragraph of the previous article or the first paragraph of this article for which Annex 1 to this Decree does not set a threshold.

In addition to this, point 6 of Article 1a of the Decree in question explains that a modification to an activity affecting the environment is a modification permitted in accordance with the regulations, is under way or has been completed, and where the impacts on the essential characteristics of the activity are such that its environmental impacts increase significantly or can be expected to increase significantly.

A screening procedure was conducted for the lifetime extension and, on 2 October 2020, decision no. 35405-286/2016-42 was issued by the Slovenian Environment Agency, Vojkova 1b, 1000 Ljubljana. That decision stated that, in order to extend the operational lifetime of Krško NPP from 40 to 60 years, i.e. until 2043, in cadastral municipality 1321 Leskovec, land parcel nos. 1197/44 and 1204/192, the developer was required to carry out an EIA and obtain an environmental protection consent.

It has been established that the lifetime extension involves a modification that affects the essential characteristics of the existing activity, since Krško NPP's operational lifetime is being extended until 2043 (i.e. an extension of operation) and that, because of the modification, the impacts could significantly increase or a significant increase in the environmental impacts can be expected as a result of the planned modification. It was also established that the lifetime extension was functionally and

economically related to at least another proposed activity, i.e. the construction of a spent fuel dry storage building.
The impact area for protected areas (protected areas and Natura 2000 areas) is determined in the Rules on the assessment of the acceptability of impacts caused by the execution of plans and activities affecting nature in protected areas (Official Gazette of RS, Nos. 130/04, 53/06, 38/10, 3/11), Article 5 of which provides: (1) The assessment of acceptability is carried out for plans that may have a significant impact on protected areas, either on their own or as cumulative impacts. (2) Plans that may have a significant impact on protected areas are those that, due to the implementation of activities affecting nature as set out in Annex 2 to these Rules, designate the intended use of land or the modifications thereof (hereinafter: designation of the intended use of land) as set out in Annex 1, which is an integral part of these Rules, and those plans that designate or plan said activities affecting nature in protected areas, or in areas whose distance from protected areas is smaller than the maximum area of remote impact specified for activities affecting nature in Annex 2 to these Rules.
According to the Decree on the classification of buildings (Official Gazette of RS, No. 96/22), the Krško NPP complex is an industrial complex. According to the Rules, complex industrial buildings are defined in Chapter II of Annex 2 as: areas of production activities that are areas of direct impact (100 m) for all groups, and areas of remote impact (1,000 m) for birds, bats, aquatic and riparian habitat types, and beetles.
Article 20 of the Rules further provides: (4) Remote impact is established if the plan envisages an activity affecting nature, as defined in Chapters I to XVIII of Annex 2 to these Rules, in the area of remote impact, except for those types of activity for which an environmental impact assessment is mandatory in accordance with the regulation governing the types of activities affecting the environment for which an environmental impact assessment is mandatory. For activities that require an EIA, the remote impact is established in an area twice as large as the remote impact area referred to in Annex 2 of those Rules, unless findings from the field, detailed data on the implementation of the activity or other factual circumstances indicate that the area of remote impact is different. (5) The area of remote impact established for a specific activity affecting nature may differ at any time from the area of remote impact of an activity affecting nature referred to in Annex 2 of these Rules if this is based on findings from the field, detailed data on implementation of the activity and other actual circumstances.
It follows from the above that the area of remote impact for the lifetime extension under the Rules is 2,000 m. There are no protected areas in the area of direct impact. There is one Natura 2000 area situated in the area of remote impact (2,000 m) according to the provisions of the Decree on special protection areas (Natura 2000 areas) (Official Gazette of RS, Nos. 49/04, 110/04, 59/07, 43/08, 8/12, 33/13, 35/13 [corrigendum], 39/13 [Constitutional Court decision], 3/14, 21/16 and 47/18): Vrbina SAC (SI3000234), at a distance of approx. 350 m.
Under Article 20 of the Rules, the area of remote impact established for a specific activity affecting nature may differ at any time from the area of remote impact of an activity affecting nature referred to in Annex 2 of these Rules if this is based on preliminary findings from the field, detailed data on implementation of the activity and other actual circumstances. Krško NPP uses water from the Sava River to operate its cooling systems. The plant has nine discharges through which wastewater flows into the Sava. In addition to the remote impact within a radius of 2,000 m as defined by the Rules, remote impact is therefore also possible downstream along the Sava.
A Supplement Assessing the Acceptability of the Impacts on Protected Areas for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years – Nuklearna elektrarna Krško d.o.o., order no.: 1456-20 VO, October 2021, supplemented January 2022 and May 2022, following public consultation (AQUARIUS d.o.o. Ljubljana, Cesta Andreja Bitenca 68, 1000 Ljubljana) was drawn up for the lifetime extension under the assumption that the area of remote impact downstream along the Sava could stretch up to 8 km downstream of the discharges from Krško NPP, where the Lower Sava SAC has been declared a Natura 2000 area (SI3000304).

Pursuant to the first paragraph of Article 61 ZVO-1, which provides that the ministry shall send applications for environmental protection consents and a draft decision on an environmental protection consent to ministries and organisations that are responsible for individual environmental protection matters, the protection or use of natural resources, or the protection of cultural heritage with respect to the proposed activity, the ministry requested that the following issue an opinion on the acceptability of the proposed activity (lifetime extension) within 21 days of receiving the application:

- Slovenian Nuclear Safety Administration, Litostrojska cesta 54, 1000 Ljubljana;
- Institute of the Republic of Slovenia for Nature Conservation, Tobačna ulica 5, 1000 Ljubljana;
- Fisheries Research Institute of Slovenia, Spodnje Gameljne 61a, 1211 Ljubljana – Šmartno;
- Ministry of Health, Public Health Directorate, Štefanova ulica 5, 1000 Ljubljana;
- Slovenian Water Agency, Mariborska cesta 88, 3000 Celje;
- Slovenian Environment Agency, Vojkova 1b, 1000 Ljubljana.

On 7 December 2021 the ministry received an opinion from the Slovenian Nuclear Safety Administration, Litostrojska cesta 54, 1000 Ljubljana (SNSA) no. 3570-13/2020/27, 7 December 2021. After reviewing the Environmental Impact Assessment Report for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years – Nuklearna elektrarna Krško d.o.o., no. 100820-dn, October 2021, supplemented 8 November 2021 (E-NET OKOLJE d.o.o.), the SNSA established that the report dealt satisfactorily with issues relating to nuclear safety and ionising radiation protection. The SNSA then gave a positive opinion, with the following condition attached:
"The operator of the power plant must monitor extreme weather events constantly and analyse them in detail. If the effects of extreme weather events exceed the design bases of the plant's structures, systems or components (SSCs), those SSCs must be upgraded on the basis of an analysis, or protected against the effects of such extreme events. In periods not longer than the interval between two consecutive Periodic Safety Reviews, the cumulative impact of extreme weather events, including combinations of such events, must be subjected to an in-depth analysis."
In connection with this condition, which the ministry has incorporated into the operative part of this environmental protection consent, the SNSA explained that the EIA addressed the impact of extreme weather events and climate change on the safety aspects of the activity (Section 5.6.1.2), and that the EIA Report estimated that the impact of the activity and overall impact of climate change on the activity during operation would be (3), i.e. impact not significant, on account of the mitigation measures that Krško NPP was already implementing and that it was required to continue to implement during the lifetime extension. Of these measures, the following are particularly important for maintaining nuclear safety:

- the structures, systems and components of the power plant are dimensioned to withstand extreme weather events and meteorological parameters with highly conservative margins;
- the Periodic Safety Review, which is performed every ten years, includes an in-depth analysis of the impact of extreme weather events on the safety of the plant.

As a result of the climate changes that the EIA Report predicts will take place during the period leading up to the end of Krško NPP's lifetime extension, the frequency or impact of extreme weather events could increase. Krško NPP must therefore monitor such events particularly carefully, analyse them in detail and take the appropriate steps set out as a condition in the operative part of the SNSA opinion. The basis for addressing extreme events and planning power plant structures, systems and components so that they are able to withstand those events are requirements set out in the Rules on radiation and nuclear safety factors (Official Gazette of RS, Nos. 74/16 and 76/17 [ZVISJV-1])), particularly Annex 1, Chapter 5.
In the opinion, the SNSA went on to propose specific technical amendments to the EIA Report by suggesting a number of explanations that could be added to the report. The SNSA also suggested that corrections be made to the draft environmental protection consent in response to the deficiencies established. The ministry inserted these corrections into the draft.

On 7 December 2021 the ministry also received an opinion from the Ministry of Health, Public Health Directorate, Štefanova ulica 5, 1000 Ljubljana (no. 354-108/2018-24, 6 December 2021) with an annex titled "Opinion under Article 61 ZVO-1 on the acceptability of the proposed activity from the aspect of impacts on human health", for the extension of the Krško NPP's operational lifetime from 40 to 60 years. It was drafted under reference no. 354-142/2018-7 (256) by the Health Ecology Centre of the National

Institute of Public Health, Trubarjeva cesta 2, 1000 Ljubljana (NIJZ) and dated 6 December 2021. Based on the data provided in the documentation enclosed, the NIJZ believes that the lifetime extension is acceptable from the aspect of its impact on human health. The opinion further states that the EIA Report adequately addresses the potential environmental impacts on human health, and refers to additional mitigation measures required to protect human health. The results of the checks made of the expected environmental impacts that are caused by the activity and that could have an impact on human health and well-being showed that changes to specific elements of the environment (quality of ambient air, noise pollution, quality of surface waters and groundwater, drinking water supply, waste management, wastewater management, electromagnetic radiation, light pollution) are, given the additional mitigation measures set out in the report, very unlikely to have a significant impact on human health.
The NIJZ remarks that the opinion does not relate to impacts of the lifetime extension on human health relating to radioactive radiation regardless of medium (air, water, soil, waste) and regardless of phase (construction, operation or decommissioning), or of whether a nuclear accident occurs in connection with the extension of Krško NPP's operational lifetime from 40 to 60 years. The competent institutions with the appropriate authorisations will produce an opinion on the impacts of radioactive radiation on human health.

On 8 December 2021 the ministry received opinion no. 3562-0380/2021-6 (8 December 2021), which had been drafted by the Novo Mesto office of the Institute of the Republic of Slovenia for Nature Conservation (ZRSVN), Adamičeva ulica 2, 8000 Novo Mesto.
The ZRSVN submitted the following expert opinion in the procedure for assessing the acceptability of the activity within the scope of the issuing of the environmental protection consent pursuant to the provisions of Article 101e of the official consolidated version of the Nature Conservation Act (Official Gazette of RS, No. 96/04 [ZON-UPB2], with corrigenda, ZON) and the fourth paragraph of Article 40 of the Rules on the assessment of the acceptability of effects caused by the execution of plans and activities affecting nature in protected areas in accordance with the first paragraph of Article 61 ZVO-1:
A. Finding regarding the adequacy and compliance of the supplement to the EIA Report for protected areas:
after reviewing the material, the ZRSVN finds that the extension of Krško NPP's operational lifetime does not affect Natura 2000 areas or other protected areas, and that it also lies outside the area of direct impact. Vrbina SAC and Lower Sava SAC (both Natura 2000 areas) are located within the area of remote impact. Lower Sava SAC is approx. 8 km from the Krško NPP complex, although it is estimated that the potential impacts could reach that far.
The material therefore has a supplement for protected areas that the ZRSVN finds, after a review, has been drawn up in the appropriate way, is in compliance with the legislation and enables an assessment to be made. The following key summary follows from the enclosed supplement: Emissions of substances and heat by Krško NPP present potential impacts on the Sava. To mitigate the impact of thermal pollution, Krško NPP will have to continue to comply with the provisions of the environmental protection permit (with regard to emissions into waters). A significant impact from the extension of Krško NPP's operational lifetime is not expected as long as the provisions of the environmental protection permit are observed. While additional mitigation measures are not necessary, Krško NPP must implement all measures to prevent excessive burdens from the discharge of wastewater into the Sava, thus ensuring that wastewater parameters remain below the limit values set out in the environmental protection permit in future (temperature of the Sava when mixed with cooling water from Krško NPP does not exceed the river's natural temperature by more than 3°C).
The ZRSVN goes on to highlight the following recommendation as a technical supplement to the documentation: that the material should clearly show the point of complete mixing, where the temperature of the Sava does not exceed the river's natural temperature by more than 3°C when mixed with cooling water from Krško NPP, as the ZRSVN finds, after its review, that it has not been explicitly mentioned.
The ministry took the remark into consideration and set the coordinates of the point of complete mixing.

B. Finding on the acceptability of the impacts of the activity on protected areas:

After reviewing the material, the ZRSVN finds that the extension of Krško NPP's operational lifetime will not have a significant impact on protected areas or their integrity or connectedness if the conditions contained in the environmental protection permit and water consents already issued are adhered to.

The ZRSVN then submitted a further expert opinion pursuant to the provisions of Article 117 ZON:
A. Finding regarding the adequacy and compliance of the EIA Report:
After reviewing the material, the ZRSVN finds that the lifetime extension of Krško NPP does not have a direct impact on natural resource areas, important ecological areas, the habitats of protected animal and plant species, or habitat types. The envisaged potential impacts relate primarily to the emissions of substances and heat into the Sava, an issue addressed adequately by the material. The ZRSVN finds that the extension of Krško NPP's operational lifetime alone will not have a significant impact on protected areas if the conditions contained in the environmental protection permit and water consents already issued are adhered to.
After reviewing the material contained in the EIA Report, the ZRSVN finds that it has been drawn up adequately and in accordance with the legislation. Section 7 of the EIA Report defines the measures for preventing, minimising and compensating for significant adverse impacts on the environment. They highlight the importance of complying with all the measures set out in consents, permits and regulations already issued for the extension of Krško NPP's operational lifetime. Section 8 of the EIA Report defines the monitoring of the status of impact mitigation factors and measures.

B. Finding on the acceptability of the impacts of the activity on the natural environment:
After reviewing the material, the ZRSVN finds that the extension of Krško NPP's operational lifetime will not have a significant impact on valuable natural features, important ecological areas, the habitats of protected species or protected habitat types. As the lifetime extension is planned within the boundaries of the existing complex and operations, because no increase in environmental impact relative to the current situation is envisaged and because the existing operation already envisages measures to reduce environmental impact, the ZRSVN does not expect any major impact on the functional properties of the important ecological area. It therefore assesses the lifetime extension as acceptable if the environmental protection consents and permits already granted are adhered to.

On 13 December 2021 the ministry received an opinion from the Fisheries Research Institute of Slovenia (ZZRS), Sp. Gameljne 61a, 1211 Ljubljana – Šmartno no. 4204-61/2016-7, 13 December 2021. The ZZRS opinion states that the issues of freshwater fisheries and the protection of fish and fish habitats have been adequately addressed and considered in the EIA Report (E-NET OKOLJE d.o.o., Ljubljana, October 2021), that the report does state that the greatest adverse impact on fish comes from the temperature maximum in the summer months (as it can cause reduced levels of oxygen in the water or even overheating of organisms at extremely high temperatures), and that it is important, given the adverse impact of high water temperatures on fish, that the mitigation measures relating to water cooling be strictly observed. According to the opinion, the lifetime extension is acceptable from the standpoint of fisheries if all the mitigation measures contained in the EIA Report and the draft environmental protection consent are carried out.

On 15 December 2021 the ministry received an opinion from the Slovenian Environment Agency (ARSO), Vojkova 1b, 1000 Ljubljana (dated 15 December 2021). The ARSO opinion states that the EIA Report (E-NET OKOLJE d.o.o., document no. 100820-dn, Ljubljana, October 2021, supplemented 8 November 2021) addresses the issue of soil comprehensively, with expertise and in accordance with the Decree on the method of drafting and on the content of reports on the effects of planned activities affecting the environment (Official Gazette of RS, Nos. 36/09, 40/17 and 44/22-[ZVO-2]), and that a Soil Status Report for the Site of the Planned Construction of an SFDS for Nuklearna elektrarna Krško d.o.o. (TALUM INŠTITUT, raziskava materialov in varstvo okolja, d.o.o., document no. 360/220, Kidričevo, 29 July 2020, hereinafter: soil status report) had been submitted in order to establish current soil status and quality. As part of the report process, soil sampling was carried out at the Krško NPP site in order to determine any potential contamination of the soil. On the basis of the soil status report, ARSO established that the soil at the Krško NPP site was not excessively contaminated and that the value of the parameters for dangerous substances in the soil did not exceed the limit immission values referred to in the Decree on limit values, alert thresholds and critical immission values of dangerous substances in soil (Official Gazette of RS, Nos. 68/96 and 41/04 [ZVO-1]). The ARSO opinion goes on to state that the scope of the lifetime extension consists exclusively of the continuation of operation of Krško NPP for a further 20 years (i.e. an extension from 40 to 60 years, or from 2023 to 2043) using the existing operating characteristics, and does not envisage the construction of new structures or facilities that would change the physical characteristics of the plant. Based on the statements contained in the enclosed documentation, ARSO established that the lifetime extension did not involve the construction of structures or any activities affecting the soil. In light of all the facts outlined above, ARSO's opinion was that as long as the developer observed the measures for preventing, reducing or eliminating adverse effects on the environment and human health set out in the EIA Report and the applicable legislation during construction and operation, the proposed activity was acceptable with regard to impact on the soil.

In the opinion, ARSO also made observations on the sections of the EIA Report that describe the existing chemical status of surface waters, and drew attention to the irregularities it had identified in the statements. The ARSO opinion states that Section 4.1.4 (Surface waters, Tables 27, 28 and 29) had correctly taken the assessments of the chemical status of surface waters from the Danube River Basin Management Plan 2022–2027; that Section 4.4.4 (Quality and quantities of surface waters and their use – Comments on the status of the water body) had been drawn up with reference to the periodic assessment for 2009–2013, but should be supplemented with reference to the periodic assessment on the basis of monitoring data for 2014–2019; and that this is important because assessment of chemical status must be entered for the most recent period (because poor chemical status has been determined in biota as a result of breaches of the environmental quality standard for mercury and brominated diphenyl ethers). The opinion goes on to state that Section 5.3.1.1 (Operation), which is part of Section 5.3.1 (Impacts on waters), must be updated in line with the periodic assessments for 2014–2019; that the chemical status of water bodies for the Management Plan 2022–2027 is good in this area for the water matrix, while the chemical status for the biota matrix and for the biota and water matrices together is poor; that assessments of status must be set out precisely and in the same way in all sections; that statements in the EIA Report must be amended to take account of the statements of ecological and chemical status of waters for the Management Plan 2022–2027 in this area; that Section 4.4.3 (Quality and quantities of groundwater and its use) does not make explicit reference to the assessment of the chemical status of groundwater for RBMP3; and that the status of the Krško Basin for 2009–2020 had been correctly presented, as had the status at facilities close to Krško NPP (Vrbina and Stari Grad) for 2006–2020. In the opinion, ARSO proposed that a table containing the results of ecological status by individual quality element for 2014–2019 for the Sava Krško-Vrbina, Sava Boštanj-Krško and Sava border section water bodies be added to Section 4.1.4 (Surface waters).

On 24 December 2021 the ministry also received an opinion from the Slovenian Water Agency (DRSV), Mariborska cesta 88, 3000 Celje (no. 35019-46/2021-9, 23 December 2021) that stated that the impact of the lifetime extension on the water regime and water status had been adequately addressed; that the lifetime extension did not involve the implementation of additional activities within the existing Krško NPP complex, but the continuation of operation, in line with all the prescribed conditions and the environmental and water permits issued; and that the developer had also been granted an extension of the water permit by the DRSV for the use of water for process purposes (cooling water) from 2039 to 2051. The DRSV opinion stated that the lifetime extension was acceptable from the standpoint of impact on the water regime and water status if all the planned protective measures set out in the supplemented EIA Report were carried out.

The ministry explains that the statement regarding the extension of the water permit to 2051 is not entirely correct: only the permit granted for the SPW006 BB2 well is valid until 7 September 2051. The water permit for the West-1/19, South-1/19 and East-1/19 wells is valid until 31 October 2050, while the validity of the water permit for abstraction from the Sava at Gauss-Krüger coordinates Y= 540294, X= 88198, Z 150 m a.s.l. on land parcel no. 1246/6 in cadastral municipality 1321 Leskovec and from the

well at Gauss-Krüger coordinates Y= 540269, X= 88045, Z 150.47 m a.s.l. on land parcel no. 1195/47 in cadastral municipality 1321 Leskovec expires on 31 August 2039.
In letter no. 35428-4/2021-2550-23 dated 15 December 2021, the ministry asked the developer to submit evidence, i.e. to respond to the opinions received and the regulatory authority's findings.

The developer responded to the request on 10 January 2022 by submitting the following documentation:
- Second Supplement to the Application for an Environmental Protection Consent for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years (letter), no. ING.DOV-007.22, 10 January 2022;
- Environmental Impact Assessment Report for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years – Nuklearna elektrarna Krško d.o.o. no. 100820-dn, October 2021, supplemented 8 November 2021 and 10 January 2022 (E-NET OKOLJE d.o.o., Linhartova cesta 13, 1000 Ljubljana);
- Supplement Assessing the Acceptability of the Impacts on Protected Areas for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years – Nuklearna elektrarna Krško d.o.o., order no.: 1456-20 VO, October 2021, supplemented January 2022 (AQUARIUS d.o.o. Ljubljana, cesta Andreja Bitenca 68, 1000 Ljubljana).

After receiving this documentation, the ministry sent a renewed request, in letter no. 35428-4/2021-2550-34 dated 16 February 2022, for an opinion on the acceptability of the proposed activity from the SNSA, ZRSVN and ARSO.

The ministry received an opinion from ARSO on 28 February 2022. In the opinion, ARSO pointed out a number of textual errors in the EIA Report that required correction.

On 9 March 2022 the ministry received a positive opinion (no. 3570-13/2020/32 dated 9 March 2022) from the SNSA.

On 16 March 2022 the ministry also received an opinion from the ZRSVN (no. 3562-0380/2021-9 dated 16 March 2022). After reviewing the material, the ZRSVN found that the proposed activity would not have a significant impact on protected areas or their integrity or connectedness if the conditions contained in the environmental protection permit and water consents already issued were adhered to. The opinion further stated that the proposed activity would also not have a major impact on valuable natural features, important ecological areas, the habitats of protected species or protected habitat types. As the lifetime extension is planned within the boundaries of the existing complex and operations, because no increase in environmental impact relative to the current situation is envisaged and because the existing operation already envisages measures to reduce environmental impact, the ZRSVN does not expect any major impact on the functional properties of the important ecological area. It therefore assesses the lifetime extension as acceptable if the environmental protection consents and permits already granted are adhered to.

After establishing that the developer had submitted complete documentation, the application for the environmental protection consent, the EIA Report and the draft decision on the environmental protection consent were made available to the public (as per Article 58 ZVO-1). In public announcement no. 35428-4/2021-2550-31 of 15 February 2022, the public was informed of all of the requirements arising from Article 58 ZVO-1 on the ministry's website, at the head office of Krško Administrative Unit, Cesta krških žrtev 14, 8270 Krško and at the head office of the Municipality of Krško, Cesta krških žrtev 14, 8270 Krško. Pursuant to the third paragraph of Article 58 ZVO-1, the public was permitted to submit opinions and observations for 30 days from the date given in the public announcement, i.e. from 22 February 2022 to 22 March 2022.

The ministry received opinions and comments (pursuant to Article 58 ZVO-1) to which it refers, pursuant to the fifth paragraph of Article 61 ZVO-1, in the continuation of this environmental protection consent, and also outlines how it took these opinions and comments into consideration in the decision. The ministry explains at this juncture that, for ease of reading, the abbreviations used below are also set out in Annex 1, which is a constituent part of this environmental protection consent:

1. Proposal to establish geotechnical monitoring for the maintenance of records on the status of the geomechanical properties of the material in the Krško NPP flood-protection embankment and of the soil below the embankment, and the hydrological and hydrogeological properties of the immediate vicinity of the plant:
   With the help of geotechnical monitoring of the Krško NPP flood-protection embankment, the stability of the embankment is continuously monitored by means of measurements of the geomechanical characteristics of the material built into the embankment, both in a saturated and unsaturated state. During the construction of the embankment, the material is in an unsaturated state (or state of optimal moisture). Over time, the saturation of the material in the embankment either increases (e.g. through the infiltration of rainwater or flood water from the environment) or decreases (e.g. through intensive evaporation). The geomechanical properties of the material in the embankment also change (deteriorate) as a result of the uncontrolled distribution of moisture and suction, which leads to a fall in the shear strength of the material and, in extreme conditions, to collapse. The continuous monitoring of the properties of the material in the embankment resulting from recurrent fluctuations in the pore pressures of the water and from suction is therefore important in terms of both the optimisation of the planning of earth embankments and the long-term provision of adequate functionality of the embankment. The continuous monitoring of the geomechanical and hydrological properties of the soil can show in good time whether there is a critical interaction between the materials in the embankment and the atmospheric and other impacts on the stress state and, consequently, on the stability of the embankment. The field instrumentation (monitoring) programme comprises the detailed monitoring of suction and adequate volumetric level of the water within the embankment, and meteorological data at the microlocation, including laboratory tests of the properties of the installed materials. It would make sense to:
   - establish a meteorological station (for measurements of precipitation and temperature) in the immediate vicinity;
   - install piezometers up to 3 m below the level of the groundwater in the area of the embankment;
   - install tensiometers in the area of the embankment;
   - install inclinometers up to 1 m below the embankment floor;
   - conduct laboratory geomechanical tests of the embankment materials (taking of representative samples at different levels of the embankment and at different locations).

   In relation to this comment, the ministry finds, after studying Krško NPP's response ("Third Supplement to the Application for an Environmental Protection Consent for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years: presentation of evidence", no. ING.DOV-178.22, 6 May 2022, with four appendices), that the geomechanical properties of the material in the embankments along the Sava and Potočnica are unable to deteriorate as a result of cyclical changes to moisture over time to such an extent as to jeopardise the functionality of the embankments.
   In 2010, prior to the first reconstruction of the embankments, geological and geomechanical investigations were conducted of both embankments. They found that the Sava embankment consisted of sandy gravel and the Potočnica embankment consisted of dolomitic aggregate, sandy silt, silty sand and fine-grained, clayey gravel. On the side next to the water, the Sava embankment has been sealed with a layer of poorly permeable sandy silt, between 10 and 30 cm thick, while the Potočnica embankment has no additional seal. These sandy and gravelly materials are not prone to aging as a result of cyclical effects of wetting and drying, as demonstrated by the good state of the embankments after more than 30 years in operation.
   According to the opinion, this suction only occurs in fine-grained earth (particle size from fine sand downwards) and generally works in such a way that the growth in suction also leads, to a certain extent, to an increase in shear strength (source: Likar, B., Fifer Bizjak, K.: "Meritve deformacijsko trdnostnih parametrov zemljin za odlagališče radioaktivnih odpadkov" (Measurements of the

deformation strength parameters of earth for radioactive waste repositories); Discussions at the 6th conference of Slovenian geotechnical engineers, Lipica, 14–15 June 2012, SloGeD). The proportion of fine-grained fractions in the Krško NPP flood-protection embankments is too small to facilitate the occurrence of suction.

Materials with the same characteristics (composition, granulation) as in the existing parts of the embankments were used in both embankment reconstructions (2011 and 2018), with particular attention being paid to controlling the materials and supervising execution.

The crown of the Sava embankment lies at a height of between 161.20 and 157.20 (at the Krško NPP dam), and that of the Potočnica embankment at a height of 159.90 (a parapet wall of a height of 0.5 m lies above this height). Prior to the construction of Brežice HPP, the median level of the groundwater along the Sava embankment was between 151.00 and 149.50 because of containment by the Krško NPP dam. After containment by Brežice HPP, the level was between 152.50 and 150.50 ("Necessary Technical Measures for Suppression of Side Effects of Brežice HPP Construction on Krško NPP", Revision C; IBE d.d., September 2015, document IBBR---3G1803C – Enclosure 2.1-2). This means that groundwater and fluctuations in groundwater level occur only in the embankment foundations and have done for decades.

Owing to the dimensions of the embankment at Sava flow rate Q_{10000}, the complete saturation of the embankment (not only with precipitation) occurs only very rarely and only to a limited extent. With the reference probable maximum flood (PMF) flow rate, which is 1.75 times higher than the highest recorded Sava flow rate, the safety height to the crown of the embankment is still at least 75 cm, which means that the percolation path is at least 5 m long at the height of the surface, whereby the duration of the high-water event is limited to a maximum of a few hours. This means that even if there were a weak spot in the embankment, exposure to a breach would be very short-lived and limited. Water level Q_{100} occurs several metres below the crown of both the embankments.

In light of these expert opinions and the trends in the hydrological flow rates of the Sava, the ministry did not follow or incorporate the proposal to establish geotechnical monitoring for the maintenance of records on the status of the geomechanical properties of the material in the Krško NPP flood-protection embankment and of the soil below the embankment, or status of the hydrological and hydrogeological properties of the area immediately surrounding the plant.

2. Further clarifications and positions of those that drafted the technical background documents (Determination of the point of complete mixing of cooling water from Krško NPP and Sava water following the construction of Brežice HPP, no. IBBRTM-A200/071 (IBE, November 2012), Necessary Technical Measures for Suppression of Side Effects of Brežice HPP Construction on Krško NPP, Rev. C (Potrebni tehnični ukrepi za sanacijo vplivov HE Brežice na NEK, revizija C), IBBR-A200/037-6 (IBE, September 2015), Verification and further analyses of reverse flows in the Krško NPP profile following construction of the Brežice HPP dam, IBBR-B056/289A (IBE, April 2019), Analysis of river temperatures in the Lower Sava in July and August 2019 and the verification of previous studies, no. IBXXT2-A200/066C (IBE, February 2020) in relation to these three sets of conditions contained in the draft environmental protection consent, i.e.

2.1. Measurement of the Sava flow rate at the Krško NPP dam:

Before Brežice HPP came into operation, Krško NPP conducted measurements of the level of the Sava at the Sava 2 point upstream of the dam, taking into account the location of the sluice gates of the Krško NPP dam and the physical modelling results of the hydraulics of the Sava riverbed to calculate the Sava flow rate. After the Brežice HPP was built, the Sava 2 flow rate measuring point was abandoned for the same reason as the Radeče water gauging station had been abandoned in the Vrhovo reservoir: owing to the damming of the river, the ratio between the water level and the flow rate was no longer unequivocal, i.e. the same water level could mean different flow rates in the river at different locations of the Brežice HPP sluice gates. The study produced as part of the IDP for Brežice HPP ("Necessary Technical Measures for Suppression of Side Effects of Brežice HPP Construction on Krško NPP", Rev. C, IBBR-A200/037-6 (IBE, September 2015)) found, in relation to the measurement of flow rate for the requirements of Krško NPP operations, that:

it would no longer be possible to calculate the Sava flow rate using the previous method. Owing to the location in the reservoir, no measurement based on water level would provide correct data on flow rate. Data on flow rate would be obtained from the flow rate monitoring system in the HPP chain on the Lower Sava (MOSS). The system has already been fully established at Arto-Blanca HPP and Krško HPP, where it is possible to verify its suitability in advance. The agreement in principle is that data on flow rates at Krško HPP will be used as reference for the operation of Krško NPP. As an additional control and duplication of the measurement, an additional flow rate measurement using an acoustic scintillation flow meter (ASFM) was examined in the profile just downstream of Krško HPP, as described in document IBBR---3G1832 (Annex E-15). Equipment based on this technology could be installed at any of the Lower Sava HPPs, but the study concluded that it was not necessary. An identical flow rate and temperature measurement system will be established at Brežice HPP. As there are no major inflows in the area of the Brežice HPP reservoir, very high-quality data control will be possible by comparing the measurements at Krško HPP and Brežice HPP. This suggestion was taken into account in the siting of Brežice HPP and formalised in an agreement between HESS and Krško NPP on the provision of the data required for Krško NPP operations and the exchange of that data between HESS and Krško NPP. Krško NPP thereby became part of a unified Sava flow rate measurement system based on water level detection (for the flow rate through spillways) and actual flow rates (for flow rate through turbines) at all hydropower plants on the Lower Sava. In the given conditions, this method of measuring flow rate is the most precise and also universal, as it enables correct measurements to be taken for the entire range of Sava flow rates, from minimal to at least Q_{10000}. This method of measuring the Sava flow rate has been in place at Krško HPP and Brežice HPP since August 2017. Owing to the different measurement principle, differences arose in the past between the flow rate measurements in the national hydrological network and at Krško NPP. These differences have been eradicated by the introduction of the unified measurement system at HPPs. Owing to the fixed conditions of the HPP profiles, such measurements are also stable in terms of time and do not require frequent checks to be made of the stability of the cross-section, as is the case with natural measurement profiles. While measurements of the flow rate at the Krško NPP dam can be conducted using modern technologies, that dam does have its specificities (resulting from the requirement to ensure operational reliability and nuclear safety), an issue that has already been addressed on a number of occasions in hydrodynamic analyses. The most recent of these analyses was drawn up in 2020 ("Verification and further analyses of reverse flows in the Krško NPP profile following construction of the Brežice HPP dam", IBBR-B056/289A, IBE, April 2019), which established the possibility of a return flow of CW cooling water in an upstream direction through the Krško NPP dam at times of extremely low Sava flow rate. To prevent this from occurring, the selective opening of the Krško NPP sluice gates was proposed to deal with such situations. This measure further complicates the hydraulic picture and introduces unreliability into even the most precise acoustic or optical measurements in conditions of low flow rate (which is when determination of the Sava flow rate is particularly important).
In the opinion of the comment's author, the existing system of Sava flow rate measurements at Krško HPP is accurate, reliable and controlled, and therefore ensures that the input data for Krško NPP operations is of suitably high quality. Measurements have also been established at the Brežice HPP dam, although there are no major inflows in the area of the flow-through reservoir that would affect the Sava flow rate. According to the comment's author, it makes no sense to conduct additional measurements of the Sava flow rate at the Krško NPP dam. He believes it does not provide any additional information, neither from the aspect of the hydrological monitoring of the Sava nor from that of the supervision of the operation of the Krško NPP dam, which is currently practically inactive.

In relation to this comment, the ministry finds, after studying Krško NPP's response ("Third Supplement to the Application for an Environmental Protection Consent for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years: presentation of evidence", no. ING.DOV-178.22, 6 May 2022, with four appendices), that Krško NPP is already ensuring that continuous measurements of Sava flow rate are carried out at the Krško NPP dam (when that dam is in operation). Krško NPP explained that when Brežice HPP was not in operation (thereby necessitating operation of the Krško

NPP dam), flow rate measurements were conducted at the individual spillways of that dam. Flow rate measurements at spillways P1 to P6 are conducted separately, while the total flow rate of the watercourse (as required under the fourth paragraph of Article 31 of the Decree on the emission of substances and heat in the discharge of wastewater into waters and the public collection system (Official Gazette of RS, Nos. 64/12, 64/14, 98/15, 44/22 [ZVO-2], 75/22 and 157/22) represents the sum of the flow rates for P1 to P6. It also follows from Krško NPP's explanation that flow rate measurements are based on a consideration of the level of the Sava, the position of a specific sluice gate (flow below or over the sluice gate), the impact of low water, etc.
The ministry did not follow the suggestion of the comment's author regarding the lack of justification for measurements of Sava flow rate at the Krško NPP dam, i.e. it ordered measurements to be conducted.

2.2. Point of complete mixing:
The requirement to determine the point of complete mixing (PCM) follows from Article 38 of the Decree on the national spatial plan for the area of Brežice hydropower plant (Official Gazette of RS, Nos. 50/12 and 96/13), which lays down the arrangements and obligations connected with Krško NPP operations and explicitly requires as follows in the 19th indent of Article 52 (Nature conservation measures): "The temperature of the water at the point of mixing may not increase by more than is prescribed in the Krško NPP administrative permits, and may not exceed the authorised limit value prescribed in those permits." For this reason, a study was drawn up ("Determination of the point of mixing of cooling water from Krško NPP and Sava water following the construction of Brežice HPP", no. IBBRTM-A200/071 (IBE, November 2012)). The comment's author summarises some of the key premises and results from this study, and adds clarifications regarding the requirements for actually using the point of complete mixing.
PREMISES AND RESULTS OF THE ANALYSES
Prior to the construction of the Brežice flow-through reservoir, the PCM was indicatively determined as being in the vicinity of the old railway bridge in Brežice. This determination was made on the basis of field and laboratory measurements, for which reason it only applied to certain flow rates. With the construction of Brežice HPP, different conditions were expected in relation to the dispersion of heat than those applying to the river. This required the drafting of a technical background document that would, in addition to the PCM, show the future thermal conditions in the mixing area in the Brežice flow-through reservoir. The mixing area is the area in which the initial dispersion of pollution or heat takes place, and is what is referred to as a "sacrifice zone", where water standards are permitted to be exceeded locally. The mixing area stretches from the point of discharge of wastewater into the water body to the PCM. Slovenian and European legislation allows the existence of mixing areas, but does not prescribe how these areas are to be determined. The study referred to above (IBE, 2012) used current expert knowledge and a 3D hydrodynamic and advection dispersion model to determine a new arbitrary PCM for conditions following the construction of the Brežice flow-through reservoir. The conclusions proposed that the low water point at Brežice HPP be taken as the PCM, and therefore as the site of continuous measurements of the temperature of the river. These measurements have been conducted as part of the monitoring of Brežice HPP since that facility began operating (August 2017). The study also made a comparison between the then-existing and the future (i.e. after damming) thermal status of the Sava for river temperature increases (relative to the starting temperature of the Sava upstream of Krško NPP) and for the degree of mixing. The measured increases in the temperature of the Sava for the period addressed at that time (September 2010) were sufficiently higher than those acquired at similar points in the simulation of future status for stratification-intensive case AVG63 (Sava flow rate of 63 m^3/s, Sava temperature of 20.3°C, average meteorological conditions for August). Taking into account the fact that the weather conditions in the AVG63 case presented a greater thermal burden and that the flow rate was at least two times lower than the average for April, it was determined that the future (dammed) situation would be better than the existing situation from the point of view of the temperature increase of the Sava downstream of Krško NPP. The degree of mixing in September 2010 was compared with the APR calculation example (Sava flow rate 247 m^3/s, Sava temperature 10.4°C, average April

meteorological conditions), as the flow rates and meteorological conditions are similar. It was found that mixing would improve by between 20 and 30% in the future and at comparable points. In light of the above findings, it was concluded that the construction of the Brežice HPP reservoir had not led to a deterioration in thermal conditions in the Sava. In the study determining the PCM (IBE, 2012), the analyses show that the dammed Sava was frequently better at removing cooling water than the undammed Sava. This was further confirmed by the “Analysis of river temperatures in the Lower Sava in July and August 2019 and the verification of previous studies”, no. IBXXT2-A200/066C (IBE, February 2020). This study included an analysis of events during the very hot period of 18 to 27 July 2019. At that time, according to the measured values the temperature of the Sava fell by -0.54°C in the section between the CW Krško NPP discharge (if all the water from Krško NPP would be completely mixed with the Sava) and the Brežice HPP discharge. This means that there was negative heat flow from Krško NPP in the section of the Brežice reservoir downstream of Krško NPP, which eliminated 18% of the heat released from the plant. The cooling effect of reservoirs in extreme thermal situations had already been considered when the variant solutions for the discharge into the Brežice reservoir from Krško NPP were being addressed (IBE and FGG, 2006). However, the analysis of measurements from summer 2019 was the first time that this effect had been demonstrated in reality. According to the comment’s author, a further reason why there is no doubt about the result is that during the ten-day period in question, with the-then average Sava flow rate of 78 m^3/s, the water in the reservoir was exchanged approx. four times. This means that the occurrence persisted through four cycles of the filling and emptying of the Brežice reservoir. Throughout the whole of summer 2019, this was the most even (and also the fastest) rise in the river temperature in the whole HPP chain. From the point of view of the requirement to use the PCM as the control point for Krško NPP operation, it must also be pointed out that this mechanism of cooling the reservoir is not unequivocal, as it depends on a host of natural parameters. Determination of the PCM temperature by computation is therefore the only reliable and universal method. Owing to the computational and experimental evidence and the permission given to the construction and operation of the Brežice flow-through reservoir, no changes have been made to the environmental protection consent for Krško NPP. That said, a change is proposed in the procedure of extending the lifetime of Krško NPP to 2043; the comment’s author therefore provides the further clarifications set out below.

FURTHER CLARIFICATIONS

Krško NPP captures the Sava for the cooling of systems and structures from measuring point M1 using a resistance thermometer (PT100), which has a high degree of accuracy and a fast response. This measuring point is located just upstream of the Sava offtake channel. The Krško NPP outlet temperature is measured at the CW outflow channel to the Sava. It is also recorded using a resistance thermometer.

The temperature at the PCM is then determined computationally from the measured inflow and outflow temperatures and the flow rates of the offtake from the Sava. Due to the strict limits for temperature rise in the Sava, which has a major impact on the scope and stability of production at Krško NPP, this method is the most accurate and the only reliable and unambiguous one. This applied to the status of the free-flowing river downstream of Krško NPP and, for the reasons listed below, is even more applicable to the river in its dammed state.

Natural heating/cooling of the reservoir: between the discharge of water from Krško NPP and the proposed PCM location, additional natural impacts arise in all meteorological and hydrological conditions. These cause heat to be transferred between the water and the atmosphere, and change the actual share of the impact from the heat led from Krško NPP to the PCM. These are:

a. global short-wave solar radiation
b. long-wave atmospheric radiation
c. long-wave radiation of a water body
d. convection
e. evaporation (with wind playing a major role)

As it is not possible to accommodate all these impacts into the real-time interpretation of the measurements, they could show an increase in the thermal load from Krško NPP, which would then lead to an unjustified reduction in production at the plant. On the other hand, measurements at the PCM could, in conditions of strengthening wind and a large loss of energy through evaporation, allow an increase in the load from Krško NPP.

Thermal stratification of the flow-through reservoir: stratification cannot be quantified in real time as it changes all the time, both throughout the day and at different parts of the reservoir. It depends on several parameters: atmospheric conditions, distance from the Krško NPP discharge, the locations of any active Krško NPP dam sluice gates, etc. One very important result of stratification is the further intensive release of heat from the surface layer of the water into the atmosphere, which is probably the main reason for the confirmed good cooling effect of the Brežice HPP reservoir in extreme summer weather conditions (IBE, 2020).

Time lag of measurements at the PCM: in periods when the Sava flow rates are at their lowest, which is typically when the thermal load on the river is highest, water can even take more than two days to travel from the profile of the Krško NPP dam to Brežice HPP and therefore to the PCM, which means production at the plant is adjusted to a two-day delay depending on the actual status of the incoming water.

Based on the expert justifications produced during the final procedure for the siting of Brežice HPP and the additional explanations given, the comment's author regards the previous method of determining temperature at the PCM, with its measurement-based calculations, as the most suitable one and as equally correct in all conditions. In his opinion, a reduction in the criteria for Krško NPP operation to only one measurement at the PCM, which would not necessarily show the actual impact of Krško NPP, would be a worse solution than the current one in terms of Krško NPP operation and environmental impact.

In relation to this comment, the ministry explains that the developer has taken exactly the same position as the comment's author in the document titled "Third Supplement to the Application for an Environmental Protection Consent for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years: presentation of evidence", no. ING.DOV-178.22, 6 May 2022, with four appendices. Subsequently, the developer proposed, in statement no. ING.DOV-460.22 of 23 December 2022, that the PCM be set at the stilling basin of Brežice HPP, where complete mixing physically occurs, rather than at the macrolocation of the old steel bridge in Brežice. It also stated that the conditions for the performance of continuous online measurements were already in place at the location of the downstream side wall on the left bank (coordinates e = 545686.070 and n = 84534.008, D96/TM system).

In relation to this, the ministry explains that it has partly followed the suggestion made by the comment's author by retaining the calculation, and has additionally ordered control measurements at the point of complete mixing of the Sava and wastewater from Krško NPP, setting its coordinates in line with the developer's suggestion, as explained in detail in the reasoning of point II/1.9 of the operative part of the environmental protection consent.

2.3. Criteria for the activation of the cooling towers:

The cooling towers are activated to cool the medium that leads heat from the main condenser. In order to adhere to the restrictions set out in the environmental protection consent, the medium is, where necessary, further cooled prior to being discharged into the Sava. According to the environmental protection consent, the highest temperature of the medium prior to discharge is 43°C. At the same time, steps must be taken to ensure that any increase in the average daily temperature of the river does not exceed 3°C. The temperature increase is higher when the Sava flow rates are lower, which in practice means that the Krško NPP cooling towers are activated when the Sava flow rate is below approx. 100 m^3/s. In the winter months in particular, it is often the case that the temperature increase is lower than the limit imposed (<3°C) even when the Sava flow rate is 90 m^3/s or less. Making the operation of the Krško NPP cooling towers directly conditional upon the Sava flow rate is therefore technically unjustified or inappropriate, as well as energy inefficient. Operation of the Krško NPP cooling towers means that the plant itself uses more energy (order of magnitude of several MW) and, as a consequence, less energy is transmitted into the network. At the same time, the hydropower plants are already operating at only a few several dozen per cent of their capacity (order of magnitude of approx. 10 MW). The ΔT = 3°C restriction is consistently adhered to, as long-term monitoring shows. An additional restriction, i.e. that the cooling towers are activated when flow rates are lower than 100 m^3/s, would implicitly mean the ΔT = 3°C limit being brought down to a lower value. In the opinion of the comment's author, this is neither logical, cost-effective nor environmentally justified.

In relation to this comment, the ministry finds that the developer has taken exactly the same position as the comment's author in the document titled "Third Supplement to the Application for an Environmental Protection Consent for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years: presentation of evidence", no. ING.DOV-178.22, 6 May 2022, with four appendices. The ministry explains that it took the statements of the comment's author and the developer's position into account and that it removed the previous condition from the draft environmental protection consent; that condition had stated that the cooling towers had to be activated when the Sava flow rate measured upstream of the Sava offtake for Krško NPP was less than 100 m^3/s. The ministry has changed the measure/condition so that it now requires Krško NPP to activate the towers to meet the following conditions: a) that the average daily waste heat emission ratio (WHER) from Krško NPP at the point of complete mixing of the Sava and wastewater from Krško NPP (with due regard to the cumulative figure for all wastewater discharges from Krško NPP), calculated for the daily average of all actual flow rates (watercourse and wastewater), does not exceed the limit (WHER), which is 1; and b) that the average daily temperature of the Sava at the point of complete mixing does not exceed 28°C and that the Sava, at the point of complete mixing, does not heat up by more than 3°C above its natural temperature measured at the offtake of Sava water for Krško NPP. The measure/condition also includes a requirement for the plant to maintain its own records of the operation of the cooling towers.

3. Focus, društvo za sonaraven razvoj (Association for Sustainable Development), Trubarjeva cesta 50, 1000 Ljubljana (hereinafter: Focus) states that the EIA Report should also address the decommissioning of the facility. Point 1.7.3 (p. 43) of the EIA Report states that it does not address the decommissioning of the plant because, according to the decommissioning programme, it will be subject to "other administrative procedures in the field of construction, nuclear safety and environmental protection". These decommissioning-related activities should be specified in more detail in Section 2.18 (p. 114), which merely repeats this quoted statement without explaining in detail which procedures in the areas of construction, nuclear safety and environmental protection are carried out specifically for the decommissioning of the nuclear facility.
   Focus goes on to refer to the provisions of Article 2 of the Decree on the method of drafting and on the content of the report on the effects of planned activities affecting the environment, which provide that the subject of the report is the description and analysis of the planned activity affecting the environment during its implementation, duration, decommissioning and termination in relation to the environment in which it is located. Focus points out that, given the age of Krško NPP, the fact that this EIA procedure is the only EIA procedure related to the plant and that lifetime extension also logically implies the termination of plant operations, there is no reason why the EIA Report should be prepared contrary to Article 2 of this Decree. Focus goes on to say that the EIA Report also fails to mention what decommissioning processes will form the legal basis for this treatment and, furthermore, that it follows from the detailed study of building construction, nuclear safety and environmental protection processes that:
   - Article 18 of the Ionising Radiation Protection and Nuclear Safety Act (ZVISJV-1) provides that the authority responsible for nuclear safety should issue a licence for, *inter alia*, "the management and decommissioning of a radiation nuclear facility". Article 109 regulates in more detail the authorisation for the commissioning and decommissioning of a nuclear facility. The SNSA can therefore be expected to issue a special decommissioning licence that, under the applicable law,

does not include an EIA, as the law explicitly requires it only for the siting of a nuclear facility (Article 95).
- The Construction Act (GZ) also applies to activities that constitute the demolition of a facility. The law defines the removal of a building as "the execution of works for the removal, demolition or dismantling of all above-ground and below-ground parts of the structure" (point 28 of Article 3). Article 4 provides that no building permit is required for removal, while Article 5 provides that "the removal of the structure may be initiated by a notice of commencement of construction" (second paragraph). It follows that no building permit is required for the demolition of the facility as part of the decommissioning. Therefore, no special permit is granted under this act. However, the third paragraph of Article 5 requires removal to be carried out in accordance with regulations setting out the basic and other requirements and with other rules. Focus concludes that no EIA would be required for this procedure, which would only be carried out if an integrated building permit were granted, which is not the case.
- As that part of the Environmental Protection Act (ZVO-1) relating to EIAs is relevant, the question arises as to whether an EIA is explicitly required for the decommissioning of a nuclear facility. Annex 1, point D.II of the Decree on activities affecting the environment for which an environmental impact assessment is mandatory deals with activities in the field of nuclear energy. It provides that "nuclear installations and other nuclear reactors, including their dismantling or removal" require an EIA. For these definitions, however, Focus points out that we have to rely on the definition of the ZVISJV-1, which is reasonably consistent with the above-mentioned provision of the Decree. Article 95 of the ZVISJV-1 deals with EIAs in relation to the siting of a nuclear facility and provides that the siting of a nuclear facility is subject to a comprehensive EIA and an EIA (first paragraph). Furthermore, only a comprehensive EIA is specified, by stating in paragraph 6 that the EIA Report shall assess all factors that may affect the nuclear safety and radiation safety of the installation during its operational lifetime and decommissioning, as well as the effects of the operation or decommissioning of the installation on the population and the environment and, in the case of a repository, the post-closure effects as well. In light of this, Focus concludes that the impact of the decommissioning of the facility must be included and assessed during the siting procedure.

Since an EIA has never been carried out for Krško NPP, and since the EIA for the lifetime extension is the first such assessment and the extension itself involves the termination of operations, Focus believes that the decommissioning of Krško NPP should also be included in the EIA pursuant to Article 2 of the Decree on the method of drafting and on the content of the report on the effects of planned activities affecting the environment, and that the "building construction, nuclear safety and environmental protection processes" as described give no legal basis for excluding decommissioning from assessment.

In relation to this comment, the ministry responds by saying that this case involves an already existing nuclear power plant whose period of operation is being changed. In an EIA Report, termination of an activity or the cessation of operation is defined as the cessation of the nuclear power plant's regular operation, meaning that:
- it no longer generates electricity;
- fuel is no longer in the reactor, but is stored safely in the spent fuel pool and/or in the spent fuel dry storage.

When the activity is being terminated, the process of decommissioning of the nuclear facility will not yet have begun, not will a study have been produced for the process.

In this period (of termination), it is still necessary to ensure nuclear materials are kept under control and to provide active cooling for the spent fuel in the pool.

The ministry goes on to explain that under point D Energy, D.II Nuclear energy, D.II.1 of Annex 1 of the Decree on activities affecting the environment for which an environmental impact assessment is mandatory, an environmental impact assessment is mandatory for nuclear power plants and other nuclear reactors, including their dismantling or removal.[13*] Footnote 13 states: "Nuclear power

stations and other nuclear reactors cease to be such installations when all nuclear fuel and other radioactively contaminated elements have been removed permanently from the installation site."
Similarly, Appendix I of the Convention on Environmental Impact Assessment in a Transboundary Context (Espoo) and the Act Ratifying the Amendment and the Second Amendment to the Convention on Environmental Impact Assessment in a Transboundary Context (MPCVO-A, Official Gazette of RS, Nos. 46/98 and 105/13) list the activities for which an environmental impact assessment is required. The list of activities in point 2b) of Appendix I includes nuclear power stations and other nuclear reactors, including the dismantling or decommissioning of such power stations or reactors (paragraph 2(b)).
Decommissioning of Krško NPP is not the subject of this administrative procedure. Nuclear power plants have certain specifics, and this case requires two parallel procedures to be carried out: An EIA will have to be carried out for decommissioning before decommissioning is permitted, which Krško NPP agrees with. A second EIA procedure will be carried out for the decommissioning of the facility pursuant to point D Energy, D.II Nuclear energy, D.II.1 of Annex 1 to the Decree.
The EIA for the decommissioning of Krško NPP will be carried out on the basis of the final Krško NPP Decommissioning Programme. The Krško NPP Decommissioning Programme is regularly updated for the purpose of introducing new international standards and accommodating the latest technology and available international experience. Once a final decision has been made on when Krško NPP ceases operation, the final Decommissioning Programme will be drawn up and will form the basis for the EIA.
According to the most recent edition of the Krško NPP Decommissioning Programme (source: 3rd Revision of the NPP Krško Decommissioning Programme, NIS Ingenieurgesellschaft mbH, document no. 4520 / CA / F 010640 5 / 7 June 2019), decommissioning will take place in two phases. In phase one, after Krško NPP ceases operating, the energy-producing part of the plant will be decommissioned so that radioactive material is removed from all facilities except for the dry storage. For most of the facilities and surfaces, this means that a state will be reached in which the requirements for nuclear facilities no longer apply (brown field). Only the dry storage and the structures, systems and components necessary for the operation of dry storage (power supply, security, temperature control, radiation and humidity monitoring, and fire protection) will remain in operation.
In phase two of the decommissioning, radioactive materials will be removed from dry storage. The dry storage building will be demolished, together with all other buildings at the Krško NPP site, resulting in the complete remediation of the site and the possibility of unlimited use (green field). Additionally, the 4th Revision of the NPP Krško Decommissioning Programme will assess the option of the fuel handling building (FHB) remaining available for the purpose of repairing multi-purpose containers after the other Krško NPP facilities have been decommissioned. The decommissioning activities will begin after the end of Krško NPP's operation in 2043 and will last until the spent fuel dry storage is fully decommissioned. The dry storage will operate until 2103 under the baseline scenario and until 2075 under the sensitivity case scenario.
In light of this and given the fact that an EIA of the decommissioning of Krško NPP must be carried out before the final cessation of operations at the plant, the ministry has laid down a measure in point II./1.20 of the operative part of this environmental protection consent requiring Krško NPP to draft a final Krško NPP Decommissioning Programme with an EIA Report for the decommissioning, and to start assessing the environmental impact no later than three years prior to the cessation of operations at the plant.

Regarding the observation that an assessment has never been produced at Krško NPP and that the EIA for the lifetime extension is the first such assessment, the ministry explains that Krško NPP commenced commercial operations in 1983, i.e. two years before the adoption of the first Council Directive of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment (85/337/EEC). However, a study titled "Environmental impact assessment for Krško NPP", SEPO, Jožef Štefan Institute, was nevertheless drafted prior to the permit being granted.

It also follows from ARSO and ministry records that the Krško NPP site has been the subject of an EIA and an environmental protection consent on three occasions: for the construction of the decontamination building (environmental protection consent to a single building permit, no. 35405-04/99, 26 March 1999); for the construction of the foundations with the installation of the GT3 reserve transformer (environmental protection consent to the single building permit no. 35405-81/00, 1 August 2000); and for the construction of the spent fuel dry storage (building permit no. 35105-25/2020/57, 23 December 2020).

4. Focus states that an assessment of the risk of major accidents should also set out the consequences of a nuclear accident. They point out that the EIA Report identifies the impact resulting from the risk of environmental and other accidents in Section 5.18 (p. 332) and the measures to avoid, reduce and offset significant adverse impacts resulting from the risk of environmental and other accidents in Section 7.1.1.7 (p. 416). Focus then makes reference to the third paragraph of Article 2 of the Decree on the method of drafting and on the content of the report on the effects of planned activities affecting the environment, which provides that the factors for which the impact of an activity is to be assessed include the likely impact resulting from the risk of major accidents involving hazardous substances, nuclear accidents and natural and other disasters, including those caused by climate change, where such risks are associated with the activity. Focus states that the impact is assessed as "not significant" (3) and that this means, according to the third paragraph of Article 2 of the Decree, that the impact is not significant on account of the mitigating measures that are implemented, and that the assessment is based on the high technical and administrative level of safety of Krško NPP operations as described in the report, according to which the "possibility of an accident has been reduced to the lowest possible level." They go on to say that the Environmental Protection Act defines an environmental accident as an "uncontrolled or unforeseen event which arises as a result of an activity affecting the environment and which has the immediate or delayed consequence of directly or indirectly endangering human life or health or the quality of the environment"; that every nuclear power plant must operate at a high level of safety, although an accident could still nevertheless occur because it is an uncontrolled or unforeseen event, i.e. not the controlled safe regular operation; and that the statement that the possibility of an accident has been reduced to the lowest possible level says nothing about the impact of a nuclear accident on the factors referred to in the second paragraph of Article 2. Focus believes that this should be defined so that the impact of the risk of a nuclear accident on the environment can be assessed. They add that after the Fukushima accident in 2011, which probably also involved "a minimal accident risk for the population, even in the event of sustained earthquakes", Japan shut down all its nuclear reactors. Germany will also shut down its reactors in 2022, and both Switzerland (2016) and Italy (2011) have rejected new reactors in referendums. They conclude that it is therefore difficult to evaluate a risk as having a non-significant impact without first presenting the impact of a possible nuclear accident.

   In relation to this comment, the ministry responds by saying that Section 5.18 of the EIA Report does address the risk of environmental and other accidents. The description shows that the risk of an accident at Krško NPP is extremely low. Sections 2.11 (Engineered safety features), 2.12 (Systems and components for preventing and mitigating the consequences of accidents) and 2.13 (Classification of power plant states), which describe their respective areas in detail, show why the risk is so low. Krško NPP operates pursuant to an operating licence (decision/approval to commence operations at Krško NPP, National Energy Inspectorate decision no. 31-04/83-5 of 6 February 1984, SNSA decision no. 39000-5/2006/17 of 13 October 2006 and decision no. 3570-8/2012/5 of 22 April 2013, and the Krško NPP Updated Safety Analysis Report (USAR)), which is directly related to the Krško NPP Safety Analysis Report and contains all the conditions and limits for ensuring that the plant operates safely. The Krško NPP Safety Analysis Report also addresses various emergency scenarios. In accordance with the requirements of Slovenian nuclear safety legislation, Krško NPP is under the permanent supervision of the SNSA. Compliance with and achievement of the outlined safety requirements in the nuclear industry is subject to established international and national monitoring procedures in the form of inspections and international assessment missions. Krško NPP is monitored on a regular basis by a large number of international missions; these focus on all aspects of operation, with greatest emphasis given to ensuring nuclear safety. Krško NPP has a valid open-ended operating licence, meaning it is technically capable of operating at least until 2043, subject to the condition that, in accordance with the applicable legislation, it performs a Periodic Safety Review every ten years and that review is approved by the SNSA. Krško NPP is obliged to ensure all aspects of the power plant's operational safety.

After the accident in Fukushima in March 2011, the European Commission carried out stress tests at all nuclear power plants in Europe. After the EU stress tests, Krško NPP was the only nuclear power plant in Europe for which no recommendations were issued. This placed it at the very top of European power plants. The results of the report show that Krško NPP is well-designed and constructed and that it demonstrates a high level of preparedness in relation to severe accidents because of the additional equipment available. Krško NPP carried out an in-depth analysis of beyond-design-basis accidents and drafted a Safety Upgrade Programme (SUP). The SUP has been approved by the SNSA and covers a number of improvements and additional systems for managing beyond-design-basis accidents. The implementation of the SUP means that Krško NPP is comparable, in terms of safety, with the newer types of nuclear power plants that are currently being built around the world. One of the major safety upgrades in progress is the construction of a spent fuel dry storage facility. The dry storage system allows spent fuel to be transferred into special canisters and storage casks that provide passive cooling and shielding against ionising radiation.

Sections 5.18 (Impacts of the risk of environmental accidents) and 5.18.1 (Operation) of the EIA Report state that Krško NPP plans and maintains preparedness for an emergency within the context of the national protection and relief plan and the principles of ensuring the nuclear safety of the power plant. Krško NPP is responsible for managing emergencies at the plant.

The steps taken to ensure preparedness and manage emergencies at the plant are set out in the Krško NPP Protection and Disaster Relief Plan (PDRP, Rev. 38). The PDRP and the protection plans (coordinated with local municipal and national protection and relief plans in the event of a nuclear or radiological accident) and the relief plans for a nuclear disaster drawn up by the municipalities of Krško and Brežice, the Posavje region and Slovenia as a whole represent an organisationally and functionally integrated system that ensures the coordinated management of emergencies at the power plant and in the environment, and between the power plant and the environment. Measures that will be implemented in the event of an emergency at the plant include operational-technical measures in the power plant's technological process, notification of the general public, professional and administrative institutions about an emergency, and the proposal of immediate protective measures for the population, if required, and radiological and other protective measures at the site of the plant.

Krško NPP, as it is now and after its operational lifetime is extended, is not classified as an installation with a higher or lower risk to the environment as defined in the Decree on the prevention of major accidents and the mitigation of their consequences (Official Gazette of RS, Nos. 22/16 and 44/22 [ZVO-2]). The EIA Report therefore does not deal with accident scenarios as required by the above-mentioned decree, but assesses normal operation and describes potential accident risks and accident prevention measures. The possibility of an emergency/accident is addressed in Section 6.4 of the EIA Report (Transboundary impacts in the event of an emergency/accident), which presents the results of the calculation of doses at certain distances for DB and BDB accidents ("Calculation of doses at certain distances for design-basis (DB) and beyond-design-basis (BDB) accidents at NPP Krško", no. FER-ZVNE/SA/DA-TR03/21-0), FER-MEIS, 2021) and of the monitoring in the event of an accident involving emissions into the atmosphere. The results of the study show that the 30-day effective dose for design-extension conditions (DEC-B) at a distance of 10 km from the power plant is 1.16 mSv, which is more than two times lower than the annual natural background dose in Slovenia (approx. 2.5 mSv). The thyroid dose (13.5 mSv) at a distance of 3 km from Krško NPP is below the limit (50 mSv for 7 days) prescribed by law for iodine prophylaxis (PDRP, Rev. 38). The reference level for action (sheltering, evacuation) in the event of an emergency is an effective dose of 100 mSv (Decree on limit doses, reference levels and radioactive contamination, Official Gazette of RS, No. 18/18, Article 27). Regardless of the calculated doses on the border of the 3 km area, which are

below the reference level for action, in the event of DBA or DEC-B accidents, the population would be preventively evacuated in compliance with the general hazard criteria (EIP-17.001, Emergency class determination, Rev. 6).
The ministry goes on to explain that it will not take a position on the comment regarding the state of nuclear reactors by country because it is not the subject of this administrative procedure.

5. Focus points out that the environmental protection consent for the extension of Krško NPP's operational lifetime may be granted for a maximum of ten years. They refer to the EIA Report, which states, on p. 36, that Krško NPP operates pursuant to an open-ended operating licence, subject to the condition that, in accordance with the applicable legislation, it performs a Periodic Safety Review every ten years and that review is approved by the SNSA. Section 2.14.4 (p. 112) goes on to state that, in 2012, the SNSA issued two decisions (nos. 3570-6/2009/28 and 3570-6/2009/32) that confirmed and approved the amendments to the Krško NPP Safety Analysis Report, which had previously limited the operational lifetime to 40 years, thereby making it possible for the lifetime to be extended by a further 20 years.
Focus points out that the system for granting licences for nuclear facilities is determined by the ZVISJV-1; that Krško NPP is required, under Article 20 of that act, to have a licence to perform radiation practices, as well as an operating licence under Article 109; and that both licences must specify their periods of validity (Article 137), which Article 138 limits to a maximum of ten years. They also point out that that article provides that a licence may be extended, and that the provisions set out for the granting of the licence shall be applied to any extension.
They also explain that the non-compliance of the operating licence with the ZVISJV-1 resulted from the fact that the ZVISJV was only adopted in 2002, while Krško NPP commenced operation in 1983. However, when adopting the act, which already regulated the concession system and its time limit, the legislator did not provide for any transitional provisions that would have required the Krško NPP concession to be aligned with the act. Since the EIA Report also shows that the operating licence for Krško NPP was amended by SNSA decision no. 3570-8/2012/5 of 22 April 2013, it is evident that the SNSA did not comply with the provisions of the ZVISJV at the time of this amendment either. Therefore, since the adoption of the ZVISJV, there has been a conflict between the actual situation and the regulatory framework, which is also an implicit inequality before the law and contradicts Article 7 of the Convention on Nuclear Safety and Council Directive 2009/71/Euratom of 25 June 2009 establishing a Community framework for the nuclear safety of nuclear installations, which requires the State Party/Member State to determine the licensing regime in the regulatory framework. The licensing system is in place, but the regulation of the subject-matter that the act is supposed to cover is not in the spirit of the above-mentioned international instruments, as the only nuclear power plant in the country is exempted from the requirements of the act.
It follows that both the open-ended operating licence for Krško NPP and the extension of the plant's operation by 20 years are contestable. Focus concludes, on this basis, that the ministry should therefore have determined that the operation of Krško NPP could only be extended by ten years, and adjusted the EIA procedure and the environmental protection consent accordingly.

In relation to this comment, the ministry responds by saying that the currently applicable environmental protection legislation does not lay down a requirement for the environmental protection consent for the lifetime extension of Krško NPP to be granted for a maximum of ten years; rather, it introduces the principle of comprehensiveness, meaning that the EIA must consider the lifetime extension to the fullest possible extent, i.e. 20 years.
The ministry goes on to explain that the open-ended operating licence for Krško NPP is not unconditional, but includes the necessary condition that a Periodic Safety Review (PSR) must be carried out every ten years and contain an action plan for implementation to ensure that all aspects of nuclear safety, including the review of the condition of the systems, structures and components with regard to aging processes, are at a level that ensures safe operation over the next ten-year period.

The period of operation of Krško NPP is subject to statutory regulation under the previous (ZVISJV) and current Ionising Radiation Protection and Nuclear Safety Act (ZVISJV-1), responsibility for the implementation of which lies with the SNSA. The operation of Krško NPP is limited in content, fact and law to a period of ten years, as the plant is required to undergo a PSR, which comprehensively assesses all aspects of nuclear and radiation safety as well as the environmental impact of the plant, every ten years. If the SNSA decides that the PSR has been successfully and positively conducted, Krško NPP will operate for the next ten years until the next PSR. This means that the Slovenian legislator has regulated all issues related to the operational lifetime of Krško NPP in the ZVISJV-1, which has been in force since 6 January 2018.

6. In relation to the Aging Management Programme (AMP), Focus refers to Section 2.16 (p. 114) of the EIA Report, which states: "On the basis of a series of studies and analyses, the SNSA confirmed, in decision no. 3570-6/2009/32 of 20 June 2012, that the state of the equipment at Krško NPP was adequate, despite aging, and that all safety margins and operating functions were guaranteed." Focus believes that the main problem is that this analysis is ten years old, which makes it outdated and irrelevant, particularly given that, more than a year after the decision was issued (8 October 2013), damage occurred to the nuclear fuel at the plant (source: Krško NPP (2013): "Remediation of the status of nuclear fuel at Krško NPP", https://www.nek.si/novice/novice/sanacija-stanja-na_jedrskem-gorivu-nek).
Focus goes on to say that in its 2013 annual report, the SNSA summarised developments as follows: "Public attention focused on the damage to the nuclear fuel, which turned out to be more extensive than expected during the outage in the autumn. The complex search for the causes and the remedial measures extended the outage by two weeks. A few days after the outage, the plant shut down again because an electronic component of the new system for measuring the primary water temperature was not working properly." (source: SNSA (2014): "2013 Expanded Report on ionising radiation protection and nuclear safety in the Republic of Slovenia", https://podatki.gov.si/dataset/741e8bc6-201b-4752-a723-5d8d20b0b3f7/resource/fdec91ba-867b-4e3c-8cea-c8275e0c179a/download/lp2013razsirjeno.pdf; p. ii).
Section 2.7.15 (p. 78) of the EIA Report further states: "All missions (including the 2017 OSART mission) and the SNSA review, along with the decision issued in the administrative procedure described above, have demonstrated the compliance of the Aging Management Programme with international recommendations and the Rules on the operational safety of radiation and nuclear facilities." Despite this, in the course of the Topical Peer Review (TPR) conducted in 2017 under Article 8e of Directive 2014/87/Euratom, the peer-review team criticised the scope of structures, systems and components covered by the AMP and identified areas for improvement: The scope of the AMP is not subject to regular review or updated in line with the new IAEA safety standards as required. The aging management of the reactor pressure vessel also shows deficits compared to the safety level expected for Europe by the EU nuclear regulators within ENSREG. Regarding the Non-Destructive Evaluation (NDE) of the reactor pressure vessel, the peer-review team criticised the fact that no comprehensive NDE was being conducted on the basic material at the level of the reactor core in order to determine whether there were any defects. The team also criticised the aging management of the hidden pipelines: the AMP did not routinely include reviews of safety-critical penetrations of pipes through concrete structures (source: ENSREG (2018) European Nuclear Safety Regulators Group: First Topical Peer Review "Ageing Management", Country-specific findings, October 2018, www.ensreg.eu/sites/default/files/attachments/hlg_p2018-37_161_1st_tpr_country_findings.pdf). In addition, the Slovenian Technical Review Report on the Krško NPP Ageing Management Program Final Report (source: SNSA, 2017, https://www.ensreg.eu/sites/default/files/attachments/slovenia.pdf), which was drafted by the SNSA in 2017, concluded that: "Beside that the Krško NPP has some remaining work to do, since not all technical implementing procedures deriving from ageing management programs have been implemented yet. During the implementation of the cable aging management program, the Krško NPP found some localized 'Hot Spots', where cable jacket showed the effects of thermal degradation. Nevertheless, the primary insulation was found to be in acceptable condition. The Krško NPP

concluded the first cycle of required aging management inspections for MV cables (started 2010) and initiated the second cycle, where the focus is on trending of the results from the first cycle. All activities in accordance with GALL [18] requirements will be concluded before transition to extended plant life time in 2023." (SNSA, 2017, p. 99). "On the other hand it is recognized that in some cases the Krško NPP should improve the coordination and overview of the work of external contracted organizations, since there has not always been enough time and resources to examine and supervise their work in detail." (SNSA, 2017, p. 100).

Focus states that this means that at the time this analysis was carried out in 2017, not all the necessary measures and procedures related to aging management had been implemented. As the EIA Report relies in its arguments on the above-mentioned 2017 report and on other studies carried out prior to this report (e.g. the SNSA decision of 2012), Focus considers that the results of more recent studies and analyses should be included in the EIA or, if certain procedures and measures have not yet been carried out, these should be carried out before the EIA Report is finally approved and the environmental protection consent is granted.

Focus points out that this is also related to the problematic statement in Section 2.7.15 of the EIA Report (p. 78): "Furthermore, the Krško NPP AMP will be reviewed and evaluated in 2021 as part of the IAEA pre-SALTO (Safety Aspects of Long Term Operation) mission. The pre-SALTO mission will carry out a thorough review of the AMPs and their implementation on the basis of IAEA standards and international best practice. The AMP will, however, be evaluated comprehensively and systematically as part of the third Periodic Safety Review (PSR3), in accordance with the programme approved by the SNSA in decision no. 3570-7/2020/22 of 23 December 2020." Focus states that this part of the report indicates that not all activities related to aging management, and therefore lifetime extension, have yet been carried out or, if they have been carried out, their results and conclusions have not been included in the preparation of the environmental impact analysis; and that the findings of the studies, if they have already been carried out, should be included in EIA. If they have not yet been carried out, they should be completed; only then should a proper EIA be carried out. Only after this analysis can an assessment of aging management, a new decision by the SNSA assessing the adequacy of aging at Krško NPP and the EIA be drawn up.

Regarding the results of the 2017 SNSA report referred to above, Focus states that the technical situation should be reviewed by independent experts, using real experience and aging data from comparable reactors. This applies in particular to core components such as the reactor pressure vessel and the primary circuit, which are not readily accessible during regular operation and whose aging may not be adequately represented in computer models.

In relation to this comment and after studying the developer's explanations ("Third Supplement to the Application for an Environmental Protection Consent for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years: presentation of evidence", no. ING.DOV-178.22, 6 May 2022, with four appendices), the ministry responds by saying that Krško NPP conducted an Aging Management Review (AMR) project in 2012 to organise processes to ensure that the systems, structures and components (SSCs) at the plant were able to perform their intended function for at least 60 years or that the regular review and maintenance processes did not lead to the failure of these intended functions. Krško NPP has updated or refreshed these analyses with the latest findings and requirements, in line with global best practice.

The damage to the nuclear fuel was not due to inadequate monitoring of SSC aging, nor has it changed the assumptions or analyses on the basis of which the AMR was carried out and the AMPs drawn up. Nuclear fuel is not part of aging programmes because it is replaced regularly and remains in the reactor for a maximum of three 18-month cycles (most nuclear fuel remains in the reactor for two 18-month cycles).

During the 2017 TPR, the peer-review team did not criticise the current practices of Krško NPP, but identified areas for in which processes could be improved. The developer has taken all these suggestions into account and has drawn up an action plan to implement the improvements relevant to the plant.

Krško NPP regularly updates its AMPs in accordance with internal document update processes. The programmes are updated using information from the US regulatory authorities, international recommendations such as those produced by the IAEA and WENRA, and other research on aging. The Krško NPP AMP is an ongoing activity that follows international experiences and developments in the field of aging of all equipment. No anomalies were found during the Topical Peer Review of aging management.

Krško NPP uses ASME SA 533, Grade B, Class 1, rolled plate, which is not susceptible to hydrogen flaking, as the base material for the reactor pressure vessel. This is also confirmed by the newly acquired WENRA document: "Updated Report Activities in WENRA countries following the Recommendation regarding flaw indications found in Belgian reactors" (November 2017). Krško NPP also attended a workshop organised by the Pressurized Water Reactors Owners Group (PWROG) at the initiative of the European nuclear power plants involved in the ENSREG TPR on selected sections of the AMP. Krško NPP presented in detail the inspection requirements for ultrasonic testing (UT) of the shell welds, the history of tank manufacture, the results of the inspections to date, and Krško NPP's proposed response to the areas identified for improvement. The presentation focused on the fact that the Krško NPP reactor pressure vessel shell is made of SA-533, which, unlike the forged rings of the SA-508 shell, is not susceptible to hydrogen flaking. The participants present confirmed that no hydrogen flaking had occurred in the SA-533.

Krško NPP inspected a number of buried pipelines and penetrations in existing buildings. For the other modifications, the existing pipelines were excavated, and inspected visually, ultrasonically and using the GWUT method. The results of the tests show that there were no significant aging mechanisms leading to deterioration. The condition of the pipelines was adequate, as shown by an independent study conducted by Technatom, which compared global and Krško NPP practice. Krško NPP carries out pipeline inspections at regular ten-year intervals.

Krško NPP's SSC AMP is ongoing and is constantly being improved and upgraded, thereby ensuring the highest level of nuclear safety. SNSA decision no. 3570-6/2009/32 of 20 June 2012 confirmed that the condition of equipment at Krško NPP was adequate despite aging, and that all necessary time-limited studies were appropriate. Since 2012, the AMP has been constantly updated and adapted to new scientific findings in the field of aging. Time-limited aging analyses (TLAA) ensure that all time constraints allow the SSCs to operate for 60 years.

In accordance with Slovenian legislation (ZVISJV-1), Krško NPP conducts Periodic Safety Reviews to demonstrate that its processes (including aging management) have been updated in line with global practice and ensure the highest level of nuclear safety.

The purpose of the international missions and the PSR is for external assessors to examine processes and suggest improvements. Improvements are proposed at every mission because the pursuit of excellence is constant and unwavering. The improvements resulting from the pre-SALTO mission are ongoing and are being monitored by the SNSA, which also issues the Krško NPP's operating licence. The third PSR is currently being prepared and will be completed in 2023. Preliminary results showed that there are no significant safety anomalies and no negative findings. The results of the PSR are reviewed and approved by the SNSA, and any changes and improvements resulting from the approved PSR report are verified.

The ministry further explains that the SNSA has given a positive opinion (no. 3570-13/2020/32, 9 March 2022) to the lifetime extension.

7. Focus believes that seismic safety has not been adequately addressed. They say that Krško NPP is the only nuclear power plant in Europe that operates in a seismically active zone, that the EIA Report accommodates the findings of a number of older studies, and that the following conclusion is drawn in Section 4.1.11 (Seismic hazard, p. 176) on the basis of the latest seismic hazard analysis of 2004 (PSHA 2004, horizontal PGA = 0.56 g): "This research, which has been carried out in the last ten years, has not confirmed the existence of such new faults or geological structures that could, in the event of an earthquake, permanently deform the surface of the location ('capable faults'), nor have there been any new findings that could significantly change the existing estimate of seismic hazard at the Krško NPP site [271] produced between 2002 and 2004 after ten years of previous research."

Focus considers these conclusions to be problematic because the PSHA 2014 study presented and used in the EIA Report has been questioned in several recent studies and publications. For example, the Peer Review Country Report: Stress tests performed on European nuclear power plants – Slovenia (source: ENSREG (2012) European Nuclear Safety Regulators Group: Peer Review Country Report – Stress Tests Performed on European Nuclear Power Plants – Slovenia, April 2012, www.ensreg.eu/sites/default/files/Country%20Report%20SI%20Final.pdf) finds as follows: In line with the requirements and standards of US nuclear regulation, a peak ground acceleration (PGA) of 0.3 g was set for a safe shutdown earthquake (SSE). New analyses of the seismic risk led to an increase in the assumed PGA to 0.42 g in 1994 and to 0.56 g in 2004, which is almost two times higher than the original assumptions (taken from ENSREG, 2012, pp. 7–9).

In relation to this comment and after studying the developer's explanations ("Third Supplement to the Application for an Environmental Protection Consent for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years: presentation of evidence", no. ING.DOV-178.22, 6 May 2022, with four appendices), the ministry responds by saying that the PGA values given by Focus are not comparable, as they may refer to different types of ground and different depths. The PGA of 0.3 g relates to the level of the foundations of the Krško NPP building, which are 20 m below the surface, while the PGA of 0.56 g (from the Probabilistic Seismic Hazard Analysis/PSHA of 2004) relates to the surface. PGA decreases with depth. Consequently, the claim that the PGA value from the PSHA from 2004 is almost twice that of the design PGA value is not accurate.

Krško NPP was designed to withstand earthquakes. The seismic design load of Krško NPP comprises the spectrum of accelerations in accordance with the American RG 1.60 guidance, scaled to a PGA of 0.3 g at the depth of the foundations (approx. 20 m below the surface). As the PGA during an earthquake decreases with depth, the design peak acceleration at the depth of the foundations cannot be directly compared with the PGA at surface derived from the PSHA. In order to compare the seismic design load of Krško NPP with the seismic load from the PSHA, the uniform hazard spectrum at surface must be transformed to the level of the foundations. That comparison shows that the spectral acceleration for a frequency of 3.33 Hz from the uniform hazard spectrum (PSHA, 2004) is approx. 12% lower than the corresponding value of the design spectral acceleration for 5% attenuation. On the basis of the spectral accelerations, which are more directly connected to the seismic forces than the PGA, it has been estimated that the original seismic forces taken into account when Krško NPP was being designed are roughly comparable to the seismic forces on the facility resulting from an earthquake with a PGA of 0.6 g on the open surface, which roughly corresponds to a PGA with a recurrence interval of 10,000 years (PSHA, 2004). The favourable impact of the interaction between the Krško NPP structure and the ground (which scatters a significant amount of the energy) was also taken into account in this transformation. The calculations from 2013 also showed that the floor spectral accelerations resulting from an earthquake with a PGA of 0.6 g at surface were roughly equal to or less than the original acceleration values for equipment with their own frequencies of between 4 and 16 Hz, which covers a wide range of engineered safety features and equipment at Krško NPP.

We found no indication in the EIA Report that the seismic hazard analysis of 2014 had been questioned in several recent studies and publications. Field research also continued after 2004 and has been at its most intensive in the last decade. A project to update the PSHA for the immediate vicinity of Krško NPP is currently under way. As part of this project, a new non-ergodic ground-motion model was developed for the location of the second nuclear power plant block at Krško in 2021. The new non-ergodic ground-motion model takes into account the local characteristics of earthquakes on the basis of the ground-motion measurements that have been provided by ARSO for more than 20 years. This has a positive impact on the results of the PSHA. It has been shown, for the immediate vicinity of Krško NPP, that the PGA and spectral acceleration at higher frequencies and for long recurrence intervals decrease relative to the values determined using the conventional ground-motion model. The references in Section 4.1.11 (Seismic hazard, p. 176) of the EIA Report, which are the subject of Focus's question, do not refer to the period after 2004. It is becoming apparent that the preliminary results show that no new faults or geological structures have been confirmed in the last ten years that could permanently deform the surface of the site in the event of an earthquake ("capable faults"), and that there are no new findings that would significantly change the existing seismic hazard analysis of the Krško NPP site from 2004. Nevertheless, GEN conducted a ground-motion hazard study in 2013 that showed that there was no risk of large permanent ground displacements, while the risk of very small permanent ground displacements was negligible (recurrence interval of more than one million years).

8. Focus further points out that the ENSREG report also mentions that seismic events with a PGA greater than 0.8 g are classified as very rare in the Krško area, with a recurrence interval of 50,000 years or more; that earthquakes with a PGA of 0.8 g or more present a risk to the reactor core (mechanical damage could affect the geometry of the reactor core and therefore the retraction of the control rods); that core meltdown cannot be ruled out in such a case; that in this seismic acceleration zone, the containment spray system and the low-pressure emergency cooling system would not be available; and that releases of radioactive material resulting from damage to the reactor core could not be ruled out.

   In relation to this comment and after studying the developer's explanations ("Third Supplement to the Application for an Environmental Protection Consent for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years: presentation of evidence", no. ING.DOV-178.22, 6 May 2022, with four appendices), the ministry responds by saying that a distinction has to be drawn between a design earthquake and an actual earthquake. A design earthquake is not determined by PGA alone but also by the default elastic spectrum of accelerations, which is smooth and has high spectral accelerations at a wider interval of frequencies. This generally does not occur during a single actual earthquake. This means that spectral accelerations in the event of an earthquake with a PGA of 0.8 g will very probably be lower within a wider interval of frequencies than those considered in the Krško NPP seismic hazard analysis. In an actual earthquake with a PGA of 0.8 g, the seismic load in terms of spectral accelerations for a wider spectrum of frequencies is very likely to be lower than the seismic load that was considered in the analysis of the safety margins. In addition, there are design factors that increase capacity in relation to the PGA. The seismic capacities given in the ENSREG report are represented by the HCLPF PGA values ("high confidence low probability of failure PGA"). The capacities expressed in this way represent the ground accelerations at surface for which there is a certain minimum probability of the selected adverse event occurring. In order to understand what would happen in the event of an earthquake with a PGA of 0.8 g, it is therefore important to know that even with such a powerful earthquake, the probability that the adverse events described above would not occur is very high.

   The seismic capacities in terms of the HCLPF PGA values mentioned in the ENSREG report do not take into account the positive impact on seismic and nuclear safety of the additional engineered safety features installed at Krško NPP over the last ten years as a result of the SUP. The upgrades covered the construction of new flood-protection systems, the reliability of electricity supply, the cooling of the reactor, the containment and the spent fuel pool, alternative control and plant management systems, and the construction of spent fuel dry storage (currently under construction). These systems have been designed to withstand very powerful earthquakes. The maximum design acceleration was 0.6 g for systems on the main island and 0.78 g for new systems away from the main island. For the construction of the new bunkered building, the operational support centre and the spent fuel dry storage, the safety acceptance criterion in the seismic vulnerability analysis was also determined by the HCLPF PGA.

   The impacts of various earthquakes and the adverse events associated with them are taken into account when the core damage frequency (CDF) is being determined. For Krško NPP, this is estimated with respect to the value acceptable under Slovenian law. Krško NPP's seismic safety is therefore adequate.

9. Focus points out that a new seismic analysis of the location was required as part of the planning of the second reactor (Krško-2) at the same location; that the SNSA formulated questions on the

possible effects of the Libna tectonic fault and requested an updated seismic hazard analysis for the existing Krško NPP reactor; and that the French Institut de Radioprotection et de Sûreté Nucléaire (IRSN) sent an open letter on 9 January 2013 calling on GEN energija, d.o.o. and the SNSA to provide further clarifications: IRSN suggested that GEN energija d.o.o. collect sufficient local data for a study on the impact of the Libna tectonic fault to minimise the uncertainties identified.
A study by Slovenian experts emphasises that the results of the load test report, such as the effects of a PGA greater than 0.8 g, should be evaluated in the light of the known expected accelerations resulting from an earthquake of moderate magnitude and with reference to the seismotectonic conditions in the area. The study concludes that the SNSA statement that "the frequency of recurrence of seismic events with a PGA greater than 0.8 g is considered to be more than 50,000 years" is not consistent with the revised PSHA and the Seismic Probabilistic Safety Assessment (SPSA) (source: L. Sirovič, P. Suhadolc, G. Costa and F. Pettenati (2014): "A review of the seismotectonics and some considerations on the seismic hazard of the Krško NPP area (SE Slovenia)". Bollettino di Geofisica Teorica ed Applicata Vol. 55, No. 1, pp. 175–195; March 2014).

In relation to this comment and after studying the developer's explanations ("Third Supplement to the Application for an Environmental Protection Consent for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years: presentation of evidence", no. ING.DOV-178.22, 6 May 2022, with four appendices), the ministry responds by saying that all the PSHAs performed so far for Krško NPP have considered the impacts of active faults in the wider surroundings of the plant. The new project to update the PSHA, which is under way and is being financed by GEN for purposes other than this procedure (at the time of writing, the final result is still not known), considers 12 active seismic source lines and several planar seismic sources, followed by four mutually independent seismic source models. It is assumed that the epicentre of a powerful earthquake could appear anywhere within a wider radius of Krško NPP. The new PSHA, which is being drawn up, examines the potential for an earthquake to be caused by the Libna fault. The new study also developed a new non-ergodic ground-motion model for the area surrounding Krško NPP that takes into account local seismic features based on ground-motion measurements that have been carried out by the Slovenian Environment Agency (ARSO) for more than 20 years.
Regarding the issue of the Libna fault, the IRSN issued a separate interpretation at the beginning of 2013 that contradicted the interpretations of the other partners (BRGM, GEOZS, ZAG) of the consortium that carried out the first phase of the project to update the PSHA for the immediate vicinity of Krško NPP. Based on the preliminary results produced up to that point, the consortium found that the Libna fault could not, without further evidence, be defined with any certainty as a seismic source that could lead to permanent ground displacement on the surface of the current or future location of Krško NPP. The results of the PSHA for ground displacement, which considered 11 faults, including the Libna fault, showed that there was no danger of major permanent ground displacement, while the danger of very minor permanent ground displacement was negligibly low. The seismic analysis also showed that Krško NPP's structures and systems could withstand significantly greater ground displacement than followed from the Probabilistic Fault Displacement Hazard Analysis for a recurrence interval of 10 million years (Krško NPP, 2013).
According to the PSHA from 2004, the median recurrence interval for seismic events with a PGA greater than 0.8 g is estimated to be around 50,000 years. An updated PSHA is currently being drafted. Based on the preliminary results of this study, no significant changes in the results are expected in relation to the currently valid PSHA from 2004.

10. Focus points out that, despite this, Krško NPP currently only meets the requirements of the original design basis of a maximum design acceleration (PGA) of 0.3 g. Only the additional systems, structures and components implemented under the SUP have been designed and implemented under the design-extension conditions (DEC) specific to this reactor design and site. DEC systems, structures and components will be installed in two newly built bunkered buildings.
It also follows from the comment that the PGA value in DEC is 0.6 g; that this value provides for almost no safety margin (a mere 0.04 g) in comparison with the SSE value currently set (0.56 g); that

the updated PSHA in this area is not mentioned in the EIA Report; that the most recent PSHA was produced in 2004; and that the fact that seismic hazard at the Krško site is considerably greater than the original design basis of the plant (0.3 g) presents a major problem.
Focus also says that even if all the planned measures had been carried out, the plant's resilience would, in its opinion, remain problematic; that the maximum possible earthquake magnitude has still not been sufficiently explained; that the increase in the seismic hazard analysis values has not led to a change to the design basis; that instead of a change to the design basis, additional systems installed in the course of the SUP have only been designed with an updated PGA of 0.6 g in mind; and that the seismic safety margins are very low, even though the likely consequences of a powerful earthquake are known.

In relation to this comment and after studying the developer's explanations ("Third Supplement to the Application for an Environmental Protection Consent for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years: presentation of evidence", no. ING.DOV-178.22, 6 May 2022, with four appendices), the ministry responds by saying that, as has already been explained, the PGA values are not always mutually comparable, as they can relate to different types of ground and different depths. Moreover, they can also relate to actual or to design earthquakes. On the basis of the spectral accelerations, which are more directly connected to the seismic forces than the PGA, it has been estimated that the original seismic forces taken into account when Krško NPP was being designed are roughly comparable to the seismic forces on the facility resulting from a design earthquake with a PGA of 0.6 g on the open surface, which roughly corresponds to a PGA with a recurrence interval of 10,000 years (PSHA, 2004). In the planning of the new facilities, which are away from the main nuclear island, the design PGA was increased by 30% regardless of the fact that the preliminary results of the seismic hazard analysis, taking into account the new non-ergodic ground-motion model, show that no significant changes are expected from the PSHA from 2004.
Focus's claim that the safety margin is a mere 0.04 g is misleading, and it is a misunderstanding to think that a sufficiently high PGA is the only factor that ensures seismic safety. Seismic safety is also ensured by an appropriate spectral acceleration and by other appropriate safety or design factors within the earthquake-resistant design standards that are taken into account during the design process itself and that increase capacity in PGA terms relative to the design PGA value.
It is not true to say that the maximum possible magnitude is not sufficiently explained. In the PSHA, the magnitudes are determined in relation to the characteristics of the individual seismic sources and incorporated into the PSHA for the Krško NPP site (PSHA 2004). The new hazard analysis, which is in the final stages of completion, also considers three branches of the logic tree for the maximum magnitude values for each individual seismic source; this ensures that the uncertainty involved in determining the maximum magnitudes is taken into account.
The impacts of various earthquakes and the adverse events associated with them are taken into account when the core damage frequency (CDF) is being determined; for Krško NPP, this is estimated with respect to the value acceptable under Slovenian law. It therefore follows that the seismic safety of Krško NPP is adequate. If PSR3 indicates that some other measure is required in addition to the measures currently in place, that other measure can be set down in the SNSA's PSR.
It is possible to conclude, on the basis of all the evidence submitted, that considerable investments have been made in the safety upgrade process, that this process is carried out on a regular basis and throughout operations, and that it is updated every ten years.
In response to the comment, the ministry has added the measure set out in point 18 of the operative part.

11. Focus states that as Krško NPP has only one water supply source, an additional, earthquake-resistant main cooling source was planned independently of the Sava (ultimate heat sink, UHS). As the stress-test report states: "The Krško NPP does not have an alternative ultimate heat sink. The installation of a new water line from the Krško HPP was mentioned in the report, but this project was abandoned. Rather, the construction of a seismically-qualified cooling tower has been proposed as an alternative to the UHS" (source: ENSREG (2012) European Nuclear Safety Regulators Group:

Peer Review Country Report – Stress Tests Performed on European Nuclear Power Plants – Slovenia, April 2012, p. 21).
However, in line with the 2019 update of the national action plan, the planned installation of an additional cooling source (UHS) has been abandoned. Therefore, only additional cooling using a steam generator cooling system has been introduced: To ensure cooling of the reactor core in the event of a power failure and/or failure of the main cooling source (UHS), an additional high-pressure pump to supply the steam generators was planned for 2015, to be installed in a separate bunker with its own water supply. In addition, the design value of the bunkered building complies with DEC requirements, which do not provide for sufficient safety margins. For all these reasons, Focus considers it necessary to carry out an updated international study on seismic risk and to take the results into account in the EIA Report.

In relation to this comment and after studying the developer's explanations ("Third Supplement to the Application for an Environmental Protection Consent for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years: presentation of evidence", no. ING.DOV-178.22, 6 May 2022, with four appendices), the ministry responds by saying that BB2 (Bunkered Building 2, a reinforced safety structure) is designed to accommodate an alternative safety injection (ASI) system, an alternative auxiliary feedwater (AAF) system and safety power supply to the building. The AUHS is ensured by the construction of BB2 and the installation of the ASI and AAF systems.
The BB2 facilities and systems from the SUP, which were built away from the foundations of the main Krško NPP island, were designed for a PGA of 0.78 g at the level of the foundations. During the construction of the new facility, the safety acceptance criterion with regard to the analysis of seismic vulnerability was also determined using the HCLPF PGA. As has been pointed out on several occasions, additional safety factors are used when designing nuclear facilities so that the likelihood of component failure (including in BB2) is approx. one or two orders of magnitude lower than the likelihood of the occurrence of the design ground acceleration. It should also be pointed out that the design PGA for BB2 and its systems exceeds the value corresponding to the recurrence interval of 10,000 years set out in the PSHA from 2004. According to the preliminary results of the updated PSHA study, which is currently being prepared, the new value of a recurrence interval of 10,000 years is also lower than the design acceleration taken into consideration for BB2.

12. Focus states that the final disposal of high-level radioactive waste from Krško NPP remains completely unresolved even 40 years after the plant was put into operation; that according to Section 4.4.11.3 (p. 258) a total of 1,553 spent fuel elements containing highly radioactive isotopes will have been produced by the end of the regular operational lifetime of the plant in 2023, a figure that rises to 2,281 spent fuel elements if the operational lifetime of the plant is extended by 20 years; and that p. 259 contains the following: "The decision to extend the operational lifetime of Krško NPP from 40 to 60 years, i.e. until 2043, was made alongside the owners' decision on the joint implementation of spent fuel disposal. There are plans to build a joint deep geological repository in the territory of Slovenia or Croatia." It also follows from the comment that Section 6.3.5 (p. 342) states that there is no concrete plan for the final disposal of high-level radioactive waste: "The exact location of the final disposal is not known at the time of writing". The completion of the spent fuel dry storage by 2023 has been delayed and the facility is not being used for the complete transfer of the 1,323 fuel elements (end of 2020), although even the EIA Report clearly admits that continued storage in the wet storage facility is risky (Section 2.7.12, p. 76): "Next to the reactor core, the spent fuel pool at Krško NPP is the most significant potential source of radiological threat to the surrounding area in the event of a nuclear accident."

    In relation to this comment, the ministry responds by saying that neither the spent fuel dry storage nor the timetable for its completion are the subject of this administrative procedure. An EIA was carried out for spent fuel dry storage and building permit no. 35105-25/2020/57 of 23 December 2020 granted for the facility by the Ministry of the Environment and Spatial Planning, Spatial Planning, Construction and Housing Directorate, Dunajska c. 48, 1000 Ljubljana.

It follows from the EIA Report and the explanations provided by Krško NPP that spent fuel to be produced during the lifetime extension will, just like the other spent fuel already present at the Krško NPP site, be safely stored in spent fuel dry storage or partly in the spent fuel pool. Spent fuel dry storage is passive and safe spent fuel storage, and additional safety improvements in the spent fuel pool area have increased the level of nuclear safety and significantly reduced all risks associated with storage.

Dry storage is a new, technologically safer way of storing spent fuel, and one that will gradually reduce the number of spent fuel elements in the pool and increase nuclear safety.

Krško NPP's spent fuel pool and the reactor core are the major potential sources of radiological hazard to the surrounding environment in the event of a nuclear accident. The spent fuel storage strategy has been changed in response to the latest events and findings from the Fukushima accident, and to the revised Resolution on the National Programme for Radioactive Waste and Spent Fuel Management 2016–2025.

Although the final location of the permanent disposal of spent fuel, for which an EIA procedure will also have to be carried out, is not the subject of this administrative procedure, the ministry agrees with the observation that efforts must be made to secure the location for the long term.

13. Focus makes reference to the IAEA guidelines "Safe and Effective Nuclear Power Plant Life Cycle Management Towards Decommissioning" (IAEA, 2002, p. 16), which state that longer-term decisions affecting waste storage taken to address safety requirements and limit costs at the end of electricity generation, should not be taken if information is not available regarding the disposal facility. Focus quotes Article 121 of the Ionising Radiation Protection and Nuclear Safety Act (ZVISJV-1). The National Programme for Radioactive Waste and Spent Nuclear Fuel Management 2016–2025 similarly provides: "RW and SF should be managed in a way that does not transfer the burden to future generations."

    In light of this, Focus believes that a precise plan for the permanent disposal of high-level radioactive waste must be submitted before the lifetime extension of Krško nuclear power plant is approved; that the plan should not merely contain a siting and public participation plan, but a financial plan as well, as provided in Directive 2011/70; and that the funds currently available, amounting to EUR 0.2 billion, are very far from the amount required (repository costs in Finland are EUR 5 billion, for example), for which reason a decision should be taken to increase the levies paid into the Slovenian nuclear waste fund.

    The ministry acknowledges that this comment contains an important question, and one that will be addressed in the future National Programme for Radioactive Waste and Spent Nuclear Fuel Management; that the final location of the permanent disposal of spent fuel is not known during at the time of writing; that the programme has not been drafted; that a repository that will store spent fuel temporarily for 100 years is under construction; and that the final repository is not the subject of this administrative procedure. Consequently, the ministry cannot take this comment into account as to do so would, among other things, mean that Krško NPP would not satisfy the environmental protection requirements for further operation, which could have environmental consequences.

14. Seismic hazard and the proximity of a tectonic fault that could be active

14.1. Earthquake: in the opinion of the Association of Ecological Movements of Slovenia (Zveza ekoloških gibanj Slovenije, ZEG), Cesta Krških žrtev 53, 8270 Krško (a third-party participant), the new findings on seismic hazard cannot be overlooked. ZEG points out that there is a seismic risk at the current and planned future nuclear power plant. The French IRSN, a world-renowned organisation in the field of nuclear safety, wrote, after careful review, that the location in Krško was not suitable for the construction of a second power plant unit as one of the tectonic faults in this area should be regarded as active. ZEG points out that this warning, which was accidentally released to the public, was withdrawn and that there is effectively no longer any seismic hazard. The fact is that the existing nuclear power plant should be closed immediately if the location is not suitable even for a newer, safer plant. ZEG states that the danger of an earthquake is real; that Krško NPP is, regardless of how some try to reject the facts and recklessly talk about the safety of the plant, the most earthquake-prone plant in Europe; and that the decision to select this location in Slovenia was a purely political one, and that it has been unsuitable and highly dangerous from the very beginning as it did not take account of seismic safety. Therefore, in ZEG's opinion, it is irresponsible to extend the lifetime of this ageing power plant when there is also an elevated risk from its increased susceptibility to damage and breakage, and still more irresponsible to construct a radioactive waste storage facility. ZEG goes on to say that the plant could also be threatened indirectly by an earthquake of greater magnitude; that there is also a likelihood of accident resulting from an earthquake because of the risk of the chain breakage of nuclear fuel rods in the reactor; and that seven broken nuclear fuel rods were found on the floor of the reactor when the plant was shut down during normal operation in 2013. These had supposedly been broken by the increased flow rate of primary water, which transfers heat to the secondary side from the core with fuel rods via the interior wall. According to ZEG, an improvised solution has been used to eliminate the possibility of fuel roads breaking again, with full steel rods being installed at critical points in place of fuel rods.

In relation to this comment and after studying the developer's explanations ("Third supplement to the application for an environmental protection consent for the extension of Krško NPP's operational lifetime from 40 to 60 years: presentation of evidence", no. ING.DOV-178.22, 6 May 2022, with four appendices), the ministry responds as follows:
regarding the claim that the decision to select the Krško NPP location in Slovenia was a purely political one, the minister replies that the plant was designed to withstand extreme external impacts and earthquakes. The seismic design load of Krško NPP comprises the spectrum of accelerations in accordance with the American RG 1.60 guidance, scaled to a PGA of 0.3 g at the depth of the foundations (approx. 20 m below the surface). On the basis of the spectral accelerations, which are more directly connected to the design seismic forces than the PGA, it has been estimated that the original seismic forces taken into account when Krško NPP was being designed are roughly comparable to the seismic forces on the facility resulting from a design earthquake with a PGA of 0.6 g on the open surface, which roughly corresponds to a PGA with a recurrence interval of 10,000 years (PSHA, 2004).
It follows from Krško NPP's clarifications that a project to update the PSHA in the vicinity of the plant is currently under way. As part of this project, a new non-ergodic ground-motion model has been developed for the vicinity of Krško NPP. This new model takes into account the local characteristics of earthquakes on the basis of the ground-motion measurements that have been provided by ARSO for more than 20 years. It has a positive impact on the results of the PSHA. It has been shown, for the immediate vicinity of Krško NPP, that the PGA and spectral accelerations at higher frequencies and for long recurrence intervals decrease relative to the values determined using the conventional ground-motion model.
A preliminary seismic hazard analysis, which is currently being prepared, is examining 12 seismic source lines within a radius of 200 km of the plant. In addition to seismic source lines, it is also considering planar seismic sources. The occurrence of a powerful earthquake with an epicentre at or near the nuclear facility is included, with the appropriate weighting, in the safety review. This is despite the fact that no active seismic source lines have been identified at the Krško NPP site.
The response to the IRSN's opinion that the location at Krško is not suitable for the construction of another power plant unit is given in point 9.
The likelihood of a fault in the operation of Krško NPP's systems and components is approximately one or two orders of magnitude lower than the likelihood of the occurrence of the design ground acceleration. Krško NPP has made additional investments in safety upgrades in the last ten years.
To ensure seismic safety and prevent accidents, mechanisms for monitoring the aging of buildings and systems in line with the requirements of the design bases of the plant and for the continuous monitoring of operations are available. A procedure has been introduced that requires measures to be taken and controls carried out on engineered safety features in the event of an earthquake with a very low measured PGA at surface (e.g. in the event of the gravitational acceleration being exceeded by one per cent).

Regarding repair to the damaged fuel elements in 2013, Krško NPP explains that the repairs it carried out with the fuel supplier (Westinghouse) were in line with best global practice. The fuel elements that were damaged by cross-flows in the reactor were therefore reconstructed in 2013. During the next outage in 2015, Krško NPP carried out a modification on the reactor structures (upflow conversion) that eliminated the cross-flows in the reactor and definitively removed the cause of the damage from 2013. All these repairs were based on the highest standards of the engineering profession and on the considerable store of operating experience from around the world.

14.2. Radioactive waste repository below the level of the groundwater

ZEG says that Slovenian nuclear experts and the SNSA should be alarmed by the separate reports drawn up by two IAEA experts who evaluated the Vrbina LILW repository project (Municipality of Krško) in January 2011, a repository that has still not yet been built. The two experts, Robert Chaplow and Jaroslav Pacovsky, gave a very negative assessment of the project: "The geological conditions of the selected site [repository] were found to be generally unfavourable … The worst finding, however, was that the ground water level is a mere 3 m below ground level, meaning that the construction and operation of the repository will take place below ground water level which clearly does not comply with IAEA requirements for the safe design of a waste repository".[1] ZEG points out that while this report is nowhere to be found on the IAEA website, it does appear in printed form. They go on to say that all of the above applies not only to the as-yet-unbuilt but urgently required repository, but also (and to an ever greater extent) to the existing nuclear power plant itself and to the fantastical idea of a second plant that can only be built on this site (against the will of the Slovenian population as expressed in a referendum); that it would not work anywhere else; that the Slovenian Environment Agency [ARSO], which is faced with the exacting task of deciding, in accordance with a court decision, whether an environmental impact assessment needs to be produced for the extension of Krško NPP's operating licence after the end of its operational lifetime in two years' time, should also take an interest in all of this; and that ARSO would find it difficult to decide otherwise than that an EIA is indeed necessary.

Regarding the comment relating to the low- and intermediate-level waste repository at Vrbina in the Municipality of Krško, the ministry explains that this repository is not the subject of this administrative procedure. A separate administrative EIA procedure has been carried out for the LILW repository at Vrbina. It ended with the granting by ARSO of environmental protection consent no. 35402-29/2017-169 of 30 June 2021 and decision no. 35402-29/2017-172 of 5 July 2021 supplementing the environmental protection consent to the developer, i.e. the Slovenian government, Gregorčičeva 20, 1000 Ljubljana, represented by ARAO, Ljubljana, Litostrojska cesta 58A, 1000 Ljubljana. The repository will be the site at which LILW produced at Krško NPP during its operation and subsequent decommissioning, as well as radioactive waste produced by medicine, research activities and industry in Slovenia, is deposited. The ministry further explains that the issue of any second nuclear power plant is not the subject of this administrative procedure.

In relation to the claim that ARSO is required to decide whether an EIA needs to be produced for the extension of Krško NPP's operating licence after the end of its operational lifetime in two years' time, the ministry explains that ARSO issued decision no. 35405-286/2016-42 on 2 October 2020, which stated that an EIA had be produced and an environmental protection consent obtained for the proposed activity ("Extension of Krško NPP's Operational Lifetime From 40 to 60 Years, to 2043"). Following that decision, the developer submitted an application to the ministry for the activity that is the subject of this administrative procedure.

14.3. Nuclear waste (LILW, HLW)

ZEG states that at a meeting between NGOs and the SNSA (2019 regular annual meeting, SNSA: NGOs), Director Igor Sirc said, in response to its question regarding the capacity of the temporary nuclear fuel storage facility, that: "The pool is almost full. Although it's not yet full, the time is approaching when it will be. The storage facility timetable is undergoing transboundary assessment and public consultation, strategic document, a comprehensive EIA, some procedures will be carried out prior to construction and operation, SNSA is participating. If the fuel coming from the reactor cannot be safely stored, safety problems will arise.” ZEG says that the SNSA director warned that problems would arise in relation to nuclear safety after 2021; they wonder whether we should be concerned about this; and they point out that in 1964, when the nuclear power plant was being planned, the regulatory authorities expected that the issue of nuclear waste storage would be resolved during the period of the plant’s operation; that the construction of nuclear waste repositories brings costs that demolish profits; that the nuclear profession offers unique energy solutions, but is, at the same time, unable to take care of its own waste; that the scenarios advanced by advocates of nuclear energy are transparent (i.e. others elsewhere should take care of and pay for waste generated by Krško NPP); that storing LILW, HLW and spent fuel is not cheap; that while we have a Fund for Financing the Decommissioning of Krško NPP, the money collected is not sufficient for the construction of the LILW storage facility, let alone for the storage of HLW and spent fuel; and that extending the plant’s operational lifetime would increase its cost-effectiveness and defer the requirement to construct storage facilities for quite a number of years. However, this would not resolve the problems; on the contrary, it would increase them and simply postpone them to a later date. ZEG goes on to say that nuclear waste is formally regulated; that the required Resolution on the National Programme for Radioactive Waste and Spent Nuclear Fuel Management 2006–2015 (Official Gazette of RS, No. 15/06), which provided that an operating licence had to be obtained for the LILW repository by 2013 at the latest, had been adopted; that we are already in 2022 and there is no repository (and, given the envisaged length of the construction process, it will not be ready for at least three years and allowances have already been made and agreed); that Krško NPP is nevertheless planning to remain in operation for 20 years, thereby increasing the nuclear waste burden; that nuclear lobbyists claim that nuclear waste is a valuable, priceless legacy to posterity, and that this claim is entirely contrary to the definition of waste and to nuclear terminology; that even if spent nuclear fuel were at some point to become suitable for use in breeder nuclear reactors, it still needs to be placed in an HLW storage facility until then, although we still do not have that facility; that the best waste is the waste that is not generated; that Member States must decide whether they wish to generate nuclear energy; and that that decision must be made by all citizens in a referendum. ZEG wonders whether a fair referendum is possible, and go on to say that the nuclear industry has already spent a great deal of money on shaping public opinion; that it has admitted that the figure is EUR 20 million, and indirectly even more; that nuclear energy and fossil fuels are deepening the financial, economic, social, political and environmental crisis; and that hydropower, solar energy, wind power, biomass and geothermal energy are all cheaper and more environmentally friendly than nuclear energy.

In relation to these comments, the ministry points out that every producer of radioactive waste and spent fuel is, under the applicable nuclear and radiation safety legislation, required to have a radioactive waste and spent fuel management programme in place. Implementation of the programme ensures that nuclear and radiation safety and minimal environmental impact are ensured at every stage. Krško NPP also has a management programme in place that is renewed and updated at least every two years in response to a technical report. There is sufficient space for spent fuel in the spent fuel pool until the end of Krško NPP’s original operational lifetime, i.e. until the end of 2023. The comments relating to the referendum, the spending of money on shaping public opinion, the deepening of the financial, economic, social, political and environmental crisis caused by nuclear energy and fossil fuels, and the electricity generated by hydropower, solar, power, wind power, biomass and geothermal energy being cheaper and more environmentally friendly than nuclear energy are not the subject of this administrative procedure. The ministry therefore takes no position on these comments.

14.4. Construction of silo in the groundwater

ZEG says that they publicly warned the government, line ministries, competent authorities, the Municipality of Krško and the media back in 2009 and 2010 about the same professional dilemmas that were pointed out by the two IAEA experts. They say that during the public consultation on the

comprehensive assessment of the LILW repository location in the Municipality of Krško, they warned of the possible consequences of building an underground repository and the possibility of problems arising in relation to groundwater (Sava), ionising radiation, inadequate technical burial solutions, the number and size of the silos, etc. ZEG remains wedded to the French solution of constructing above-ground LILW repositories, and points out that they sent their own expert groundwork for an above-ground repository to the Ministry of the Environment and Spatial Planning, ARAO, the SNSA and ARSO back in 2009/2010. They draw particular attention to the unacceptability of constructing wells for the storage of LILW in the groundwater in the Krško Polje area, and further point out that the speed of the groundwater shortens the lifespan of the concrete of the wells considerably, most likely to below the envisaged 300 years. In ZEG's opinion, the location at Vrbina is therefore completely unsuitable and will require (1) continuous monitoring of the radioactive contamination of the groundwater for the entire lifespan of the repository and (2) the removal of the repository and its transfer to a geologically more solid and impermeable environment, which cannot be found, in such a permanent form, anywhere on Earth.
They go on to say that the lack of a definition of LILW is a particular problem and that contractors often mix/smuggle HLW into it without knowing where to deposit it, and that there is in fact nowhere it can be deposited safely; that waste will in any case present a danger to all forms of life in the vicinity, and even more so in the distant future; that the reality is that radioactive waste labelled as LILW is actually LILW *and* HLW and that this term merely hides the fact that all emissions of radioactive material and radiation are from nuclear fuel emissions and from radioactive construction and other technical waste that cannot be regarded as nuclear fuel; that this means that LILW will take up less of the Vrbina repository's space, i.e. that despite the definition given to the facility, in reality it will also be a repository for HLW; that the disposal of radioactive waste in the fast-flowing groundwater of Krško Polje is therefore inexcusable and irresponsible towards future generations and forms of life; that nowhere in Europe (even in France, which has 60 nuclear energy facilities and an above-ground LILW repository) are nuclear facilities so close to where people live than in Krško (between approx. 300 m and 1 km). ZEG says that they have, on several occasions, pointed out substantive anomalies in the documentation compiled as the basis for the Decree on the national spatial plan (Decree on DPN) for a low- and intermediate-level radioactive waste repository; that the key fact is, in their opinion, that because the input data is completely different, the EIA Report and the Safety Analysis Report are now inadequate and incorrect; and that this means that all calculations of the impact of the LILW and HLW repository on human beings and the environment are incorrect and could have long-term effects on quality of life and residence in Posavje. ZEG draws attention to the project to construct repositories for LILW and HLW at Vrbina, which the Slovenian government has classified as "ready to go" projects, i.e. priority projects ready for implementation. Given that the current repository project at Vrbina is technologically contestable (storage of LILW in groundwater), ZEG casts doubt on its feasibility and point out that it is not known whether the repository will be built for Slovenian waste only or for Croatian waste as well, as there is still no official (signed) agreement with Croatia. ZEG also says that they will insist that, following the example of Vrbina (Slovenian government decision), residents of the village of Spodnji Stari Grad at a distance of 500 m from the LILW and HLW repository and from Krško NPP be moved for reasons of health protection and quality of life and residence

The ministry notes that as this comment relates to the LILW repository at Vrbina, which is not the subject of this administrative procedure, it cannot take a position on it. A separate administrative EIA procedure has been carried out for this repository (LILW Vrbina). It ended with the granting by ARSO of environmental protection consent no. 35402-29/2017-169 of 30 June 2021 and decision no. 35402-29/2017-172 of 5 July 2021 supplementing environmental protection consent to the developer, i.e. the Slovenian government, Gregorčičeva 20, 1000 Ljubljana, represented by ARAO, Ljubljana, Litostrojska cesta 58A, 1000 Ljubljana.
The ministry further explains that the classification of radioactive waste in set out in Article 4 of the Rules on radioactive waste and spent fuel management (Official Gazette of RS, No. 125/21). Radioactive waste in solid form, which is the only type of waste that can be stored in the temporary

LILW repository at Krško NPP, is classified into the following categories with regard to level and type of radioactivity:

- very low-level radioactive waste (VLLW) for which the regulatory authority competent for nuclear and radiation safety may decide on clearance
- low- and intermediate-level radioactive waste (LILW) whose management does not need to consider heat generation and that can be classified into two groups:

    1. short-lived LILW, where the specific activity of the contained alpha emitters, having a half-life exceeding 30 years, is equal to or lower than 4,000 Bq/g in any individual package but in no case greater than 400 Bq/g on average in the overall amount of LILW;
    2. long-lived LILW, where the specific activity of alpha emitters exceeds the limitations applying to short-lived LILW;

- high-level radioactive waste (HLW) containing radionuclides, the decay of which generates such an amount of heat that has to be considered when it is being managed;
- radioactive waste containing naturally occurring radionuclides that are produced in the extraction and processing of nuclear mineral raw materials or in other industrial processes and that are not considered sealed sources of radiation under the regulation governing the use of radioactive sources and radiation practices.

Only LILW is stored at the Krško NPP radioactive waste storage facility. Waste is collected at the site at which it is generated, sorted, and then placed in packages for storage in line with its classification. Prior to storage, every package is measured using the gamma-ray spectroscopy system, which determines the isotopic composition of the package, as well as the dose rate on contact and the specific activity. This ensures that only LILW is stored at the storage facility, in line with the criteria set out in the Rules on radioactive waste and spent fuel management.

The conditioning of packages is a multidisciplinary process that is supervised throughout and subject to a prescribed set of procedures. The results of the measurements are entered in the Central RW Records (CERAO), which are maintained by the SNSA.

Regarding the comment that the residents of the village of Spodnji Stari Grad at a distance of 500 m from the LILW and HLW repository and from Krško NPP be moved, following the example of Vrbina (Slovenian government decision) and for reasons of health protection and quality of life and residence, the EIA Report shows that the nearest densely populated settlement, Spodnji Stari Grad, lies approx. 700 m northeast of the site of the plant. The nearest residential buildings are located in the village of Spodnji Stari Grad, approx. 550 m east of the proposed activity/lifetime extension, and in the settlement of Spodnja Libna, approx. 560 m north of the proposed activity.

14.5. Other observations by ZEG

ZEG also points out that the financing of the long-term surveillance and monitoring of the repository is not clear and that the duration of the long-term surveillance has not been determined; wonder how the radioactive waste will be divided between Slovenia and Croatia and whether the Croatian parliament decision prohibiting the export of nuclear waste into its territory still applies; wonder what the envisaged costs of storing and protecting HLW for many millennia are and whether they are comparable with the costs of closing the Žirovski Vrh uranium mine (RUŽV); and state that the Slovenian Environment Agency's documents do not contain a safety study of the impact of the nearby NATO military airbase at Cerklje ob Krki and its area of controlled and restricted use; that the nuclear safety of Krško NPP and the LILW repository could be tragically compromised because of the proximity of the airbase and the ongoing war between Ukraine and Russia; that the Slovenian government decision on the planned construction of a civilian passenger airport (alongside the military airbase) in Cerklje, of the same size as Brnik and Maribor, has still not been annulled; and that there have been too few expert and safety documents and environmental studies of the possible impact of the Brežice HPP reservoir on the LILW repository, which is about 600 m south of the site.

ZEG goes on to say that if, as previous documents issued by the Ministry of the Environment and Spatial Planning and the Slovenian Environment Agency (ARSO) suggest, construction of the LILW and HLW repositories lasts approx. three years without taking the construction of the embankment into account, the ARSO consent must give the real date of completion, i.e. 2024; that local representatives (Local Posavje Partnership) and domestic and foreign environmental NGOs (references and expert knowledge) should be present at the filling of the silo with radioactive waste, alongside representatives from the Radiation Protection Service and the National Institute of Public Health; and that the same applies to radiological monitoring.

In relation to these comments, the ministry responds by saying that this administrative procedure addresses the extension of Krško NPP's operational lifetime. It therefore takes no position on comments not relating to the lifetime extension.
Regarding the impact of the nearby NATO military airbase in Cerklje ob Krki, Section 2.13.1 (Probabilistic safety assessment – Level 1) of the EIA Report states that the risk of an accident involving a military or commercial aircraft in the area of Krško NPP has been assessed within the context of the plant's safety assessments, taking into consideration all flights over the Krško NPP site and not just those connected with the Cerklje airbase. The total evaluated core damage probability resulting from an aircraft crashing into Krško NPP is less than $2E^{-7}$/year and the early release probability from the same cause is $1E^{-8}$/year (source: NEK ESD-TR-02/10, Rev. 2 Evaluation of PSA Impact of Expansion of Airport Cerklje). The impact of the nearby NATO military airbase in Cerklje ob Krki on Krško NPP is analysed in detail from the point of view of the expansion and upgrading of Cerklje airport. Krško NPP has redundant engineered safety features that are physically separate from each other. As part of the Safety Upgrade Programme (SUP), Krško NPP has installed additional engineered safety features within two bunkered (reinforced safety) buildings that are physically separate and at a suitable distance from the main island of the power plant, which is where the reactor is located in a double-shell containment area. This ensures that the plant's operation can be safely halted in the event of a large commercial airliner crashing into it. Regarding the Slovenian government decision to plan a civilian passenger airport alongside the military airbase in Cerklje of the same size as Brnik or Maribor, the ministry explains that this is not the subject of this administrative procedure.

14.6. ZEG suggests that the Slovenian Court of Audit should draft an opinion as to whether the construction of a second nuclear power plant in Slovenia is feasible given that the EU has given Slovenia a deadline of ten years for its green transition. They go on to say that the July 2020 report from the French Court of Audit on the delays to the construction of the nuclear power plant in Flamanville show that this timescale is impossible. In this period, Slovenia could transition to electricity generation using solar panels and wind power. ZEG also says that successive governments and parliaments in Slovenia must stop systematically obstructing the construction of solar panels and wind farms, which they have been doing for the last 20 years, and that the decision to abandon the construction of a new nuclear power plant and extend the operational lifetime of the existing one is unacceptable because the plant's components are worn out and obsolete. They warn that the proposal to construct a second nuclear power plant in Slovenia is also harmful and unacceptable because of the unacceptable costs, and that the initiators of the construction are underestimating the costs considerably, and that it is already clear that the price per kilowatt hour of wind energy and photovoltaic energy is four times lower than the price of nuclear electricity. ZEG goes on to say that many of the costs associated with the working nuclear power plant at Krško will not be paid until the plant stops operating, and that the decision to build a second plant would involve private investors skimming off the cream while all the Slovenian state and its citizens have to show for it is nuclear waste (and the costs that come with it) for centuries to come. They also say that in July 2020 the French Court of Audit warned, in reference to the file for the EPR nuclear power plant in Flamanville, that construction had started in 2007 and was already 11 years late; that the price of the project had started off as EUR 3.3 billion and risen to today's figure of EUR 12.4 billion, with the court estimating a final price of EUR 19.1 billion; that a new nuclear power plant takes more than ten years to build and would be unable to replace the electricity lost from the closure of Block 6 of Šoštanj power station (TEŠ 6) on time; that the electrical current from a nuclear power plant is at least four times more expensive than wind energy and solar panels; that Slovenia does not have a location for the nuclear waste and spent fuel repository except in the groundwater of the Sava River, and that this repository will release radionuclides into the drinking water pumping stations in Brežice, Zagreb and other places further downstream within 300 years at the latest; and that by that time there will have been no financial revenue or benefit from the nuclear power plant for 250 years.

In relation to this comment, the ministry explains that as the subject of this administrative procedure is the extension of Krško NPP's operational lifetime, it will not take a position on comments that do not relate to the proposed activity (construction of a second nuclear power plant, the Flamanville nuclear power plant, the transition to electricity generation using solar panels and wind power, etc.). It points out that measures to speed up the use of renewables have already been adopted in the EU and Slovenia.

14.7. ZEG argues that we should be concerned about new findings in the field of nuclear energy; that things today are different to what they were more than half a century ago when Yugoslavia joined the group of nuclear states; and that we naively believed at that time that science would soon find a way to permanently dispose of nuclear waste concurrently with our use of nuclear energy, although this has not happened; that nuclear energy makes a significant contribution to Slovenia's energy supply, but far less than the advocates of nuclear energy claim; that nuclear energy cannot contribute to energy independence as all the uranium is imported (only a statistically insignificant part of it comes from Slovenia); that the claim that nuclear energy generates 40% of the country's energy is, of course, not true; that Krško NPP generates up to 6 TWh of electricity a year, but this is Slovenian electricity in name only, as half of it goes to Croatia, meaning that the plant generates only around 3 TWh of electricity for Slovenia, i.e. less than a quarter of the electricity needed to supply the country. They continue by saying that electricity is merely one of the energy products available; that electricity accounts for around 23% of the energy mix, with electricity from nuclear energy accounting for only around 5% of that; that while this share is not negligible, it can quickly, straightforwardly and cheaply be replaced by more reliable, more environmentally friendly and cheaper renewables; that the achievement of climate neutrality by 2050 is a binding target; that the EU has set a reduction in emissions of at least 55% by 2030 as an interim step towards climate neutrality; and that the recipe is simple: reduce overall electricity consumption, and replace polluting fossil fuels and risky nuclear energy with renewable energy sources, sustainably. ZEG says that the abandonment of fossil fuels and nuclear energy and the transition to renewables must be quick and completed by 2050, but done in a balanced way; that existing, built and operating infrastructure must be used as far as possible; that technologies that provide the quickest return on investment at the lowest cost should be given priority; that energy independence cannot be achieved by a gigantic nuclear power plant; that a new plant would entail complete dependence on imports of technology, equipment and fuel; and that the only things Slovenia can call its own are the cooling water, the areas contaminated with nuclear waste and nuclear hazard. In their opinion, the correct path entails a reduction in energy use, the use of all suitable renewable energy sources and the storage/conversion of energy such as hydro, wind, solar, aerothermal, hydrothermal and geothermal energy, biomass, waste gas, sewage treatment plant gas and biogas, etc. They say that one of the solutions, floating solar power plants situated at reservoir dams, could produce more electricity than Slovenia's half of the nuclear power plant produces; that Professor Peter Novak has presented "Installation of photovoltaic power plants on Slovenian lakes and ponds", which analyses 322 lakes and ponds and the dams of larger HPPs; that the surface area of dammed rivers suitable for floating solar power plants measures 3,172 ha; that the estimated cost of the investment in these solar power plants is roughly EUR 2 billion for a connection power of 3,172 MW and annual energy production of 3.7 TWh, and that they can be built in only a few years; that electricity generation would, in tandem with the operation of hydropower plants, be uninterrupted, day and night, summer and winter; that, with ten-year depreciation, the price of solar electricity from a floating solar power plant would be below EUR 50/MWh and, after ten years, practically free for a further 20 years. ZEG goes on to say that the discussion about energy supply should be an opportunity for serious consideration and decisions on how solutions to stop global warming can be used in a timely, just and inclusive manner in Slovenia; that the emphasis should be on reducing energy consumption and on the transition to domestic, permanent and renewable energy sources; and that those leading this discussion should not be nuclear lobbyists. ZEG argues that the discussion will, of course, be unable to avoid nuclear energy, but without the glorification and misleading statements that have been a feature up to now; that the evaluation of technologies must take into account all costs and emissions, including the hidden costs of nuclear waste disposal; that a wide discussion on national nuclear energy supply must conclude with a referendum, which is the only way to increase trust between residents, NGOs, the profession and the state; and that this can help to head off the NIMBY, NIMET effects more quickly.

In relation to these comments, the ministry explains that this administrative EIA procedure addresses the extension of Krško NPP's operational lifetime. It therefore takes no position on comments not relating to the lifetime extension.

14.8. ZEG's comments on the EIA Report:

14.8.1. New findings: ZEG argues that the EIA Report completely ignores new findings and effectively says that everything will be as it was but for a little longer and that this will not lead to a burden being placed on the population or the environment. ZEG believes that this is not true and that new knowledge, particularly in the field of waste disposal, should be the guiding principle of the EIA Report. They further point out that the EIA Report downplays the problem of nuclear waste disposal (LILW and HLW), almost as if the issue had already been resolved; that it has not been resolved; and that we must have a solution for the permanent disposal of nuclear waste before Krško NPP's operational lifetime is extended.

In relation to this comment and after studying the documentation and explanations supplied by the developer ("Third Supplement to the Application for an Environmental Protection Consent for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years: presentation of evidence", no. ING.DOV-178.22, 6 May 2022, with four appendices), the ministry responds by saying that Krško NPP pays a great deal of attention to minimising the generation of nuclear waste and to reducing the volume of radioactive waste already stored. In doing so, it follows the latest findings and technologies. For example, the previous method of conditioning LILW packages for storage, which followed the principle of solidification using a vermiculite-cement mix, has been replaced by a new technology: in-drum drying. This has reduced the volume of LILW generated by a factor of 20 for evaporator concentrate and by a factor of 5 for spent ion exchangers. Volume has been and will continue to be reduced by means of the high-pressure compaction of LILW packages, as well as the incineration of combustible materials and the melting of metal radioactive waste by external service providers. The existing storage facility has been further equipped with a system for controlling the ambient conditions, thereby making it less likely that LILW packaging will corrode.
Krško NPP has been and still is active in the preparation of projects and analyses for the construction of an LILW repository in Slovenia and a long-term LILW repository in Croatia. We are keen to enable the timely handover of radioactive waste to both recipients in a manner that complies with the very latest standards and findings of the profession, and to ensure the best possible environmental protection. Under the Krško NPP Decommissioning Programme and the Programme for the Disposal of RW and SF from Krško NPP, the Slovenian half of LILW from Krško NPP will be disposed of at the Vrbina LILW repository, which is not far from Krško NPP, while the Croatian half will be disposed of in a repository whose location has yet to be determined. Until such disposal starts in 2050, LILW will be stored at the radioactive waste management centre at Čerkezovac. A separate administrative EIA procedure has been conducted and an environmental protection consent issued for the LILW repository at Vrbina. Spent fuel or the HLW from the processing of spent fuel is earmarked for further processing, packaging and disposal after a period of dry storage. A deep geological (national, regional or multinational) repository is envisaged in both cases, i.e. for spent fuel and for HLW from the processing of spent fuel. We must acknowledge the progress made in international and regional efforts to introduce a joint regional disposal programme.

Regarding the comment that a solution must be found for the permanent disposal of nuclear waste before the operational lifetime of Krško NPP is extended, the ministry explains that the location of the permanent disposal of nuclear waste will be the subject of a separate EIA.

14.8.2. Nuclear power plant as a weapon of war: ZEG points out that when the nuclear age began, the prevailing doctrine was that nuclear armament was a guarantor of world peace; that the peaceful use of nuclear energy was a cover for participation in the nuclear arms race; that predictions that nuclear energy could be used for the safe and cheap supply of energy to humanity have not come true; and that the nuclear illusion is coming to an end. They point to events in Ukraine, where nuclear power plants have become the target of military attacks, which shows that there is no boundary between military and civilian nuclear programmes; that all nuclear power plants have become a military threat; that if Putin's rhetoric is to be understood, Slovenia is also a possible target for Russian military aggression, and that Krško NPP, a power plant of American manufacture, could be a tempting target for the Russian army. ZEG believes that the EIA Report should assess this very real danger.

In relation to this comment, the ministry responds by saying that Section 2.17.12 of the Safety Upgrade Programme (SUP) states, *inter alia*, that in August 2013 the European Commission published a final report on the findings of the extraordinary safety checks made of all power plants. The report confirmed that Krško NPP was achieving excellent results and was adequately prepared for extreme events. The report also included an overview of recommendations for safety improvements at individual nuclear power plants. According to this overview, Krško NPP is the only nuclear power plant that did not receive a single recommendation, one of the reasons being that it had already carried out B.5.b actions (in response to WTC attack on 11 September 2001). It had drawn up a draft SUP and was able to prove large integrated safety margins in terms of both seismic and flood safety. The modernisation of safety solutions at Krško NPP, which was carried out in 2021, includes the best available technological solutions and follows international practice (e.g. Switzerland, Belgium, Sweden and France). This applies in particular to the reliable cooling of the core in order to ensure the integrity of the containment, the management of severe accidents and the cooling of spent fuel.

Krško NPP's spent fuel pool and the reactor core are the major potential sources of radiological hazard to the surrounding environment in the event of a nuclear accident. The spent fuel storage strategy has been changed in response to the latest events and findings from the Fukushima accident, and to the revised National Programme for Radioactive Waste and Spent Fuel Management 2016–2025 (ReNPRRO16–25, Official Gazette of RS, No. 31/2016, 29 April 2016). The spent fuel dry storage construction project will be completed in 2023 (EIA Report for Upgrading Spent Fuel (SF) Storage Technology by Introducing Dry Storage – Krško NPP, No. 101118-dn, March 2020, amended in June 2020); this will further enhance nuclear safety and minimise the risk of potential accidents in the spent fuel pool.

On the basis of its own analyses and the recommendations of international organisations and administrative bodies, Krško NPP has adopted a set of short- and long-term projects. One of the short-term projects involved purchasing specific mobile equipment (e.g. diesel generators of different power configurations, air compressors, water pumps, a towing vehicle). Systems in the plant have been fitted with the appropriate mobile equipment connections. As part of the long-term projects and based on the SNSA decision, a thorough analysis was carried out and a comprehensive upgrade programme formulated for the prevention of severe accidents and the mitigation of their consequences. This was completed in 2021, with the exception of the completion of construction of the dry storage and the transfer of spent fuel (first campaign), which will now take place in the first half of 2023.

14.8.3. Terrorist threat: ZEG states that the EIA Report does not properly address the real possibility of a terrorist attack. They point out that the fact that a Soviet-made TU-141 unmanned aerial vehicle had flown from Ukraine a few days ago and come down near Zagreb, i.e. only 40 km from Krško NPP, pointed to new nuclear threat dimensions, and that while it is true that the nuclear reactor is protected by concrete armour and that not even a larger bomb could damage it, it is enough for nuclear safety to be jeopardised by an attack or hostile provocation that destroys sensitive components (electricity lines, cooling systems, control room, steam pipelines, etc.). ZEG wonders whether the Safety Analysis Report omits the threat of terrorism because the information is confidential or because there is no such report. They go on to say that the EIA Report ignores the possibility of a terrorist attack using a vintage Tupolev Tu-141 Strizh, let alone the possibility of an attack using a modern supersonic Kinzhal missile, which can carry conventional or nuclear warheads. ZEG believes that the most suitable time to shut down the nuclear power plant was 40 years ago and the second most suitable time is now.

In relation to this comment, the ministry points out that Krško NPP was constructed so that its redundant engineered safety features (ESFs) are physically separate from each other. As part of the SUP, Krško NPP has additionally installed ESFs together with coolant tanks within two reinforced safety (bunkered) buildings that are physically separate and at a suitable distance from the ESFs of the plant's main island, where the reactor is located in a double-shell containment. This ensures that the plant's operation can be safely halted in the event of a large commercial airliner crashing in its vicinity. Therefore, on account of the construction principles applied at Krško NPP and referred to above, an unmanned aerial vehicle such as the one that came down in Croatia could not present a direct threat to the plant. Krško NPP is also protected from other terrorist attacks and acts of sabotage. However, because of its sensitive nature, information on the plant's physical protection against an aircraft crash, terrorist attack or act of sabotage is classified.

14.8.4. Misunderstanding about the competencies of nuclear experts: ZEG says that the competencies of nuclear experts should lie in nuclear safety and the control of nuclear processes that operate in the field of use of nuclear energy and radiation sources; that the planning of national energy policy is not part of the nuclear profession's remit; that energy policy is public policy in the field of energy supply (obtaining energy from energy sources, and converting, transmitting, storing, trading and using it, particularly with a view to reducing energy consumption; and that energy consumption must be at least halved by 2050, as set out in the "Clean Planet For All" strategy. They argue that while nuclear energy is, of course, one of the options for achieving these targets, the nuclear profession cannot be the drivers of energy policy; that citizens should decide on the country's energy supply, and particularly on risky nuclear energy; and that it expected a referendum to be held on extending Krško NPP's operational lifetime.

Because of the generalised nature of these comments, the ministry will not take a position on it in this procedure.

14.8.5. Reduced energy consumption: ZEG says that page 38 of the EIA Report places emphasis on the expected increase in electricity consumption, and fails to mention a general reduction in energy consumption. They also say that the EIA Report completely misrepresents the Paris Agreement and the UN Framework Convention on Climate Change; that the focus, when talking about reducing GHG emissions is on reducing energy consumption and transitioning to renewable energy sources, not on increasing energy consumption from nuclear power plants; that Krško NPP's reference to the taxonomy and to nuclear energy being part of the solution for achieving climate neutrality in the EU is mistaken; that nuclear energy is not recognised as a green but rather as a transitional solution, with limitations; and that the key limitation is the requirement to have constructed a final repository by 2050. They say that the EIA Report ignores the issue of the final repository, almost as if the extension of Krško NPP's operational lifetime did not lead to an increase in the nuclear waste burden.

In relation to this comment, the ministry responds by saying that, as the EIA Report mentions, Slovenia's Integrated National Energy and Climate Plan (NECP) and the Resolution on Slovenia's Long-Term Climate Strategy to 2050 (Official Gazette of RS, Nos. 119/21 and 44/22 [ZVO-2]) determine the key areas that require measures to be taken towards achieving the objective of climate

neutrality, which include efficient energy use, the circular economy and other measures to reduce energy needs. Despite all the efforts made to reduce energy consumption, electricity consumption is not yet falling sufficiently, and is to some extent increasing. Indeed, projections suggest that this will be case worldwide in the next few decades. The NECP therefore envisages an increase in electricity consumption in Slovenia. This information has been incorporated into the EIA Report,
which also states that nuclear energy is important for the transition to a low-carbon society, which accords with the European Commission's Complementary Climate Delegated Act of 2 February 2022. The restriction relating to the construction of final disposal facilities up to 2050 also applies to existing installations for electricity generation from nuclear energy approved after 2025 (source: Commission Delegated Regulation (EU) …/… of 9 March 2022 amending Delegated Regulation (EU) 2021/2139 as regards economic activities in certain energy sectors and Delegated Regulation (EU) 2021/2178 as regards specific public disclosures for those economic activities, Annex I, Section 4.28, Brussels, 9 March 2022, C(2022) 631). Sections 4.4.10 (Radioactive waste pollution) and 4.4.11 (Spent fuel (SF)) of the EIA Report provide information on the radioactive waste and spent fuel disposal plans under the Programme for the Disposal of Radioactive Waste and Spent Fuel from Krško NPP and the national radioactive waste and spent fuel management programmes of Slovenia and Croatia.

14.8.6. Specific comments: ZEG points out that the EIA Report states, on pages 132 and 436, that: "If Krško NPP's operational lifetime is not extended, Slovenia's energy independence would be threatened. The shortfall in energy would have to be made up by using other sources or by purchasing electricity from other countries. The consequences would be economical, political and ecological." ZEG believes that this type of extortion is extremely inappropriate; that Krško NPP is not in a position to threaten society; that it is already unacceptable that it has delayed the EIA for the lifetime extension; that nuclear energy has too great an impact on national security for us to nod blithely and say that it is too late for us to do anything else; and that it is not too late to choose the most suitable option. They go on to say that the extension of Krško NPP's operational lifetime is of significantly greater benefit to Croatia than Slovenia, and that Slovenia once again finds itself in a subordinate position – something that the EIA Report fails to mention at any point.

In relation to this comment, the ministry explains that an examination of which country stands to benefit most from the proposed activity is not the subject of this administrative procedure.

14.8.7. ZEG also says that the EIA Report contains an untruth on pp. 117, 311 and 442: "The types and annual quantities of waste (including radioactive) generated by Krško NPP will not change substantially as a result of the extension of its operational lifetime. The rate at which waste is generated will remain the same." ZEG points out that even if the rate at which waste is generated remained the same, the total quantity of waste would change (increase) substantially, for two reasons. The first is the extension of the operational lifetime by (at least) 20 years, which means an increase in waste of at least 50%; the second is the silent understanding that Croatian waste (SF and HLW, and probably also LILW) will remain in Slovenia on a permanent basis. This means a threefold increase in nuclear waste on the amount envisaged when the plant was being built. As ZEG points out, the EIA Report does not address the impact of a threefold increase in nuclear waste. They also say that along with the lifetime extension, a decision must be made to get Croatia to take its share of the nuclear waste; that Croatia must complete the takeover and removal of its half of the radioactive waste and spent fuel from the Krško NPP site two years after the end of the original operational lifetime (2023 + 2 = 2025), as per the BHRNEK treaty; and that this obligation (final takeover and removal of its half of LILW and HLW by 2025) must be a basic precondition for even discussing the possible lifetime extension of the plant. They argue that with a nuclear policy of "fait accompli", Slovenia will become permanently responsible for all nuclear waste on its territory, including Croatia's half.

In relation to this comment, the ministry responds by saying that Sections 5.10 (Impact of waste) and 5.10.1 (Operation) of the EIA Report provide precise figures on how much waste will be generated as a result of the extension of Krško NPP's operational lifetime. When they signed the Intergovernmental Treaty in 2003, Slovenia and Croatia undertook to be responsible for taking their respective shares of radioactive waste from Krško NPP two years after the end of the original operational lifetime. Given this fact and the fact that a great many fewer radioactive waste packages have been placed into storage in the last few years than was the case when the plant started operating (changes to processing technologies for liquid radioactive waste, further processing through incineration, high-pressure compaction, melting of metal waste, etc.), the lifetime extension will not produce a 50% increase in waste.

14.8.8. ZEG points out that the EIA Report makes an incorrect safety assessment when it comes to the lifetime extension (pp. 44, 332 and 444) when it states: "Given the solutions envisaged and the safety functions ensured, extending the operational lifetime will not present a risk of an environmental or other accident." ZEG believes that the nuclear power plant poses a threat and, furthermore, that if exposure to the threat increases by at least 50%, the risk itself also increases by at least the same amount. They also say that we have to be aware that complete nuclear safety does not exist: "100% nuclear safety does not exist" (Dr Leon Cizelj, JSI; 2016). They say that an extended period of operation means increased nuclear hazard, and that the EIA Report should address this.

In relation to this comment, the ministry replies, after studying Krško NPP's explanations ("Third Supplement to the Application for an Environmental Protection Consent for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years: presentation of evidence", no. ING.DOV-178.22, 6 May 2022, with four appendices), that this assertion would be correct if the risk of an accident was the same every year. Since it was put into operation, Krško NPP has continuously reduced the risk of an accident by means of a large number of safety upgrades. The plant is 17 times safer today than it was when it started operating. ZEG's claim is therefore untrue. The core damage frequency (CDF) when the plant started operating and in its first years of operation was approx. 2.4^{E-04}/year. If this value is integrated until the end of the originally planned operational lifetime, a probability of 9.6^{E-03} is obtained.
The CDF value has fallen considerably over the years on account of the improvements made to the plant. If an estimate is made for the hypothetical 40-year extension of the operational lifetime, a probability integral of 7^{E-03} is obtained.

14.8.9. ZEG quotes the following text on pp. 335, 345, 417 and 445 of the EIA Report: "During the extended operational lifetime, the regular monitoring that is already being carried out now (measurements of river water pumping for process purposes, measurements and analyses of wastewater discharged into the sewage system, radiation measurements) will continue to be conducted throughout the plant." In relation to this, ZEG says that the minimum that needs to be additionally carried out is the periodic monitoring of water and the monitoring of the health of the population close to the nuclear facilities for exposure to tritium; that the use of health ecology methods should be introduced in Slovenia as well in order to assess, monitor, take measures and prevent those factors in the environment that could potentially harm the health of current or future generations; that experiences from abroad show the harmful effects of tritium, e.g. the IRSN report from 2021 on the harmful effects of tritium on health; that tritium from nuclear power plants causes numerous instances of damage to DNA and cytogenetic effects, leading to cancer during chronic exposure to tritium at lower levels of exposure as well as longer periods of exposure.

In relation to this comment, the ministry replies, after studying Krško NPP's explanations ("Third Supplement to the Application for an Environmental Protection Consent for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years: presentation of evidence", no. ING.DOV-178.22, 6 May 2022, with four appendices), that the periodic monitoring of water and of dose loads of the population is an important part of tritium monitoring. As purity of drinking water is generally extremely important for the health of the population, all contributions made by contaminants in the environment and their effects on drinking water quality must be identified. Health monitoring is performed by taking into account the operational limits, which along with the prescribed effective dose limit also include checks of dose exposure. Within this, measurements are taken of the contribution of tritium and its share in the effective dose of the most exposed individuals.

The basic limit from the location permit is an effective dose of 50 mSv in one year (at a distance of 500 m and more from the reactor – from releases into the environment). This is only 2% of the dose from natural radiation to which the population could be exposed in the course of one year. A level of radiation this low cannot have consequences for individuals and cannot be separated from natural radiation. Doses from operational releases into the environment may only be calculated, or are not measurable by the available radiological measurements of the human body. Releases of radioactivity are also further limited by additional operational limits of activity that derive from general limits for surface waters and ensure an even lower impact on the surrounding area. For natural radiation from natural sources that cause an annual effective dose of around 2,000 µSv (2 mSv) or more, it is not true that it has a negative impact on the health of the population; this is because the body has adapted to this radiation and because it does not deviate from other natural impacts such as to enable early changes to chromosomes or human health to be observed. Water is continuously sampled for tritium at drinking water pumping stations, in the Sava River and in the Krško NPP discharge channel. At Krško NPP, water containing tritium is occasionally released only after the radioactive liquids have evaporated. This requires a radiochemical analysis of a sample from the control tank and administrative approval from the radiation protection organisational unit.

The concentration of naturally occurring tritium in rainwater is approximately 1 Bq/l, which causes the natural presence of tritium in food and living organisms. Tritium is a constituent of water (HTO). The possibility of organically bound tritium (OBT) affecting living organisms has been highlighted in recent years. Measurement methods enable us to trace the presence of tritium in the environment in an extremely precise way. For example, in 2021 the IRB laboratory conducted periodic special sampling of apples and corn in the immediate vicinity (the sampling was commissioned by Krško NPP) and found OBT in both materials. Only at one point in the immediate vicinity of the facility (by the perimeter fence) was the measurement four times higher than the wider surroundings, while at other places the difference was lower. In this case, a difference can arise in relation to tritium because of the constant ventilation of premises. The majority of the ventilation filters release steam. The difference decreases very quickly with distance because steam dissipates to a significant degree in the atmosphere. Measurable differences regarding the level of natural tritium can no longer be observed at a distance of more than 1 km from the perimeter. If we wish to estimate the impact of OBT on the health of the population, the ~~calculation~~ shows us that its contribution to the dose after the consumption more than 100 kg of apples (for example) is completely negligible. The effective dose or total contribution of all forms of tritium (unbound and organically bound) is 0.05 µSv ($5.0E^{-5}$ mSv) from the consumption of water and food at Brege, and around 0.1 µSv ($1E^{-4}$ mSv) from the consumption of water from the Sava (JSI estimates for 2021).

Tritium does not accumulate or build up in living organisms (see “An updated review on tritium in the environment”, Eyrolle Frédérique et al., Institut de Radioprotection et de Sûreté Nucléaire (IRSN), November 2017, Journal of Environmental Radioactivity). Its radiotoxicity remains less significant than that of other naturally occurring or typical artificial radionuclides.

The sampling and measurement of H-3 in the immediate and wider vicinity of Krško NPP is presented in more detail in the “Monitoring the status of impact mitigation factors and measures” section of this decision.

Concentrations of tritium activity in drinking water in the surroundings of Krško NPP are of the same order of magnitude as seen elsewhere in Slovenia. The tritium values at the Brege pumping station or for Spodnji Stari Grad, which is connected to the Krško water supply system, are the highest in Slovenia and are undoubtedly a result of the impact of Krško NPP. However, even the highest values are still less than 2% of the limit values set out in the EU Drinking Water Directive (100 Bq/l).

From Table 87: The median values of H-3 concentration at pumping stations and the water supply network in the vicinity of Krško NPP between 2017 and 2020 (Section 4.4.6.3 of the EIA Report:

Measurements of radioactivity in the water supply network and at pumping stations) show that there were no particular differences from year to year. In the case of the Rore pumping station, H-3 concentrations correspond to the natural concentrations found in surface waters. The values are lower in the case of Brežice, partly because of the use of water from the Glogov Brod well, where the majority of the tritium decays (the water seeps down to the depth of the well for more than 20 years, which also leads to the cleaning of other contaminants from the use of the soil for agricultural purposes).
We can conclude from the tabulated data on H-3 concentrations that around half the Krško water supply network (sampled from the Spodnji Stari Grad network) is fed by water from Brege. The annual average H-3 activity concentrations in precipitation, which are not specifically mentioned, are slightly higher for Brege and Krško than they are for Dobova or Ljubljana, which could also have an impact on the groundwater at this location.
The highest estimated annual effective dose in the surrounding area of Krško NPP in the JSI report for 2020 due to drinking water from the water supply system on the Krško Polje/Brežiško Polje was calculated at the Brege pumping station (4.5 µSv for an adult reference person, 6.4 µSv for children and 26.9 µSv for infants). The values are slightly higher than in 2019. Practically all the load derives from naturally occurring radionuclides, with artificial radionuclides accounting for no more than 1.2% of the load.
In comparison with the other two pumping stations and with the Ljubljana water supply system, the impact of naturally occurring radionuclides is highest for Brege. For this pumping station, there is also a direct link between the surface and the groundwater in the case of the use of chemical agents in agriculture as illustrated by the measurements set out in the "Report on the quality of drinking water in the public water supply systems in the Municipalities of Krško and Kostanjevica na Krki in 2019". While the concentrations of some harmful chemical compounds are below their respective prescribed upper limits, they are still present. Their total impact is probably not completely negligible. In this period, according to the data referred to, around half the water pumped into the Krško water supply network comes from Brege. In order to provide the population with drinking water of higher quality, the groundwater from the Brege pumping station would have to be replaced by water from greater depths, which is naturally considerably purer.

14.8.10. ZEG says that the statement on pages 36 and 40 of the EIA Report ("At the time of construction, a minimum operational lifetime of 40 years was envisaged for the facility …") is incorrect and misleading; that the operational lifetime envisaged for the plant at start-up was 40 years ("envisaged" not "minimum"); that Krško NPP was designed and constructed for an operational lifetime of 40 years; and that the entire plant, including the spent fuel pool, was dimensioned for a period of operation of this duration. They go on to say that the Krško NPP Decommissioning Programme 6/2004 specifies the conditions for decommissioning after an operational lifetime of 40 years; and that the phrase "minimum operational lifetime of 40 years" entered the material later and is inaccurate or incorrect.

In relation to this comment, the ministry responds by saying that the phrase "minimum operational lifetime" was input information for the designers, who had to design the plant so that it was capable of operating for at least 40 years, which ensured that sufficient safety and operational margins were built into the project for the operational lifetime of 40 years envisaged at the time. Comprehensive monitoring of the state of the facility, systems and structures, the timely replacement of vital equipment and continuous technological upgrades to the plant mean that, in tandem with the monitoring of global trends in the lifetime extension of nuclear power plants, Krško NPP is able to operate reliably and safely for another 20 years.

14.8.11. ZEG quotes the statement on p. 36 of the EIA Report: "Safe and reliable operation in all conditions is Krško NPP's number one priority. Since its construction, Krško NPP has carried out a series of upgrades that have increased the site's safety and efficiency. These upgrades also ensure that generation complies with environmental provisions. The production effects of many years of investment are reflected in greater efficiency of production processes, resulting in an increase in electricity generation, i.e. from 4.5 TWh/year to 5.45 TWh/year. The increase in generation can be attributed to the multiple investments made, the lengthening of the fuel cycle to 18 months, the shortening of the regular outage periods, and the preventive replacement and updating of work processes." In response to this, ZEG says that the priority given to increased electricity generation reduces nuclear safety; that the INES1 event, which occurred in October 2019, is proof of this; and that Krško NPP has not ensured that operation takes place in line with the approved operational conditions and limits, as the penetrations of the containment were not sealed between 5.20 pm on 5 October 2019 and 2.22 pm on 7 October 2019.

In relation to this comment, the ministry notes, after studying Krško NPP's explanations ("Third supplement to the application for an environmental protection consent for the extension of Krško NPP's operational lifetime from 40 to 60 years: presentation of evidence", no. ING.DOV-178.22, 6 May 2022, with four appendices), that Krško NPP was accidentally non-compliant with operating conditions and restrictions for around 45 hours during the 2019 outage. After discovering this event, Krško NPP took immediate action in accordance with its instructions and procedures. This action returned the plant to compliance with the operational conditions and limits, and Krško NPP notified the competent regulatory authority (SNSA) of the situation immediately, in line with the legal requirements. After this immediate action was taken, Krško NPP undertook a thorough analysis of the event. It also took long-term action to ensure that such situations would not arise in future. Krško NPP operates in accordance with the prescribed (nuclear) legislation, which also covers reporting on potential events and anomalies to the SNSA. In addition to this, Krško NPP is visited at least once a week by SNSA inspectors, who check compliance with the operational conditions and limits and with all requirements for safe operation.

14.8.12. ZEG refers to the statements in the EIA Report relating to the extraordinary safety review (EU stress tests) (pp. 37 and 75). They say that, following the extraordinary safety review, the SNSA ordered a Safety Upgrade Programme (SUP) to be carried out; that the SUP had to be completed by 2016 (but has, in fact, not yet been completed); that referring to the incomplete SUP as an example of good practice, without explaining the delay or the impact of the delay on nuclear safety, is cynical; and that misleading behaviour like this does not strengthen trust in nuclear safety.

In relation to this comment, the ministry notes, after studying Krško NPP's explanations ("Third supplement to the application for an environmental protection consent for the extension of Krško NPP's operational lifetime from 40 to 60 years: presentation of evidence", no. ING.DOV-178.22, 6 May 2022, with four appendices), that the SUP has been completed, with the exception of the construction of the spent fuel dry storage (SFDS), which was added to the SUP at a later date. The SUP was not completed in 2016, for two reasons: first, the contractors were unable to provide equipment and carry out work by the deadline specified by the SNSA; second, subsequent analyses indicated that further safety improvements could be made, which led to additional safety upgrades to the plant being included subsequently in the SUP. Therefore, and despite the delay, the SUP's aim, of constantly improving nuclear power plant safety, is indeed an example of good practice.

14.8.13. ZEG claims that Section 1.3 of the EIA Report (Title and purpose of the activity) again contains a misleading and inaccurate statement ("At the time of construction, a minimum operational lifetime of 40 years was envisaged for the facility ..."). "While a minimum operational lifetime of 40 years was envisaged, a number of safety and other upgrades have been carried out in this period, along with numerous analyses, that indicate that the extension of the operational lifetime is an appropriate and globally established solution in terms of safety and cost-efficiency. The upgrades have created technical conditions that allow Krško NPP to operate for at least another 20 years, i.e. until the end of 2043. Safety upgrades are not covered by the EIA and would have been carried out regardless of whether Krško NPP's operational lifetime was extended, as they were part of Slovenia's post-Fukushima action plan following the EU stress tests."

In relation to this, ZEG claims, therefore, that Krško NPP surreptitiously carried out several activities in the SUP aimed at extending the plant's operational lifetime, but did not assess these activities in the EIA Report. They also say that the EIA Report is only supposed to give legitimacy to measures that have already been carried out and are designed to extend operation, and that with this policy of "fait accompli", Slovenia is becoming a hostage to the nuclear lobby.

In relation to this comment, the ministry responds by saying that the Krško NPP SUP was designed to upgrade safety and was undertaken, pursuant to the national post-Fukushima action plan following the EU stress tests, regardless of the extension or otherwise of Krško NPP's operational lifetime. The third paragraph of Article 9 of the Decree on the method of drafting and on the content of the report on the effects of planned activities affecting the environment provides that the description and assessment of the impacts of the planned activity should also include the impacts that are expected to result from actions connected with the activity or other environmental activities, during preparation work or construction, use or operation, or during the duration, removal or termination of the activity. In accordance with this Decree and as stated in Section 1.7.2 (Subject of the report), because the lifetime extension concerns the existing power plant complex, the report addresses the impact of the lifetime extension on the entire plant following the modification, including the spent fuel dry storage, which will begin operating in 2023.

14.8.14. ZEG quotes p. 43 of the EIA Report: "The decommissioning of the facility under the decommissioning programme [13], which is envisaged after operation comes to an end at the plant, will be subject to other administrative procedures relating to construction, nuclear safety and environmental protection; as such, the decommissioning of the facility, in those parts relating to impacts resulting from termination of the activity, is not addressed in this report." In relation to this, ZEG points out that the decommissioning of the facility should be addressed in the EIA Report because decommissioning is one of the risk factors that should be examined in terms of time, safety and finance.

The response to this comment is given in the response under point 3.

14.8.15. ZEG goes on to say that the EIA Report ignores the disposal of LILW and HLW. If the assumption is made that LILW generated during the lifetime extension will be placed in the repository currently being constructed for the existing nuclear power plant, this must also be addressed in the EIA Report, as the lifetime extension will have an impact on the storage of LILW in terms of quantity and of the rate and technology of waste disposal. ZEG says that the issue of the disposal of HLW has not been resolved, that it should be addressed in the EIA Report and, moreover, that the assumption that it will be resolved by the temporary dry storage of HLW and spent fuel is mistaken. They also point out that there is an explicit requirement to determine and record Croatia's obligation to take its share of LILW and HLW even before the potential extension of Krško NPP's operational lifetime from 40 to 60 years.

In relation to this comment, the ministry responds by saying that the EIA Report does address the generation and management of radioactive waste and spent fuel in accordance with the requirements of the Decree on the method of drafting and on the content of the report on the effects of planned activities affecting the environment. A separate administrative EIA procedure has been carried out for the LILW repository at Vrbina. It ended with the granting by ARSO of environmental protection consent no. 35402-29/2017-169 of 30 June 2021 and decision no. 35402-29/2017-172 of 5 July 2021 supplementing environmental protection consent to the developer, i.e. the Slovenian government, Gregorčičeva 20, 1000 Ljubljana, represented by ARAO, Ljubljana, Litostrojska cesta 58A, 1000 Ljubljana. Construction of the LILW repository lies within the remit of the Agency for Radwaste Management (ARAO). The capacity of the repository will be sufficient for the disposal of half the LILW that will be generated during Krško NPP operation up to 2043 and the subsequent decommissioning of the plant, and for the disposal of LILW from other Slovenian producers (medicine, industry, research activities), as the EIA Report points out. Spent fuel dry storage is a temporary solution. After the period of dry storage, the following measures are envisaged: further processing, packaging and disposal of the spent fuel.

A deep geological repository, which will ensure an adequate interval of time between waste and the environment, is envisaged for HLW. In accordance with the Programme for the Disposal of Radioactive Waste and Spent Fuel, HLW will be disposed of in a suitable deep geological repository. Croatia's obligation to take half the radioactive waste and spent fuel from Krško NPP is set out in the Act Ratifying the Treaty between the Government of the Republic of Slovenia and the Government of the Republic of Croatia on the regulation of status and other legal relations regarding investment in and the exploitation and decommissioning of Krško Nuclear Power Plant and the Joint Declaration at the time of signature of the Treaty between the Government of the Republic of Slovenia and the Government of the Republic of Croatia on the Regulation of Status and Other Legal Relations Regarding Investment in and the Exploitation and Decommissioning of Krško Nuclear Power Plant (Official Gazette of RS [Mednarodne pogodbe], No. 5/03) The obligation to take over and remove half of the radioactive waste and spent fuel from Krško NPP set out in the Intergovernmental Treaty has been transposed into Croatian legal instruments, such as the Strategy of Management of Radioactive Waste, Spent Sources and Spent Fuel (Strategija zbrinjavanja radioaktivnog otpada, iskorištenih izvora i istrošenog nuklearnog goriva (NN br. 125/14)) and the implementation of the strategy up to 2025 with an outlook to 2060 (Nacionalni program provedbe Strategije zbrinjavanja radioaktivnog otpada, iskorištenih izvora I strošenog nuklearnog goriva, Program za razdoblje do 2025. godine s pogledom do 2060. godine, Odluka Vlade RH o donošenju Narodne Novine br. 100/18). Given that Croatia's obligations regarding the takeover of its share of radioactive waste and spent fuel are regulated in the above-mentioned documents and are the subject of bilateral agreements, the ministry does not understand ZEG's request that Croatia's obligation to take its share of LILW and HLW be determined and recorded even before the possible potential extension of Krško NPP's operational lifetime from 40 to 60 years.

14.8.16. In relation to Section 2.7.6 (Seismic safety) of the EIA Report, ZEG points out that in 2008 the IRSN (Institut de radioprotection et de Sûreté Nucléaire IRSN, 31, Avenue de la Division Leclerc, 92260 Fontenay-aux-Roses) took part in field research and the drafting of a probabilistic seismic hazard analysis (PSHA) for the project to construct a second unit at the site of Krško nuclear power plant; that they provided consultancy services within the team for the GEN-energija electricity producing company in cooperation with a Slovenian geological and construction institute; that the first phase involved finding out whether there were any faults that could cause damage on the surface in the event of an earthquake; that the IRSN took part in a geological survey of the geological fault and helped interpret any new geophysical data that might reveal the possibility of active displacements or faults; that in 2013 the IRSN field team in Slovenia found that the seismic fault below Krško nuclear power plant, operated by GEN-energija, was actually active, and advised GEN-energija that the location was not suitable for the construction of a second plant or for extending the operational lifetime of the existing plant by 20 years; that after receiving these expert findings GEN-energija immediately suspended cooperation with IRSN and declared the cooperation agreement null and void; that GEN-energija's reaction was completely unprofessional, irresponsible and scientifically inappropriate; that the representative of the IRSN field team organised a press conference at the Faculty of Social Sciences in Ljubljana and distributed copies of the paper confirming that the seismic fault could be understood to be active and that the location was not suitable for a nuclear power plant. ZEG says that they have a copy, and go on to say that now, nine years later, GEN-energija is starting a project to extend Krško NPP's operational lifetime for a further 20 years (to 2043), instead of closing it in 2023 as advised by the plant's manufacturer Westinghouse, as well as advising the construction of another reactor at the same location in the densely settled area of Krško. ZEG believes that this is both professionally and ethically unacceptable; that IRSN's 2013 report, which warned that the location was unsuitable for nuclear facilities, has been ignored; and that, given the fact that this report has never been refuted (but simply concealed), it is only right that the IRSN report be inserted into the EIA Report.

The response to the IRSN's opinion that the location at Krško is not suitable for the construction of another power plant unit is given in point 9. The ministry also explains that the SNSA webpage referred to below contains a list of all documents relating to seismic safety at Krško NPP and the IRSN comments, arranged in chronological order by date of publication:
http://ursjv.arhiv-spletisc.gov.si/si/info/posamezne_zadeve/o_potresni_varnosti_nek/index.html

14.8.17. Regarding Section 2.7.9 (Other extreme weather events), ZEG says that extreme events are becoming ever more frequent as a result of climate change, but that the assessment does not address this fact; that Krško NPP is already heating the Sava by more than 3°C; that the plant occasionally receives permission for a 3.5°C increase in temperature, which the public have not been informed about; that the EIA Report does not mention how many times and for how many days the permitted rise in the temperature of the Sava was exceeded, and what the forecasts are for future exceedances of the permitted temperature rise, nor does it address the increase in Sava temperatures above the permitted level in the event that the plant's operational lifetime is extended. ZEG also says that Krško NPP operation occasionally heats the Sava by a daily average of up to 3.5ºC (based on temporary permits issued by ARSO).

In relation to this comment, the ministry responds by saying that the impact of climate change on the activity is addressed in Section 5.6 (Impact of climate change on the activity) of the EIA Report. The developer has constructed additional cooling towers in response to climate change. The heating of the Sava is limited to 3°C under the provisions of the applicable Environmental Protection Permit for Emissions into Waters no. 35441-103/2006-24 of 30 June 2010, which was amended by decision no. 35441-103/2006-33 of 4 June 2012 and decision no. 35441-11/2013-3 of 10 October 2013, or in accordance with point II/1.11. of the operative part of this environmental protection consent, which provides that the developer must ensure that the average daily temperature of the Sava at the point of complete mixing does not exceed 28°C and that, at the point of complete mixing, the Sava is not heated by more than 3°C above its natural temperature as measured at the offtake of Sava water for Krško NPP. The Measures to Manage Crisis Conditions in Energy Supply Act (Official Gazette of RS, No. 121/22, ZUOKPOE) came into force on 22 September 2022. Article 8 of that act also relates to Krško NPP operation, and provides that during a period of a declared higher level of risk to energy supply as referred to in the third paragraph of Article 3 of this act and the necessity to ensure uninterrupted energy supply, the requirements and conditions referred to in the environmental protection permit for the operation of Krško NPP regarding the limit values for the waste heat emission ratio shall not be applied between 1 October and 30 April. In the case referred to in the previous paragraph, the temperature of the Sava at the point of complete mixing with wastewater from Krško NPP below the Brežice HPP dam may, regardless of the requirements of the environmental protection permit for Krško NPP operation, be 3.5 K higher than the temperature of the Sava at the offtake of Sava water for Krško NPP between 1 October and 30 April. In the case referred to in the first paragraph of this article, Krško NPP must ensure continuous measurements of the temperature of the Sava at the offtake of Sava water for Krško NPP and at the point of complete mixing with wastewater from Krško NPP below the Brežice HPP dam. The temperature measurements referred to in the previous paragraph must be continuous and consistent, with data recorded at least once an hour and entered in the Slovenian Environment Agency's online database. The operator of Krško NPP must, in addition to the mandatory use of cooling using existing cooling devices, prepare and implement additional measures to ensure that any adverse effects on the environment that could arise from this deviation are kept to a minimum. The operator of Krško NPP must, without delay and no later than within 48 hours, send the ministry responsible for the environment an email detailing the deviation referred to in the first paragraph of this article.
With due regard to the cited provision of the ZUOKPOE, the ministry has, in point II/1.16 of this environmental protection consent, prescribed an additional requirement, which provides that in the event of a declared higher degree of risk to energy supply and a demonstrable need for uninterrupted energy supply, the temperature of the Sava between 1 October and 30 April may be 3.5 K higher than the temperature of the Sava at the offtake of Sava water for Krško NPP (average daily

temperature rise = ΔT), where the temperature of the Sava at the point of complete mixing may not exceed 28°C. The average daily temperature rise of the Sava is calculated as the difference between the average daily temperatures of the Sava measured at the point of complete mixing and the average daily temperatures of the Sava measured at the offtake of Sava water for Krško NPP.

14.8.18. In relation to Section 2.7.10.3 (Solid radioactive waste), ZEG points out that the extension of Krško NPP's operational lifetime will generate greater quantities of radioactive waste, but that the EIA Report does not address where this waste will go, except in the form of the following vague statement: "Storage capacities will be sufficient until such time as the public services of Slovenia and Croatia each take over their half of the radioactive waste as per the Intergovernmental Treaty [11]."

In relation to this comment, the ministry responds by saying that Section 5.10 (Impact of waste) of the EIA Report does address the impact of waste during operation and when the activity is terminated. The final location of the permanent disposal of radioactive waste, for which an EIA procedure will also have to be carried out, is not the subject of this administrative procedure.

14.8.19. In relation to Section 2.7.11 (Spent fuel), ZEG says that the extension of Krško NPP's operational lifetime will generate greater quantities of spent fuel, but that this is not addressed; that the report simply states vaguely that spent fuel will be moved from the pool to dry storage, but says nothing about disposal; that this will create greater quantities of spent fuel at Krško NPP, thereby increasing the nuclear risk; that the spent fuel pool, whose operational lifetime is also to be extended, should also be subject to assessment; that extending operational lifetime also entails extending the temporary storage of spent fuel at Krško NPP, including Croatia's share, which further increases the nuclear risk; that the disposal of HLW, the location of the repository and year of completion of the repository should also be defined before any extension; and that the taxonomy template contains the commitments that must also be met after Krško NPP's operational lifetime is extended, i.e. a reliable plan and the financing of the search for and construction of a final HLW repository by 2050.

In relation to this comment, the ministry responds by saying that the spent fuel to be produced during the lifetime extension will, just like the other spent fuel already present at the Krško NPP site, be safely stored in spent fuel dry storage or partly in the spent fuel pool. Spent fuel dry storage is passive and safe spent fuel storage, and additional safety improvements in the spent fuel pool area have increased the level of nuclear safety and significantly reduced all risks associated with storage. An EIA was carried out for spent fuel dry storage and building permit no. 35105-25/2020/57 of 23 December 2020 granted for the facility by the Ministry of the Environment and Spatial Planning, Spatial Planning, Construction and Housing Directorate, Dunajska c. 48, 1000 Ljubljana.
The final location of the permanent disposal of spent fuel, for which an EIA procedure will also have to be carried out, is not the subject of this administrative procedure.

14.8.20. In relation to Section 2.7.12 (Safety Upgrade Programme (SUP)), ZEG points out that the SUP was meant to upgrade safety not extend the operational lifetime of the plant. All SUP measures must therefore also be assessed from the aspect of operational lifetime extension and, furthermore, that this is missing from the EIA Report.

In relation to this comment, the ministry responds by saying that the Krško NPP SUP was designed to upgrade safety and was undertaken, pursuant to the national post-Fukushima action plan following the EU stress tests, regardless of the extension or otherwise of Krško NPP's operational lifetime. The third paragraph of Article 9 of the Decree on the method of drafting and on the content of the report on the effects of planned activities affecting the environment provides that the description and assessment of the impacts of the planned activity should also include the impacts that are expected to result from actions connected with the activity or other environmental activities, during preparation work or construction, use or operation, or during the duration, removal or termination of the activity. In accordance with this Decree and as stated in Section 1.7.2 (Subject of the report), because the lifetime extension concerns the existing power plant complex, the report addresses the impact of the lifetime extension on the entire plant following the modification, including the spent fuel dry storage, which will begin operating in 2023.

The ministry has granted third-party participant status to all entities that requested access to the administrative procedure and who met the conditions referred to in the second paragraph of Article 64 ZVO-1. The status of third-party participant was acquired by the following entities:

- Zveza ekoloških gibanj Slovenije (ZEG, Association of Ecological Movements of Slovenia), Cesta krških žrtev 53, 8270 Krško pursuant to decision no. 35439-7/2022-2550-5 of 25 April 2022.
- Focus, društvo za sonaraven razvoj (Association for Sustainable Development), Trubarjeva cesta 50, 1000 Ljubljana pursuant to decision no. 35439-8/2022-2550-4 of 25 April 2022.
- Hidroelektrarne na Spodnji Savi, d.o.o., Cesta bratov Cerjakov 33a, 8250 Brežice pursuant to decision no. 35439-5/2022-2550-5 of 5 May 2022.

The ministry sent letter no. 35428-4/2021-2550-46 of 5 April 2022, which contained the opinions on the acceptability of the proposed activity acquired pursuant to Article 61 ZVO-1, and the comments from the public acquired during the public consultation, to the developer for its response.

In accordance with the ministry's invitation, the developer added the following documents to the applications of 10 and 25 May 2022:

- "Third Supplement to the Application for an Environmental Protection Consent for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years: presentation of evidence", no. ING.DOV-178.22, 6 May 2022, with four appendices;
- Supplemented Environmental Impact Assessment Report for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years – Nuklearna elektrarna Krško d.o.o. no. 100820-dn, October 2021, supplemented 8 November 2021, 10 January 2022 and 5 May 2022 – following public consultation (E-NET OKOLJE d.o.o., Linhartova cesta 13, 1000 Ljubljana, in printed and electronic form).

In accordance with announcement no. 35428-4/2021-2550-56 of 30 May 2022 and decision no. 35428-4/2021-2550-59 of 8 June 2022, the ministry held an oral hearing at its offices on 28 June 2022 to provide the developer and the third-party participants with an opportunity to declare their positions on all the facts and circumstances of importance to the decision-making process, and particularly the acceptability of the proposed activity (lifetime extension).

The oral hearing was attended by Zveza ekoloških gibanj Slovenije (ZEG, Association of Ecological Movements of Slovenia), Cesta krških žrtev 53, 8270 Krško, Focus, društvo za sonaraven razvoj (Association for Sustainable Development), Maurerjeva ulica 7, 1000 Ljubljana, and representatives of the developer. The ministry received a letter/communication from the third-party participant Hidroelektrarne na Spodnji Savi, d.o.o., Cesta bratov Cerjakov 33a, 8250 Brežice on 24 June 2022 stating that it would not be attending the hearing as it had decided, after re-examining the material being addressed in the procedure, that it had no comments to make or any requests for administrative clarifications from the parties to the procedure.

After the oral hearing, Zveza ekoloških gibanj Slovenije (ZEG), Cesta krških žrtev 53, 8270 Krško submitted further documents, which were forwarded to the developer:

- on 14 and 21 July 2022 (document no. 71/22 of 14 July 2022 titled "Comments by Zveza ekoloških gibanj Slovenije (ZEG) on the draft minutes of the oral hearing in the administrative matter of the issuing of an environmental protection consent for the extension of Krško NPP's operational lifetime from 40 to 60 years to NEK Krško d.o.o., Vrbina");
- on 26 and 30 September 2022 (document no. 96/22 of 26 September 2022 titled "ZEG's

response to the written comments of the developer Nuklearna elektrarna Krško, d.o.o., Krško NPP letter, their reference: ING.DOV-345.22, 7 September 2022");
- on 8 November 2022 (additional responses from Zveza ekoloških gibanj Slovenije (ZEG), Cesta krških žrtev 53, 8270 Krško to the comments of the developer no. ING.DOV-400.22, 4 November 2022).

On 19 December 2022 the ministry sent the developer letter no. 35428-4/2021-2550-94 apprising it of its views of the developer's position on the environmental conditions and the ministry's measures as set out in letter no. 35428-4/2021-46 of 5 April 2022 ("Third Supplement to the Application for an Environmental Protection Consent for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years: presentation of evidence", no. ING.DOV-178.22/2022, 6 May 2022, with four appendices);

The developer replied to this in letter no. ING.DOV-460.22/5341, 23 December 2022 (with Appendix 1).

Transboundary impact assessment procedure

1. Introduction

Proposed activity: Extension of Krško NPP's operational lifetime from 40 to 60 years. In accordance with point 3 of Appendix 1 to the Act Ratifying the Convention on Environmental Impact Assessment in a Transboundary Context (Official Gazette of RS [Mednarodne pogodbe], No, 11/98, hereinafter: Espoo Convention), Krško NPP constitutes: an installation solely designed for the production or enrichment of nuclear fuels.

Slovenia conducted transboundary consultations with Croatia, Austria, Italy, Hungary and Germany in adherence with the Espoo Convention and the Guidance on the applicability of the Convention to the lifetime extension of nuclear power plants, which was adopted at the 8th Session and Meeting of the Parties to the Protocol (8–11 December 2020), United Nations Economic Commission for Europe, translated into Slovenian, as in letter no. 35409-282/2020-2550-3, the provisions of Article 7 of Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment (codification) and Article 59 ZVO-1.

The ministry notes that the EIA documentation contains the information for establishing transboundary impact referred to in Article 4 and Appendix II of the Espoo Convention. Appendix II of the Espoo Convention provides that the documentation must contain: a description of the proposed activity and its purpose; a description of the environment likely to be significantly affected by the proposed activity and its alternatives; a description of the potential environmental impact of the proposed activity and its alternatives and an estimation of its significance; a description of mitigation measures; an explicit indication of predictive methods and underlying assumptions as well as the relevant environmental data used; an identification of gaps in knowledge and uncertainties encountered in compiling the required information; where appropriate, an outline for monitoring and management programmes and any plans for post-project analysis; and a non-technical summary including a visual presentation as appropriate.

The ministry consulted with all ministries and organisations and, after supplementing it, established that the material was suitable for transboundary consultation in accordance with the provisions of the Espoo Convention.

2. Notification

In a letter dated 23 July 2020, the Austrian Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology sent a written request for inclusion in the procedure of extending Krško NPP's operational lifetime. In its reply (reference no. 35409-282/2020-2550-2), Slovenia notified

Austria that a Slovenian Environment Agency decision had been issued stating than an EIA procedure had to be performed for the extension of Krško NPP's operational lifetime, and provided assurances that it would proceed in accordance with European and international standards and consult with Austria once it had received the application. Krško NPP submitted application no. 35409-282/2020-2550-1 on 30 October 2020.

Under the first paragraph of Article 3 of the Espoo Convention, for a proposed activity listed in Appendix I that is likely to cause a significant adverse transboundary impact, the party of origin shall, for the purposes of ensuring adequate and effective consultations under Article 5, notify any party which it considers may be an affected party as early as possible and no later than when informing its own public about that proposed activity.

The ministry notified all neighbouring countries by sending letter no. 35409-282/2020-2550-8, 9, 14, 15 to the Ministry of Foreign Affairs requesting it to provide notification to the following neighbouring countries: Croatia, Austria, Italy and Hungary.
The Croatian Ministry of the Environment and Energy was notified in letter no. 35409-282/2020-2550-13 of 21 May 2021; the Austrian Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology was notified in letter no. 35409-282/2020-2550-7 of 21 May 2021; the Hungarian Department of Environmental Preservation, Ministry of Agriculture was notified in letter no. 35409-282/2020-2550-16 of 25 May 2021; and the Italian Ministry for Environment, Land and Sea Protection was notified in letter no. 35409-282/2020-550-11 of 21 May 2021.
The following were enclosed with the notifications: a notification on the official UN/UNECE Espoo Convention form ("Notification to an affected party of a proposed activity under Article 3 of the Convention") and the Project Long-Term Operation of Krško NPP, (2023–2043), Rev. 1, 22 February 2021 (English translation).

The ministry sent the material in accordance with Article 3 of the Espoo Convention and point 1 of Article 7(a) and (b) and Annex II to Directive 2011/92/EU (a description of the activity, including any available information on its possible transboundary impact, and the nature of the possible decision), and asked the countries to indicate within 30 days whether they wished to participate in the environmental decision-making procedure.

In the course of the procedure, Germany asked to participate in accordance with point 7 of Article 3 of the Espoo Convention. In accordance with the Espoo Convention and the second paragraph of Article 7 of Directive 2011/92/EU, Slovenia incorporated it into the participation process and sent it all the documentation.

All the notified countries sent responses by the specified deadlines confirming participation in the transboundary procedures referred to in point 3 of Article 3 of the Espoo Convention.

3. Preparation of EIA documentation

In letter no. 35409-282/2020-2550-1 of 30 October 2020, NEK d.o.o. forwarded the draft "Extension of Krško NPP's Operational Lifetime From 40 to 60 Years" project as the basis for the preparation of the EIA.
The material was supplemented by letter no. 35409-282/2020-2550-25 of 8 June 2021 containing:

- Environmental Impact Assessment Report for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years – Nuklearna elektrarna Krško d.o.o. no. 100820-dn, May 2021, Ljubljana; and
- "Supplement Assessing the Acceptability of the Impacts on Protected Areas for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years – Nuklearna elektrarna Krško d.o.o." no. 1456-20-VO, May 2021, Ljubljana.

In letter no. 3509-282/2020-2550-37, Krško NPP added translations of the lay summary into English, German and Croatian to the material, along with a translation into Hungarian (in an additional supplement).

The ministry checked whether the documentation contained all the information referred to in Article 4 and Appendix II of the Espoo Convention on Environmental Impact Assessment in a Transboundary Context and required to be sent to the competent authority of the party of origin, and whether it contained at least the information referred to in Appendix II.
After reviewing it, the ministry established that the material contained the following:
a) a description of the proposed activity and its purpose;
b) a description, where appropriate, of reasonable alternatives;
c) a description of the environment likely to be significantly affected by the proposed activity and its alternatives;
d) a description of the potential environmental impact of the proposed activity and an estimation of its significance;
e) a description of mitigation measures to keep adverse environmental impact to a minimum;
f) an explicit indication of predictive methods and underlying assumptions, as well as the relevant environmental data used;
g) an identification of gaps in knowledge and uncertainties encountered in compiling the required information;
h) where appropriate, an outline for monitoring and management programmes and any plans for post-project analysis; and
i) a non-technical summary, including a visual presentation as appropriate (maps, graphs, etc.).

The Decree on the method of drafting and on the content of the report on the effects of planned activities affecting the environment (Official Gazette of RS, Nos. 36/09, 40/17 and 44/22 [ZVO-2]) lays out the content of an environmental impact assessment report in full. The ministry reviewed the enclosed EIA Report, examined its content and, after making the necessary additions, established that the material contained all the elements referred to in the Decree on the method of drafting and on the content of the report on the effects of planned activities affecting the environment.

After the supplements were supplied in the national procedure (Environmental Impact Assessment Report for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years – Nuklearna elektrarna Krško d.o.o. no. 100820-dn, Ljubljana, October 2021, supplemented 8 November 2021 and 10 January 2022), the ministry established that the material was complete and constituted a suitable basis for transboundary consultation. The EIA Report was drawn up by 22 experts in the fields of ecology, physics, landscape architecture, architecture, biology, machine engineering, construction, chemistry, chemical technology, mechanical engineering, geology and health.

In letter no. 35409-282/2020-2550-39 of 16 February 2022, Krško NPP provided translations of the following documentation into the English, German and Croatian languages:

1. Environmental Impact Assessment Report, Extension of Krško NPP's Operational Lifetime From 40 to 60 Years – Nuklearna elektrarna Krško d.o.o. no. 100820-dn, Ljubljana, October 2021, supplemented 8 November 2021 and 10 January 2022;
2. Supplement Assessing the Acceptability of the Impacts on Protected Areas for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years – NEK d.o.o., October 2021, supplemented January 2022;
3. Soil Status Report for the Site of the Planned Construction of an SFDS for Nuklearna elektrarna Krško d.o.o. (reference no. 360/2020);
4. Project: Long-Term Operation of Krško Nuclear Power Plant (2023–2043), Rev. 3
5. Environmental Protection Consent for the Activity: Extension of Krško NPP's Operational Lifetime From 40 to 60 Years (draft);
6. Lay Report Summary; Environmental Impact Assessment Report for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years – NEK d.o.o.

4. Transboundary consultation

In accordance with point 5 of Article 3 of the Espoo Convention, upon receipt of a response from an affected party indicating its desire to participate in the EIA procedure, the party of origin shall provide:
a) relevant information regarding the EIA procedure, including an indication of the time schedule for transmittal of comments;
b) relevant information on the proposed activity and its possible transboundary impact.
Slovenia provided the EIA Report on the basis of its own information. The information referred to in point 6 of Article 3 of the Espoo Convention was not required.

CROATIA

In letter no. 35409-282/2020-2550-41 of 22 February 2022, Slovenia sent documentation in the Slovenian language and in letter no. 35409-282/2020-2550-41 and 47, documentation translated into the Croatian language, to Croatia. It also proposed that it conduct a technical consultation with Croatia. The following documents were therefore sent to Croatia:
- Studija utjecaja na okoliš za produljenje pogonskog vijeka NEK s 40 na 60 godina – NEK d.o.o., listopad 2021, dopuna 10. siječnja 2022, broj 100820-dn (Environmental Impact Assessment Report for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years – Nuklearna elektrarna Krško d.o.o., October 2021, supplemented 10 January 2022, no. 100820-dn;
- Projekt: Dugoročni pogon Nuklearne elektrarne Krško (2023–2043), Rev. 3 (Long-Term Operation of Krško Nuclear Power Plant (2023–2043), Rev. 3);
- Okolišna suglasnost za zahvat: produljenje pogonskog vijeka NEK -a s 40 na 60 godina (nacrt) (Environmental Protection Consent for the Activity: Extension of Krško NPP's Operational Lifetime From 40 to 60 Years (draft));
- Netehniški sažetak studije (Lay Report Summary); Izvještaj o utjecaju na okoliš za produljenje životnog vijeka NEK sa 40 na 60 godina – NEK d.o.o. (Environmental Impact Assessment Report for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years – NEK d.o.o.);
- Dodatak za ekološko mrežu (Supplement Assessing the Acceptability of the Impacts on Protected Areas);
- Izvješte o stanju tla (Soil Status Report).

In letter no. 35409-282/2020-2550-58 of 31 March 2022, Croatia confirmed its participation, the technical consultation and the organisation of a public consultation in Croatia. Technical consultations between the competent ministries and organisations took place by video link on 6 May 2022. As letter no. 35409-282/2020-2550-92 of 10 June 2022 shows, the following documents were presented: the "Extension of Krško NPP's Operational Lifetime (2023–2043)" project, and the Environmental Impact Assessment for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years. The transboundary impact on the event of emergencies and accidents was discussed, and clarifications of all questions were provided. The impact on the water body of the Lower Sava was discussed from environmental aspects, and it was established that more detailed measures had to be applied to this issue.

The competent Croatian ministry organised a public presentation of the EIA, which took place on 27 May 2022 at the Faculty of Electrical Engineering and Computer Science, Unska 3, Zagreb. Slovenia supplied an expert team that gave the presentation in the Croatian language.
The documentation and presentations are also publicly available in electronic form on the Ministry of Economy and Sustainable Development's website.

On 6 July 2022 the ministry received Croatia's written opinion (reference no. 351-03/21-08/02, 24 June 2022, hereinafter: Final Opinion of Croatia, document no. 35409-282/2020-2550-100), which also included the Ministry of the Economy and Sustainable Development, Zelena Akcija and Greenpeace. The Slovenian Ministry of the Environment and Spatial Planning forwarded it to Krško NPP. In response to Croatia's opinion, Krško NPP drafted:
- NEK d.o.o.'s comments on the Final Opinion of Croatia and the request to supplement the

Environmental Impact Assessment in response to Croatia's observations, class: 351-03/21-08/02, no. 517-05-1-22-21, 24 June 2022;

- NEK d.o.o.'s comments on the observations of Zelena Akcija regarding the Environmental Impact Assessment Report for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years, Municipality of Krško, Slovenia, Zagreb, 6 June 2022;
- NEK d.o.o.'s response to the Final Opinion of Croatia and the request to supplement the Environmental Impact Assessment in response to Croatia's observations (mišljenje Republike Hrvatske i poziv na dopuno studije uticaja na okoliš na temelju primjedbi), class: 351-03/21 – 08/02, URBroj: 517-05-1-22-21, 21 June 2022;
- Answer to the comments from Greenpeace Croatia reacting on the documentation in the Environmental Impact Assessment for the lifetime extension of the NPP Krško from 40 to 60 years, 9 June 2022.

In response to Krško NPP's comments on the Final Opinion of Croatia, class 351-03/21-08/02, no. 517-05-1-22-21 of 24 June 2022, the ministry's positions are as follows:

<u>Question 1</u>: In relation to the study, Section 1.2.3 (Long-term operation of Krško NPP in relation to Slovenia's future energy supply) gives the impression that this extension is only necessary/important for Slovenia, as it provides it with energy stability. It is important to clarify what is at stake for Croatia's energy stability and what Croatia gains from this project.

The ministry notes that the EIA Report was supplemented with the proposed content. In accordance with the agreement from the technical consultations with Croatia of 6 May 2022, the importance of Krško NPP to Croatia from an energy and climate policy standpoint was presented to the Croatian public in a public presentation held on 27 May 2022 at the premises of the Faculty of Electrical Engineering and Computer Science of the University of Zagreb. The presentations are also publicly available in electronic form on the Ministry of Economy and Sustainable Development's website.
The ministry explains that a study titled "Energy, systemic, economic and ecological aspects of the extension of the operational lifetime of Krško NPP", which was drawn up by Elektroinštitut Milan Vidmar and the Faculty of Electrical Engineering at the University of Zagreb, showed that Krško NPP would be irreplaceable during the period of the proposed lifetime extension. If the lifetime of Krško NPP is not extended, both countries will be reliant on electricity imports, where and if available. EU Member States' national energy and climate plans show a net energy deficit, meaning that electricity imports will not always be available when needed and that reducing consumption will be the only alternative in crisis situations. This is not in line with the first dimension of the Energy Union: "Security, solidarity and trust - diversifying Europe's sources of energy and ensuring energy security through solidarity and cooperation between EU countries". Operating Krško NPP until 2043 is a first step towards decarbonisation and long-term energy independence. It will not be possible for either country to maintain short-term energy security without Krško NPP. The situation is even worse for future energy use, as electricity is considered the predominant form of energy in the economy (industry, transport, services) and for most of the population's energy consumption. Current developments and their forecasts do not indicate a sufficient technological breakthrough capable of replacing Krško NPP's current generation capacity with renewable energy (RE) while meeting the current and future required criteria of reliability, safety, environmental sustainability and economic viability. The requirement to preserve spatial features, biodiversity, valuable natural features, protected areas and valuable cultural assets makes it difficult to introduce new renewable energies capable of replacing Krško NPP in the next 20 years. Based on the scenarios and sensitivity analyses of energy balances and electricity demand, it is clear that extending Krško NPP's operational lifetime is the most technically, environmentally and economically advantageous solution. Events in recent months, which have seen a steep rise in fuel and electricity prices, are further confirmation of the urgency of maintaining production at Krško NPP, as it guarantees relatively affordable and sufficient supply of the electricity that industry and commerce so desperately need. If Krško NPP's operational lifetime is not extended, the stability and reliability of the electricity systems of Slovenia and Croatia will be at risk, which could slow their progress towards climate

neutrality.
The energy, climate and economic aspects of the impact of the extension of Krško NPP's operational lifetime on Croatia are presented in Section 6.3.8 of the EIA Report.
Krško NPP is therefore a stable source of electricity for both Croatia and Slovenia, and one that offers continuous and reliable production. At the end of 2019, the total available power of power plants in Croatia stood at 4,711.8 MW; this figure included 1,781 MW from thermal power plants, 2,199.7 MW from hydropower plants, 646.3 MW from wind turbines and 84.8 MW from solar power plants. The capacity of Krško NPP available to Croatia (348 MW) amounts to an additional 7.4% of production capacity, with continuous supply. Between 2014 and 2019, Krško NPP covered 15.2% of Croatia's electricity consumption. Krško NPP has negligible GHG emissions; indeed, according to a life-cycle assessment (LCA), emissions from the plant are on a par with renewable energy sources (wind, solar, etc.).
Croatia's Integrated National Energy and Climate Plan and its Strategy for Low-Carbon Development up to 2030, with an outlook to 2050 (Official Gazette of the Republic of Croatia, No. 63/2021) envisage electricity generation at Krško NPP until 2043, which will help to reduce greenhouse gas emissions in line with the commitments set out in the Paris Agreement and the European Green Deal. Extending Krško NPP's operational lifetime will have a positive impact on Croatia's energy needs and contribute to its energy stability.

Question 2: In addition to this, neutron radiation (more precisely, neutron collisions with the cores and neutron reactions with the cores of the reactor vessel material) causes the material to age and lose its physical properties over time. This relates to the material of the reactor vessel on the equatorial plane (closest to the nuclear fuel, where the neutron flux is highest). This is particularly important for the welds on the reactor vessel in the equatorial area and for the welds along all pressurised water pipes and fittings at the ends of the reactor vessel. A more detailed explanation must therefore be provided of how the systematic identification of aging mechanisms and their effects on the reactor vessel and all its components is to be planned in the event that Krško NPP's operational lifetime is extended.

After studying Krško NPP's comments, the ministry responds by saying that an Aging Management Programme (AMP) has been established and updated, and that time-limited aging analyses (TLAA) have been produced and updated on the basis of NUREG-1801. The compliance of the AMPs and the TLAAs with IAEA (IGALL) requirements has been examined and confirmed. AMPs are regularly updated at Krško NPP by taking into account new regulatory requirements, foreign and domestic experiences and new R&D findings. Krško NPP has so far implemented 42 AMPs using the GALL approach. IAEA (IGALL) compliance has been examined and confirmed for every programme.
The reactor vessel irradiation control programme controls the effects of aging resulting from a loss of fracture toughness from irradiation and the brittleness of the low-alloy steel material of the reactor pressure vessel. The monitoring methods are in accordance with 10 CFR 50, Appendix H. This programme refers to the requirements for evaluating neutron irradiation, the removal of control capsules, the mechanical testing/evaluation of the sample, and the production of a diagram of the temperature/pressure limits of acceptability for the operation of the reactor vessel. The requirements mentioned in this programme ensure that the reactor vessel's materials meet the requirements regarding the fracture toughness energy of the material under 10 CFR 50, Appendix G, and meet the pressurised thermal shock (PTS) requirements of 10 CFR 50.61. For the period of the lifetime extension, the programme also includes an alternative method of monitoring neutron irradiation (NUREG-1801), which is performed using an ex-vessel neutron dosimetry (EVND) system. Samples are examined, tested and analysed by accredited external laboratories.
Krško NPP also has an in-service inspection programme in place for the non-destructive testing of the reactor vessel and reactor vessel closure head in accordance with ASME XI. For the non-destructive evaluation (NDE) of the basic material of the reactor pressure vessel at the level of the core, Krško NPP is part of the PWROG (Pressurized Water Reactor Owners Group) working group, and implements the latest industrial R&D findings on a continuous basis.
According to all the expert inspections performed so far, the state of the reactor vessel is sufficiently

adequate (the pressure boundary safety function is operational) to ensure that Krško NPP is able to operate over the long term.
The maximum temperature for nil ductility transition (ARTNDT) is currently 78.3ºC for an operational lifetime of 60 years. This temperature relates to the inside of the reactor vessel and the basic reactor vessel material. In nuclear power plants regulated by the provisions of 10 CFR 50, resistance to brittle fracture is ensured by the p-T limiting curve and the Charpy test upper-shelf energy of the reactor vessel material. The p-T limiting curve constitutes the temperature and pressure spectrum within which operation is permitted, and is fixed on the basis of the ARTNDT and the maximum neutron flux (n/cm^2) of fast neutrons in accordance with the provisions of 10CFR50 Appendix G. In this sense, it guarantees operation within the pressure-temperature limiting curve of resistance of the reactor vessel to brittle fracture. The pressure-temperature limiting curve is therefore part of Krško NPP's Technical Specifications. Another way of ensuring resistance to brittle fracture is by having material with a sufficient Charpy test upper-shelf energy, which is the energy required to fracture materials using the Charpy test. The minimum value of this energy is set in 10 CFR 50 Appendix G and amounts to 68 J at the end of the operational lifetime. For Krško NPP, the upper-shelf energy is a minimum of 83.8 J for an operational lifetime of 60 years.
By carrying out regular periodic inspections of structures, systems and components (SSCs), Krško NPP ensures that they are capable of withstanding any design-basis accident even during the period of extended operation (i.e. after more than 40 years of operation). Krško NPP also ensures that aging management processes and preventive measures do not lead to any loss of the original safety margins. This is also confirmed by the inspections conducted by the SNSA, by international inspection missions (TPR, OSART, WANO, IAEA) and by the independent expert institutions involved in all regular outages of the power plant. TLAAs are also performed for SSCs that are subject to time-limited operating conditions; these are independently confirmed by external inspectors so as to ensure that the design bases and requirements for the analysed SSCs are maintained.

Question 3: The study in Section 4.1.4.1 (Thermal pollution) and the non-technical summary in the "Water" section state that the extension of Krško NPP's operational lifetime will not change the way wastewater is discharged, but will increase the proportion of cooling water discharged via the cooling towers. The impact of this increase needs further clarification. The status of the surface water body of the Sava, into which the cooling water is discharged, is currently "good". According to the Water Basin Management Plan 2022–2027, which is currently being prepared, the status of the Sava surface water body is no longer "good" for the biota indicator. Clarification needs to be provided as to what has contributed to the deterioration of the status of the biota and/or whether this is related to the impact of Krško NPP. It is also noted that Krško NPP is obliged to comply with certain limits for indicators, in particular for the temperature of the cooling water discharged into the Sava, and that the temperature of the wastewater at discharge V7 must not exceed 43°C, which is significantly higher than the values specified in Croatian regulations (maximum 30–35°C). The prescribed limit for delta T (ΔT) at the boundary of the mixing zone is, cumulatively with all other thermal impacts, the same as in the Croatian regulations (ΔT of 3°C). Clarification needs to be provided of where exactly the mixing boundary lies and how this 43°C affects the fauna and flora that migrate upstream and downstream and are deemed to be valuable natural features.

After studying the comments supplied by Krško NPP and the data received from the Slovenian Environment Agency (ARSO), the ministry responds by saying that the frequency of operation of the cooling towers will increase in response to the anticipated climate change in order to maintain the thermal load within the specified parameters. The highest quantities of wastewater come from the condenser cooling system (CW), i.e. 91.4%, followed by cooling towers (CT) at 5.2% and small component cooling systems (SW) at 3.2% (see Section 5.6.1, Figure 84). More frequent operation of cooling towers significantly reduces the amount of water from the condenser cooling (CW) system, and wastewater from the cooling towers has a lower temperature than the condenser cooling water. When the Sava flow rate is low (<50 m^3/s), the cooling towers provide recirculation at 15 m^3/s without discharges from the cooling towers. With a moderately low Sava flow rate (50–100 m^3/s), 10 m^3/s is recirculated and 5 m^3/s is discharged, i.e. three times less than the amount that would be discharged if the cooling towers were not in operation.

Taking into account the temperature scheduling model at the Brežice HPP's reservoirs, this is an area around 100 m downstream of discharge V7, but not along the entire width of the riverbed, where the mixing of water occurs. The effect of strongly heated water is therefore very local. In 2020 the daily average of the proportion of transmitted heat accounted for by discharge V7 never exceeded the limit value set out in the environmental protection permit. Although the maximum permitted temperature at discharge V7 is 43°C, the highest measured temperature of the water at the condenser outlet in 2020 was 35.9°C and did not exceed 30°C on 81% of the days. Periodic national monitoring of the ecological status of rivers is carried out downstream of discharges from Krško NPP on the Sava–border section water body (SI1VT930), where the measuring point is located at Jesenice na Dolenjskem. The ecological status was assessed as "moderate" in 2009 and 2011 (the phytobenthos and macrophytes parameter of trophic condition was assessed as "moderate" in 2009, and the phytobenthos and macrophytes parameter of saprobic condition was assessed as "moderate" in 2011), while the ecological status was assessed as "good" in 2010 and in the period 2012–2019. The trophic condition and saprobic conditions for phytobenthos, macrophytes and benthic invertebrates were actually assessed as "very good" in 2016 and 2018. Krško NPP operation therefore does not have a significant impact on the ecological status of the Sava.

Krško NPP captures the Sava for the cooling of systems and structures from measuring point M1 using a resistance thermometer (PT100), which has a high degree of accuracy and a fast response. This measuring point is located just upstream of the Sava offtake channel. The Krško NPP outlet temperature is measured at the outflow channel to the Sava. It is also recorded using a resistance thermometer.

The temperature at the point of complete mixing is then determined from the measured inflow and outflow temperatures and the flow rates of the offtake from the Sava. Due to the strict limits for temperature rise in the Sava, this is the most accurate and only reliable method. This is described in detail in Section 4.4.4.1 of the EIA Report. Measurements at a fixed point downstream of Krško NPP cannot provide absolutely reliable results because conditions vary (flow rate, solar radiation, thermal stratification, humidity, heat exchange with the atmosphere, etc.). Because of the heating and cooling that takes place, a mixing point determined far away from the discharge is not representative; moreover, the hydropower plant can mean that there is a 12-hour time lag.

Krško NPP regularly monitors the temperature of the water to ensure that the Sava does not rise more than 3°C above its natural temperature. The maximum difference between the temperature of the Sava before the sampling location for cooling water and its temperature after it is mixed with the cooling water may not exceed a daily average of 3°C (3°K). This requirement is consistently adhered to, something that Krško NPP also confirms by year-round measurements of the temperature of the Sava (monitoring).

Sections 4.1.4 and 5.3.1.1 of the EIA Report show that the poor status of the biota is not due to discharges from Krško NPP but to general contamination with mercury and brominated diphenyl ethers (BDE), which do not come from Krško NPP. The EIA Report states: "Assessments of the chemical status of surface waters for the biota matrix show that, in Slovenia as in all European countries, mercury and brominated diphenyl ethers (BDE) are the substances that cause poor chemical status of surface water bodies because they fail to meet the environmental quality standards (EQS) for biota. The previous water management plan indicated a poor chemical status as a result of the EQS being breached for mercury in biota in 98.6% of surface water bodies. Mercury and BDE are classed as persistent bioaccumulative toxic contaminants (PBT) and accumulate in organisms. A similar situation is to be found in all European countries that have carried out analyses of these substances in fish. In Slovenia, monitoring has been conducted in biota in 60 surface water bodies, in international profiles, in areas without any human impact, and in polluted areas. The EQS for organisms were exceeded at all measuring points at which analyses of mercury and BDE were conducted. In light of this, the poor chemical status for the parameters of mercury and BDE was extrapolated to all surface water bodies. A low confidence level is therefore attached to the poor chemical status determined for biota in all surface water bodies in Slovenia in which chemical status was determined by extrapolation."

Estimates indicate that the highest inputs of the contaminants concerned into the Danube RBD are the result of atmospheric depositions in the river basins of the Drava, Middle Sava, Lower Sava and Savinja;

they also show that inputs of hydrogen and sulphur from atmospheric deposition fell between 2013 and 2015, with a slight increase observed in 2016.
Taking this into account and comparing the data estimates on the types and strengths of pressures from atmospheric deposition with an assessment of the status of surface water bodies, it is estimated that atmospheric deposition exerts a significant pressure that causes poor chemical status by breaching the EQS for mercury in biota.

Question 4: In the description of the potential impacts of flooding in the study (Section 5.6.1, Drive, Module 1 – Sensitivity analysis of the activity), the maximum flow rate of the Sava during a flood with a recurrence interval of 10,000 years is: 4,790 m^3/s, which corresponds to a height of 155.35 m above Adriatic sea level. It is noted that Krško NPP is designed for floods with a frequency of 0.01% per year. The height of the plateau on which it is located is 155.20 m above sea level, and the entrances and openings of the buildings are 155.50 m above sea level. Section 5.6.1.2 (Impact of extreme weather events and climate change on the safety aspects of the activity) mentions a flow rate of 3,470 m^3/s for design floods with a recurrence interval of 10,000 years. This corresponds to an elevation of 155.35 m a.s.l. Section 2.7 (Ensuring the safe operation of Krško NPP) estimates the maximum flow rate of the Sava in the event of a flood with a recurrence interval of 10,000 years (based on hydrological data from 1926 to 2000) to be 4,790 m^3/s. There are similar differences in the estimates of the probable maximum flood (PMF), which Section 2.7.8.2 (Chronology of improvements to Krško NPP flood protection since 2010) calculates as 7,081 m^3/s with a recurrence interval of 10,000 years and a height at the Krško NPP dam of 155.61 m a.s.l. By contrast, Section 5.6.1.2. mentions a flow rate of 6,500 m^3/s for the PMF. Hydraulic calculations have been carried out on multiple occasions (including in response to the construction of reservoirs at the nearest hydropower plants), and have led to the raising of embankments, the construction of a protective wall, etc., all with the aim of investing flood protection. While there is no doubt that Krško NPP is protected against floods, the different values in different sections of the study must be justified and, where necessary, corrected.

After studying Krško NPP’s explanations, the ministry finds that Section 5.6.1.2. contains a technical error: specifically, an excessively low value of 3,470 m^3/s has been given for a 10,000-year flow rate, which is incorrect. The 10,000-year flow rate is 4,790 m^3/s, which corresponds to a height of 155.35 m a.s.l. Under PMF, a flow rate of 6,500 m^3/s is given, which is incorrect. The PMF flow rate is 7,081 m^3/s. In Section 2.7.8.2, a typographical error has occurred, i.e. 155.61 m a.s.l. is given for the PMF height, which is incorrect. The PMF flow rate is 7,081 m^3/s with a height at the Krško NPP dam of 156.41 m a.s.l.
A further explanation of flood flow rates and heights is given below: Krško NPP is protected against a number of flood flow rates and resulting water levels.
The first level of safety is the 10,000-year flood. This is 4,790 m^3/s, which corresponds to a height of 155.35 m a.s.l. at the threshold of the Krško NPP dam. The plant is absolutely safe with this height, even without flood protection, as the openings to the plant are 155.50 m a.s.l.
In addition, the plant is protected from major flooding by the height of the spoil heaps and the flood-protection embankments. It is therefore safe from a PMF, the flow rate for which is
7,081 m^3/s with a height at the Krško NPP dam of 156.41 m a.s.l. In these conditions, the wind could blow from an unfavourable direction and various surge waves appear in the reservoir. There is an additional safety margin in terms of height to protect the power plant in the event of a surge. The water would therefore overflow the flood embankments (without surges or the additional safety margin) if the Sava flow rate reached 11,130 m^3/s.
As an additional flood-protection measure, further flood protection has been provided for buildings (protection of up to 157.53 m a.s.l.); this also provides functional protection in the event of an earthquake with a ground acceleration of 0.6 g.

Question 5: Section 6.3 of the study (Transboundary impacts during normal Krško NPP operation) should be supplemented with an analysis of the existing status of downstream surface water bodies, e.g. CSR1001-021 Sava, and information provided on current status and on whether there are any changes in relation to the next Water Area Management Plan (WAMP) 2022–2027 for the territory of Croatia, as there have been in the new Water Management Plan 2022–2027 for Slovenia. The new WAMP 2022–2027 also includes a report on whether or not WAMP 2016–2021 was realised. The impact of the hydropower plants downstream of the Sava in Slovenia on the thermal pollution of the river downstream of Krško and further on into Croatia should also be mentioned.

After studying Krško NPP's comments, the ministry explains that Section 6.3.2 (Transboundary impacts on water) makes reference to the status of the water body in the Croatian border area. According to the WAMP 2016–2021, the status of watercourse CSRI0001_021 Sava upon entering Croatia is as follows: general status "good", chemical status "good" and ecological status "good", specific polluting substances "very good" and hydromorphological characteristics "very good". WAMP 2022–2027 for Croatia is in the process of being adopted. Assessments of the status of individual water bodies are therefore not yet available. WAMP 2022–2027 concludes that the status of water bodies in 2016–2018 was worse than in 2015 in terms of biological, physicochemical and hydromorphological quality elements, and relatively worse so when it came to specific pollutants. The deterioration in ecological status can be explained by the fact that status is assessed using a significantly larger number of measuring stations than was the case in 2015. This is particularly true for biological quality elements, with the percentage of stations analysing those elements increasing from 15% to 83% (WAMP 2022–2027). Analyses of physicochemical elements are now carried out at 99% of stations (up from 89%) and analyses of specific pollutants at 90% of stations (up from 84%). Analyses carried out at the Drenje site in 2018 show that the status of the water body had deteriorated in terms of ecological status (macrophytes and biological quality elements, data supplied by Hrvatske vode).

Water pollution can be of natural or anthropogenic origin, and may include chemical pollution, organic and microbiological pollution, and excessive quantities of nutrients. Thermal pollution is one type of anthropogenic pollution. Indicators of water pollution can include oxygen quantity, BOD_5, nitrogen quantity (nitrates and nitrites), phosphate quantity, the presence of heavy metals, existing organic compounds and acidity. It should be stressed at this point that the Krško NPP does not release any substances that cause chemical, organic or microbiological pollution. Using a ten-year data set, the EIA shows, for example, that COD and BOD_5 at the cooling system inlet are the same as at the outlet of the plant. The only pollution present is thermal pollution, which is within the permissible limits (and still well below the limit value). The average ΔT value between 2010 and 2020 was 1.94°C, i.e. below the permitted daily average of 3°C.

Between 2010 and 2020, the average temperature of the Sava at the point of complete mixing rarely exceeded 27°C in one day (four times in July 2015, once in August 2017 and four times in August 2018), but it never exceeded 28°C. According to the measurements in the study "Energy facilities on and along the Sava River – Analysis of river temperatures in the Lower Sava in July and August 2019 and the verification of previous studies" (Revision A, IBE, April 2020), the Brežice HPP reservoir has an additional cooling effect on the water under extreme conditions of high air temperatures and low Sava flow rates. This also applies to other reservoirs on the Lower Sava, which provide an opportunity to mitigate the effects of climate change.

Regarding the thermal impact downstream, measurements of the Sava temperature are shown for the entire mixing profile, at the Čatež site, at Jesenice na Dolenjskem and at Drenje-Jesenice (close to the border with Croatia). Figure 1 (see the response that follows) shows that there is no significant temperature increase at the Drenje site in Croatia. This is certainly mainly due to the confluence of the Sava and Krka and partly to the confluence of the Sava and Sotla. There are no anthropogenic thermal emissions into water downstream of Krško NPP. The first major impact is at the site of the TE-TO power plant in Zagreb and then in Sisak. The thermal load has fallen significantly at Sisak since the removal from operation of two 2 x 210 MWe power plant units (thermal impact of the order of magnitude of Krško NPP), while the existing gas-fired power plant has been constructed as a CHP plant that generates relatively little waste heat because it has a capacity of 70 MWe (condensation part).

The study "Analysis of biological methods for assessing the ecological status of fish in European intercalibration-type rivers of the Pannonian and Dinaric ecoregions; analysis of the effects of environmental factors and anthropogenic pressures on biological quality components" (PMF 2020, client: Hrvatske vode) did not mention anthropogenic thermal pollution as one of the main water pollution pressures in Croatia.

Krško NPP will not change its energy parameters in the next 20 years, i.e. the discharge of waste heat into the Sava and the atmosphere will remain the same as before. In terms of impact, climate change manifests itself as changes to the flow rate of the Sava. According to existing projections ("Estimate of changes to rivers in Slovenia up to the end of the 21st century", 2018), a 5% decrease in flow rate is predicted, although a 5% increase in flow rate is equally possible. If the flow rate falls, the same amount of heat is transferred to less water, resulting in an increase in WHER and ΔT of up to 5%, which is proportionate to the reduction in flow rate. This change would increase the ΔT from 1.94°C to an average of 2.037°C, which is still well below the ΔT of 3°C. The increase in the temperature of the Sava resulting from climate change will add ΔT to the slightly higher natural values of river temperature. The projected trend of average annual temperature increase is 0.2–0.25°C (and in summer 0.3-0.4°C) per decade for the Lower Sava region ("Climate change estimates for Slovenia up to the end of the 21st century", 2018). Krško NPP has the option of mitigating the impact by increasing the use of cooling towers, which have sufficient capacity for the task. The EIA provides clear guidelines as to when the use of cooling towers should be increased.

Question 6: With the planned expansion of Krško NPP's operational lifetime, particular attention should be paid to the monitoring of thermal and radiological contamination caused by the plant. Particularly since global warming caused by climate change will lead to an increase in water temperatures in surface waters, the additional permissible increase of 3°C will have a much greater impact than at the time of Krško NPP was being constructed.

After studying Krško NPP's explanations, the ministry responds by saying that the plant prevents the Sava from overheating using a number of measures, including a combined cooling system and the engagement of the cooling towers. If the combined cooling system is insufficient to meet these conditions, the plant is required to reduce its power accordingly. In 2008 Krško NPP extended its cooling capacity with the construction of a third block of cooling towers (four cells added to the existing six). The total cooling capacity is now 627.8 MW. The upgrading of the cooling towers in 2008 increased cooling capacity by 36%, reducing the likelihood of situations in which the plant was required to reduce power in response the 3°C level possibly being exceeded. Section 5.6.1 of the EIA gives an estimate of the days in which the need could arise for the plant's power to be reduced. As the likelihood of such events is extremely small, additional measures are not required (Table 123) – indeed, plant power has not had to be reduced on a single occasion since the cooling towers were upgraded in 2008. The cooling towers can disperse 49.5% of the power plant's total waste heat, which means it has large reserve capacity for heat removal.

Between 2010 and 2020, the average temperature of the Sava at the point of complete mixing rarely exceeded 27°C in one day (four times in July 2015, once in August 2017 and four times in August 2018), but it never exceeded 28°C. The projected trend in the rise of the average temperature in the summer months is between 0.2 and 0.25°C per season and 0.3 and 0.4°C per decade for the area of the Lower Sava ("Estimate of climate change in Slovenia up to the end of the 21st century", Synthesis report – Part One, ARSO, November 2018). In relation to the measurements contained in the study titled "Energy buildings along and on the Sava – Analysis of river temperatures in the Lower Sava in July and August 2019 and the verification of previous studies" (Revision A, IBE, April 2020), the reservoir of the Brežice hydropower plant has an additional cooling effect on the water under extreme conditions of high air temperatures and low Sava flow rates. This also applies to other reservoirs on the Lower Sava, which provide an opportunity to mitigate the effects of climate change. We therefore predict that, with the continuation of the restriction on Krško NPP causing an increase in the temperature of the Sava of more than 3°C (3°K), there will be no problematic reduction in the amount of oxygen available to aquatic life in the river.

The waste heat emission ratio for the period 2010–2020 was 0.646 and the ΔT 1.94 °C. This indicates

that, on average, the thermal load did not reach EDOT = 1 and the ΔT did not reach 3°C. The analyses show that the number of days on which the cooling towers are put into operation to stop the boundary conditions from being exceeded will increase in the future, as will the probability that the plant's output will have to be reduced. Section 5.6.1 describes how existing systems are sufficient to mitigate the impacts of climate change.
With regard to the daily maximum temperatures of the Sava, an overview of the measurements at four locations is given: at the inlet to the Krško NPP cooling system (Krško NPP inlet), downstream of the Krško NPP outlet (after complete mixing), and at the measuring points at Čatež, Jesenice na Dolenjskem and Drenje Jesenice (Figure 2). Measurements at the Čatež I station within the national monitoring network are 8 km away from the plant, measurements at Jesenice na Dolenjskem are 18 km away from the plant, and measurements at Drenje Jesenice are on the border with Croatia. Brežice reservoir lies between Krško NPP and the Čatež I and Jesenice na Dolenjskem measuring points, while the Krka river flows into the Sava behind Brežice reservoir.
The following conclusions can be drawn from the measurement results (Figure 2):
- The growth trend was higher in the 1979–1999 period, with a considerably more moderate trend in the 2000–2020 period. Looking at all four locations (average), there is no increase in maximum daily temperature.
- There is a clear correlation between temperatures at different measurement locations.
- The temperature downstream of Krško NPP after complete mixing is very close to the measurements at Jesenice na Dolenjskem. Cumulative impacts do not cause a rise in the Sava's maximum temperatures.

Climate change will lead to an increase in maximum temperatures, but the cumulative impact overlaps with a barely noticeable increase in temperature downstream of Krško NPP.

In response to the findings relating to the Sava, the ministry has determined more detailed measures for protecting Sava water in points II/1.1–1.17 of the operative part of this environmental protection consent.

<u>Question 7</u>: To a lesser extent, the study also took into account the synergistic effects of other planned or already implemented measures in the vicinity, such as the LILW repository at Vrbina and the hydropower plants upstream and downstream of the plant. Clearer explanations should be provided of those radiological synergistic effects that will result from the extension of Krško NPP's operational lifetime, the spent fuel dry storage and the Vrbina LILW repository adjacent to the plant, and specifically with regard to: - the cementing of concrete tanks at the Krško NPP site (envisaged at the waste manipulation building);
- the transport of concrete containers to and from the Krško NPP site and/or Croatia;
- the lowering of concrete containers into the disposal silo (functioning of the repository);
- the transport of existing LILW packages from the Krško NPP site for processing abroad (for Croatia's share of LILW).

The ministry explains that, as Section 1.7.2 of the Environmental Impact Assessment Report for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years points out, because the lifetime extension concerns the existing power plant complex, the report addresses the impact of the lifetime extension on the entire plant following the modification, including the spent fuel dry storage, which will begin operating in 2023 (impact of the activity). The Vrbina LILW repository is also considered to be a related activity in terms of overall impact. Section 5 of the EIA Report evaluates the possible environmental impacts of the lifetime extension.
The preparation of concrete containers with packages of radioactive waste is carried out in the waste manipulation building (WMB). Existing RW packages will be placed directly into the designated concrete containers or ISO IP2 transport containers. The WMB was designed precisely for the purpose of conditioning LILW before it was sent for processing (incineration, melting), activities that Krško NPP is already carrying out, and for the final handover and packaging into special canisters for final acceptance by ARAO and FOND. The building has been designed in such a way as to ensure radiological protection

of the surrounding area and the environment, as well as to provide adequate working conditions in the building itself (thickness of walls, closed ventilation filter system, implementation of a closed floor drainage system, etc.). The covering of concrete canisters with filling mortar using mobile equipment is also planned in the WMB. After the completion of the drying process and the hardening of the filling mortar, the canisters will be loaded onto lorries and taken from the Krško NPP site, where all requirements for the transport of radioactive material will be observed. ARAO and Fond will be responsible for organising transport.
The transport of radioactive waste from Krško NPP is carried out, as before, in accordance with the Transport of Dangerous Goods Act (Official Gazette of RS, No. 33/06 [official consolidated version], 41/09, 97/10 and 56/15) and related regulations, in particular the Decision on the publication of Annexes A and B to the European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR) (Official Gazette of RS, Nos. 9/03, 66/03, 9/05, 9/07, 125/08, 97/10). Radioactive waste is already being transported, e.g. to Sweden for incineration, and environmental impacts in the future are expected to be similar to those today, but below the permissible limit values. The environmental impact of the transport due to the extension of the operating period will not differ significantly from the transport already taking place, which was taken into account in the EIA.
The placement of containers in the disposal silo is a normal operation at the Vrbina LILW repository and is taken into account in the assessment of the overall impact. The same applies to the EIA of the Vrbina LILW repository, which took into account the combined impacts of Krško NPP and the LILW repository. A special separate process for obtaining an environmental protection consent is being carried out for the Vrbina LILW repository. The procedure has been completed and an environmental protection consent has been issued for the LILW repository.

Question 8: Considering the distance of the nearest point of Croatia from Krško NPP, the dose values during foreseeable accidents should be supplemented by values for distances of 10 km and more.

The dose data presented at the public hearing for distances of 3 km and 10 km from Krško NPP are shown below.
30-Day Effective and Thyroid Dose AriaIndustry – Spray – RADTRAD
Loss of coolant accident (LOCA) Design extension conditions (DEC-B)
Loss of coolant accident (LOCA)
Calculations for different weather conditions, times of day and year, and for different programmes and methods, show similar behaviour and low values for the effective dose and the thyroid dose within 30 days of release for the largest design-basis accident at Krško NPP: the 30-day effective dose, the 30-day thyroid dose and the calculations made using RADTRAD – AriaIndustry (Spray) in May 2020 and JRODOS (DIPCOT and LASAT) in 2016 and 2020. The calculations show that doses are reduced by one order of magnitude at a distance of between 10 km (the nearest point of Croatian territory) and 35 km from Krško NPP (approximate distance to Zagreb).
30-day thyroid dose [mSv] The radiological effects of any accident are generally low:
- The dose from a design-basis accident is within the limits set out in the plant's permits and licences.
- The dose from the reference scenario of a severe accident (with core meltdown) is only one order of magnitude higher than the dose from the design-basis accident.
- The 30-day thyroid dose is 13.5 mSv at a distance of 3 km from Krško NPP and is below the limit value for iodine prophylaxis (50 mSv for 7 days).
- The 30-day equivalent dose is 1.16 mSv at a distance of 10 km from Krško NPP (the shortest distance from the border with Croatia), which is less than a quarter of the annual background dose in Slovenia (4.79 mSv) and Croatia (3.73 mSv).
- The 30-day total effective dose equivalent (TEDE) at a distance of 50 km from Krško NPP is lower than the permissible annual dose for the population (1 mSv/year) for the same period.
- The 30-day TEDE at a distance of 70 km from Krško NPP is negligible compared to the natural radiation dose.
- The 30-day equivalent dose at the Austrian border (95 km from Krško NPP, Leibnitz) is

0.0129 mSv, which is about 4% of the natural background dose in the same period.
• At short and medium distances, the dose decreases very quickly as the distance increases.
For comparison purposes, the average global annual dose from natural radiation is 2.4 mSv, and the average annual dose from natural radiation is 3.86 mSv in Austria, 3.73 mSv in Croatia, 3.54 mSv in Hungary, 4.02 mSv in Italy and 4.79 mSv in Slovenia.
All relevant radiological data (effective dose, thyroid dose, surface contamination, isotope volume concentration) for Croatia were calculated and analysed on a grid with progressively increasing grid size in 5 steps from 0.5 x 0.5 km to 8 x 8 km.

Responses to the comments of Zelena Akcija to the “Studija utjecaja na okoliš produljenja rada Nuklearne elektrane Krško, Općina Krško, Republika Slovenija” (Environmental Impact Assessment Report for the Extension of Krško NPP’s Operational Lifetime, Municipality of Krško, Republic of Slovenia), Zagreb 6 June 2022:

Question 1: The EIA Report should also address the decommissioning of the plant.

The ministry explains that Sections 1.7.3 (p. 43) and 2.18 (p. 114) of the EIA Report state that the report does not address the decommissioning of the plant because, according to the decommissioning programme, it will be subject to “other administrative procedures in the field of construction, nuclear safety and environmental protection”.

The ministry explains that an EIA will have to be produced in accordance with the Environmental Protection Act (ZVO-2), which is relevant to the assessment of environmental impact.
The EIA for the decommissioning of the facility will be carried out on the basis of the Decree on activities affecting the environment for which an environmental impact assessment is mandatory.
Under Article 2 in conjunction with Annex 1 to that Decree, an EIA is mandatory:
- D – Energy sector; D.II – Nuclear energy:
- D.II.1 – Nuclear power plants and other nuclear reactors, including their dismantling or removal.
Appendix I of the Espoo Convention lists the activities for which an EIA is required. The list of activities in Appendix I includes nuclear power stations and other nuclear reactors, including the dismantling or decommissioning of such power stations or reactors (paragraph 2(b)).
A special project, to include all elements required by construction legislation, will be drawn up for the decommissioning process. Even if the construction legislation does not require a building permit for demolition or decommissioning, which would be subject to a review in the “integrated procedure”, a review according to the Decree referred to above is required and will be carried out in any case.
In addition, point 5 of Article 110 of the Ionising Radiation Protection and Nuclear Safety Act (ZVISJV-1) provides that the minister responsible for the environment should determine the detailed content of the application for a permit and the content of the documents for the decommissioning of nuclear facilities to be approved by the authority responsible for nuclear safety in the licensing procedure, as well as the content of other documents to be attached to the application, depending on the level of risk for each group of facilities. In view of the provisions of the Decree on activities affecting the environment for which an environmental impact assessment is mandatory and the above-mentioned provision of the ZVISJV-1, the SNSA cannot issue a permit for the decommissioning of Krško NPP without an EIA.
The EIA for the decommissioning of Krško NPP will be carried out on the basis of the final Krško NPP Decommissioning Programme. The Krško NPP Decommissioning Programme has not been drafted because it is regularly being updated to take account of new international standards, the latest technology and the available international experiences.
It is not true that no assessment has ever been carried out for Krško NPP. An EIA was produced for the existing plant as a technical background document at the time the plant was being constructed. Assessments were also produced under later legislation for:
- the construction of the decontamination building, environmental protection consent no. 35405-04/99 of 26 March 1999;
- the construction of foundations and the installation of a backup transformer, environmental

protection consent no. 35405-81/00 of 1 August 2000;

- the construction of spent fuel dry storage, building permit no. 3510525/2020/57 of 23 December 2020.

It should be noted that Krško NPP began commercial operations in 1983, two years before the adoption of the first Directive on the assessment of the effects of certain public and private projects on the environment (85/337/EEC).

As described in the EIA Report for the lifetime extension, an EIA will be carried out for the decommissioning of Krško NPP in due time (before the actual decommissioning begins). A decision on this will be taken by the appropriate state authorities, as in the case of the EIA required for the lifetime extension of Krško NPP.

As the ministry notes that no final decommissioning programme was produced during the assessment of the lifetime extension in order that an assessment of the decommissioning could be performed at the same time, and an assessment of environmental impact for the extension must be performed, the ministry determined under Measure 20 in the operative part as follows:

20. Krško NPP must draft a final Krško NPP Decommissioning Programme, containing an EIA Report for decommissioning, and commence the EIA no later than three years prior to the end of operations.

Question 2: A major accident risk assessment should also identify the consequences of a nuclear accident.

Section 5.18 (p. 332) of the EIA Report defines the impacts deriving from the risk of an environmental or other accident, while Section 7.1.1.7 (p. 416) defines the measures for preventing such accidents and minimising any major adverse effects. The third paragraph of Article 2 of the Decree on the method of drafting and on the content of the report on the effects of planned activities affecting the environment provides that the factors for which the impact of an activity is to be assessed include the likely impact resulting from the risk of major accidents involving hazardous substances, nuclear accidents and natural and other disasters, including those caused by climate change, where such risks are associated with the activity. The impact is specifically assessed as "not significant" (3), which according to the third paragraph of Article 2 of the Decree means that the impact is not significant because mitigation measures have been implemented. The assessment is based on the high level of safety of Krško NPP operation, in both technical and administrative terms, as described in the report ("the possibility of an accident has been reduced to the lowest possible level"). The Environmental Protection Act defines an environmental accident as an "uncontrolled or unforeseen event which arises as a result of an activity affecting the environment and which has the immediate or delayed consequence of directly or indirectly endangering human life or health or the quality of the environment." Although every nuclear power plant is required to have a high level of operational safety, an accident can still nevertheless occur because it is an uncontrolled or unforeseen event, i.e. not the controlled safe regular operation. The statement that the possibility of an accident has been reduced to the lowest possible level says nothing about the effects of a possible nuclear accident on the factors referred to in the second paragraph of Article 2. We believe that this should be defined so that the impact of the risk of a nuclear accident on the environment can be assessed. After the Fukushima accident in 2011, which probably also involved "a minimal accident risk for the population, even in the event of sustained earthquakes", Japan shut down all its nuclear reactors. Germany will also shut down its reactors in 2022, and both Switzerland (2016) and Italy (2011) have rejected new reactors in referendums. It is therefore difficult to evaluate a risk as not having a significant impact without first presenting the impact of a possible nuclear accident.

On the basis of Krško NPP's comments, the ministry responds by saying that Section 5.18 of the EIA Report does address the risk of environmental and other accidents. The description shows that the risk of an accident at Krško NPP is extremely low. Sections 2.11 to 2.13, which describe in great detail the systems for ensuring safety, the systems for preventing and mitigating accidents, and the classification of the plant states, show why the risk is so low.

Krško NPP operates on the basis of an operating licence that is directly connected to the plant's Safety

Analysis Report. It contains all the conditions and limits that ensure that the plant operates safely. The Krško NPP Safety Analysis Report also addresses various emergency scenarios. In accordance with the requirements of Slovenian nuclear safety legislation, Krško NPP is under the permanent supervision of the SNSA. Compliance with and achievement of the outlined safety requirements in the nuclear industry is subject to established international and national monitoring procedures in the form of inspections and international assessment missions. Krško NPP is monitored on a regular basis by a large number of international missions; these focus on all aspects of operation, with greatest emphasis given to ensuring nuclear safety.

Krško NPP has a valid open-ended operating licence, meaning it is technically capable of operating at least until 2043, subject to the condition that, in accordance with the applicable legislation, it performs a Periodic Safety Review every ten years and that review is approved by the regulatory authority. i.e. the Slovenian Nuclear Safety Administration. Krško NPP is obliged to ensure all aspects of the power plant's operational safety.

After the accident in Fukushima in March 2011, the European Commission carried out stress tests at all nuclear power plants in Europe. After the EU stress tests, Krško NPP was the only nuclear power plant in Europe for which no recommendations were issued. This placed it at the very top of European power plants. The results of the report show that Krško NPP is well-designed and constructed and that it demonstrates a high level of preparedness in relation to severe accidents because of the additional equipment available. Krško NPP carried out an in-depth analysis of beyond-design-basis accidents and drafted a Safety Upgrade Programme (SUP).

The SUP has been approved by the SNSA and covers a number of improvements and additional systems for managing beyond-design-basis accidents. The implementation of the SUP means that Krško NPP is comparable, in terms of safety, with the newer types of nuclear power plants that are currently being built around the world.

One of the major safety upgrades in progress is the construction of a spent fuel dry storage facility. The dry storage system allows spent fuel to be transferred into special canisters and storage casks that provide passive cooling and shielding against ionising radiation.

Section 5.18.1 of the EIA Report states that Krško NPP plans and maintains preparedness for emergencies in accordance with Slovenia's protection and disaster relief concept, and the principles of ensuring the nuclear safety of the power plant. Krško NPP is responsible for managing emergencies at the plant. The steps taken to ensure preparedness and manage emergencies at the plant are set out in the Krško NPP Protection and Disaster Relief Plan (PDRP). The PDRP and the protection plans (coordinated with local municipal and national protection and relief plans in the event of a nuclear or radiological accident) and the relief plans for a nuclear disaster drawn up by the municipalities of Krško and Brežice, the Posavje region and Slovenia as a whole represent an organisationally and functionally integrated system that ensures the coordinated management of emergencies at the power plant and in the environment, and between the power plant and the environment.

Measures that will be implemented in the event of an emergency at the power plant include operational-technical measures in the power plant's technological process, notification of the general public, professional and administrative institutions about an emergency, and the proposal of immediate protective measures for the population, if required, and radiological and other protective measures at the site of the power plant.

Krško NPP, as it is now and after its operational lifetime is extended, is not classified as an installation with a higher or lower risk to the environment as defined in the Decree on the prevention of major accidents and the mitigation of their consequences. The EIA therefore does not deal with accident scenarios as required by the above-mentioned regulation, but assesses normal operation and describes potential accident risks and accident prevention measures. In the case of a fire risk, for example, we do not describe what will burn in the event of a fire, but assess the measures taken to prevent a fire in the first place. This, together with the relevant measures, leads to an assessment of "impact not significant on account of the mitigation measures" in accordance with the methodology set out in the Decree on the method of drafting and on the content of the report on the effects of planned activities affecting the environment.

The possibility of an emergency/accident is addressed in Section 6.4 of the EIA Report, which presents

the results of dose calculations at certain distances for a design-basis (DB) or a beyond-design-basis (BDB) accident at Krško NPP and monitoring in the event of an accident involving releases to the atmosphere. The results of the study show that the 30-day effective dose for design-extension conditions (DEC-B) at a distance of 10 km from the power plant is 1.16 mSv, which is more than two times lower than the annual natural background dose in Slovenia (approx. 2.5 mSv). The thyroid dose (13.5 mSv) at a distance of 3 km from Krško NPP is below the limit (50 mSv for 7 days) prescribed by law for iodine prophylaxis. The reference level for action (sheltering, evacuation) in the event of an emergency is an effective dose of 100 mSv (Article 27, Decree on limit doses, reference levels and radioactive contamination, Official Gazette of RS, No. 18/18). Regardless of the calculated doses on the border of the 3 km area (OPU), which are below the reference level for action, in the event of DBA or DEC-B accidents the population would be preventively evacuated in compliance with the general hazard criteria.
The statement that there are no nuclear reactors left in operation in Japan is false. In March 2021, ten years after Fukushima, Japan had nine pressurised water nuclear reactors in operation. As of January this year, ten reactors were in operation while 15 were waiting for permission to restart. In February, France announced plans to build 14 new nuclear reactors, and a new Finnish reactor went online on 12 March 2022. According to the IAEA, nuclear reactors are currently under construction in the following European countries: two in Slovakia, one in France and two in the UK. Nuclear reactors are also being built elsewhere in the world, including: 16 in China, four in Korea, four in Russia, three in Turkey, two in Japan, two in the United Arab Emirates, two in the USA and one in Belarus. Around 440 nuclear reactors are currently in operation in 32 countries worldwide (plus Taiwan), supplying about 10% of the world's electricity needs. Fifty-five nuclear reactors are under construction in 19 countries.

Question 3: The environmental protection permit for the extension of Krško NPP's operational lifetime can be granted for a maximum of ten years.
The EIA Report states on p. 36 that Krško NPP operates under an open-ended operating licence, subject to the condition that, in accordance with the applicable legislation, it performs a Periodic Safety Review every ten years and that review is approved by the SNSA. Section 2.14.4 (p. 112) goes on to state that, in 2012, the SNSA issued two decisions (nos. 3570-6/2009/28 and 3570-6/2009/32) that confirmed and approved the amendments to the Krško NPP Safety Analysis Report, which had previously limited the operational lifetime to 40 years, thereby making it possible for the lifetime to be extended by a further 20 years.
The licensing system for nuclear facilities is laid down in the ZVISJV-1. Under Article 20 of this act, Krško NPP requires a licence to perform radiation practices and, under Article 109 of the act, an operating licence as well. Both licences must specify their period of validity (Article 137), with Article 138 limiting it to a maximum of ten years. That article also provides that a licence may be renewed and that the provisions laid down in this act for the granting of a licence shall apply *mutatis mutandis* to the renewal of a licence.
The non-compliance of the operating licence with the ZVISJV-1 resulted from the fact that the ZVISJV was only adopted in 2002, while Krško NPP commenced operation in 1983. However, when adopting the act, which already regulated the concession system and its time limit, the legislator did not provide for any transitional provisions that would have required the Krško NPP concession to be adapted to the act. Since the EIA Report also shows that the operating licence for Krško NPP was amended by SNSA decision no. 3570-8/2012/5 of 22 April 2013, it is evident that the SNSA did not comply with the provisions of the ZVISJV at the time of this amendment either. Therefore, since the adoption of the ZVISJV, there has been a conflict between the actual situation and the regulatory framework, which is also an implicit inequality before the law and contradicts Article 7 of the Convention on Nuclear Safety and Council Directive 2009/71/Euratom of 25 June 2009 establishing a Community framework for the nuclear safety of nuclear installations, which requires the State Party/Member State to determine the licensing regime in the regulatory framework. The licensing system is in place, but the regulation of the subject-matter that the act is supposed to cover is not in the spirit of the above-mentioned international instruments, as the only nuclear power plant in the country is exempted from the requirements of the act.

It follows that both the open-ended operating licence for Krško NPP and the extension of the plant's operation by 20 years are contestable. The competent authority should therefore have determined that the operation of Krško NPP could only be extended by ten years, and adjusted the EIA procedure and the environmental protection consent accordingly.

The ministry notes that it is conducting an EIA procedure and will therefore only take a position on content connected with the EIA. It notes that many countries have open-ended operating licences. However, the licence for Krško NPP is not unconditional, but includes the necessary condition that a Periodic Safety Review (PSR) must be carried out every ten years and contain an action plan for implementation to ensure that all aspects of nuclear safety, including the review of the condition of the systems, structures and components with regard to aging processes, are at a level that ensures safe operation over the next ten-year period.

The operational lifetime of Krško NPP is regulated by the previous ZVISJV and the current ZVISJV-1. The SNSA is responsible for implementation of this special law. The operation of Krško NPP is, in relation to safety, limited in content, fact and law to a period of ten years, as the plant is required to undergo a PSR, which comprehensively assesses all aspects of nuclear and radiation safety as well as the environmental impact of the plant, every ten years. If the SNSA decides in 2023 that the outcome of the PSR is successful and positive, Krško NPP will operate for the next ten years until the next PSR. This means that the Slovenian legislator has regulated all issues related to the operational lifetime of Krško NPP in the ZVISJV-1, which has been in force since 6 January 2018, and that the final decision on operation is made by the SNSA.

One must consider the fact that nuclear power plants have certain specificities, that they are subject to the provisions of two directives/international conventions that require an EIA to be as comprehensive as possible (in this case, for the entire operation, 20 years) and that thorough ten-year safety reviews have to be carried out before the SNSA can issue an act authorising or not authorising operation (final decision).

<u>Question 4</u>: Aging Management Programme

Section 2.16 (p. 114) of the Environmental Assessment Report for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years (E-NET OKOLJE, 2021), states: "On the basis of a series of studies and analyses, the SNSA confirmed, in decision no. 35706/2009/32 of 20 June 2012, that the state of the equipment at Krško NPP was adequate, despite aging, and that all safety margins and operating functions were guaranteed." The main problem here is that this analysis is ten years old, which makes it outdated and irrelevant, particularly given that, more than a year after the decision was issued (8 October 2013), damage occurred to the nuclear fuel at the plant. In its 2013 annual report, the SNSA summarised developments as follows: "Public attention focused on the damage to the nuclear fuel, which turned out to be more extensive than expected during the outage in the autumn. The complex search for the causes and the remedial measures extended the outage by two weeks. A few days after the outage, the plant shut down again because an electronic component of the new system for measuring the primary water temperature was not working properly." (SNSA, 2014, p. ii).

Section 2.7.15 (p. 78) of the EIA Report further states: "All missions (including the 2017 OSART mission) and the SNSA review, along with the decision issued in the administrative procedure described above, have demonstrated the compliance of the Aging Management Programme with international recommendations and the Rules on the operational safety of radiation and nuclear facilities." Despite this, in the course of the Topical Peer Review (TPR) conducted in 2017 under Article 8e of Directive 2014/87/Euratom, the peer-review team criticised the scope of structures, systems and components covered by the AMP and identified areas for improvement: The scope of the AMP is not subject to regular review or updated in line with the new IAEA safety standards as required. The aging management of the reactor pressure vessel also shows deficits compared to the safety level expected for Europe by the EU nuclear regulators within ENSREG. Regarding the non-destructive evaluation (NDE) of the reactor pressure vessel, the peer-review team criticised the fact that no comprehensive NDE was being conducted on the basic material at the level of the reactor core in order to determine whether there were any defects. In addition, the peer-review team also criticised the aging management

of the hidden pipelines: safety-critical pipe penetrations through concrete structures are not routinely inspected as part of the AMP.
In addition, the Slovenian Technical Review Report on the Krško NPP Ageing Management Program Final Report*, which was drafted by the SNSA in 2017, concluded that: "Beside that the Krško NPP has some remaining work to do, since not all technical implementing procedures deriving from ageing management programs have been implemented yet. During the implementation of the cable aging management program, the Krško NPP found some localized 'Hot Spots', where cable jacket showed the effects of thermal degradation. Nevertheless, the primary insulation was found to be in acceptable condition. The Krško NPP concluded the first cycle of required aging management inspections for MV cables (started 2010) and initiated the second cycle, where the focus is on trending of the results from the first cycle. All activities in accordance with GALL [18] requirements will be concluded before transition to extended plant life time in 2023." (SNSA, 2017, p. 99). "On the other hand it is recognized that in some cases the Krško NPP should improve the coordination and overview of the work of external contracted organizations, since there has not always been enough time and resources to examine and supervise their work in detail." (SNSA, 2017, p. 100).
This means that at the time this analysis was carried out in 2017, not all the necessary measures and procedures related to aging management had been implemented. As the EIA Report relies in its arguments on the 2017 report and on other studies carried out prior to this report (e.g. the SNSA decision of 2012), we consider that the results of more recent studies and analyses should be included in the EIA or, if certain procedures and measures have not yet been carried out, these should be carried out before the EIA Report is finally approved and the environmental protection consent is granted.
We believe that the statement in Section 2.7.15 of the EIA Report (p. 78) is problematic: "Furthermore, the Krško NPP AMP will be reviewed and evaluated in 2021 as part of the IAEA pre-SALTO (Safety Aspects of Long Term Operation) mission. The pre-SALTO mission will carry out a thorough review of the AMPs and their implementation on the basis of IAEA standards and international best practice. The AMP will, however, be evaluated comprehensively and systematically as part of the third Periodic Safety Review (PSR3), in accordance with the programme approved by the SNSA in decision no. 3570-7/2020/22 of 23 December 2020." This part of the report indicates that not all activities related to aging management, and therefore lifetime extension, have yet been carried out (or, if they have been carried out, their results and conclusions have not been included in the preparation of the EIA Report). The findings of the studies should be included in the EIA if they have already been implemented and, If they have not yet been carried out, they should be completed; only then should a proper EIA be carried out. Only after this analysis can an assessment of aging management, a new decision by the SNSA assessing the adequacy of aging at Krško NPP and the EIA be drawn up.
Regarding the results of the 2017 SNSA report referred to above, the technical situation should be reviewed by independent experts, using real experiences and aging data from comparable reactors. This applies in particular to core components such as the reactor pressure vessel and the primary circuit, which are not readily accessible during regular operation and whose aging may not be adequately represented in computer models.

The ministry notes that the SNSA informed it on 12 January 2023 that the pre-SALTO mission had concluded and that the draft report contained findings that did not necessitate a change to the EIA Report. After studying Krško NPP's comments, the ministry notes that Krško NPP conducted an Aging Management Review (AMR) project in 2012 to organise processes to ensure that the systems, structures and components (SSCs) at the plant were able to perform their intended function for at least 60 years or that the regular review and maintenance processes did not lead to the failure of these intended functions. Krško NPP has updated or refreshed these analyses with the latest findings and requirements, in line with global best practice.
The damage to the nuclear fuel was not due to inadequate monitoring of SSC aging, nor has it changed the assumptions or analyses on the basis of which the AMR was carried out and the AMPs drawn up. Nuclear fuel is not part of aging programmes because it is replaced regularly and remains in the reactor for a maximum of three 18-month cycles (most nuclear fuel remains in the reactor for two 18-month cycles).

During the 2017 TPR, the peer-review team did not criticise the current practices of Krško NPP, but identified areas in which processes could be improved. Krško NPP has taken all these suggestions into account and has drawn up an action plan to implement the improvements relevant to the plant.
Krško NPP regularly updates its AMPs in accordance with internal document update processes. The programmes are updated using information from the US regulatory authorities, international recommendations such as those produced by the IAEA and WENRA, and other research on aging. The Krško NPP AMP is an ongoing activity that follows international experiences and developments in the field of aging of all equipment. No anomalies were found during the TPR of aging management.
Krško NPP uses ASME SA 533, Grade B, Class
1, rolled plate, which is not susceptible to hydrogen flaking, as the base material for the reactor pressure vessel. This is also confirmed by the newly acquired WENRA document: "Updated Report Activities in WENRA countries following the Recommendation regarding flaw indications found in Belgian reactors" (November 2017). Krško NPP also attended a workshop organised by the Pressurized Water Reactors Owners Group (PWROG) at the initiative of the European nuclear power plants involved in the ENSREG TPR on selected sections of the AMP. Krško NPP presented in detail the inspection requirements for ultrasonic testing (UT) of the shell welds, the history of tank manufacture, the results of the inspections to date, and Krško NPP's proposed response to the areas identified for improvement. The presentation focused on the fact that the Krško NPP reactor pressure vessel shell was made of SA-533, which, unlike the forged rings of the SA-508 shell, is not susceptible to hydrogen flaking. The participants present confirmed that no hydrogen flaking had occurred in the SA-533.
Krško NPP inspected a number of buried pipelines and penetrations in existing buildings. For the other modifications, the existing pipelines were excavated, and inspected visually, ultrasonically and using the GWUT method. The results of the tests show that there were no significant aging mechanisms leading to deterioration. The condition of the pipelines is adequate, as shown by an independent study conducted by Technatom, which compared global and Krško NPP practice. Krško NPP carries out pipeline inspections at regular ten-year intervals.
Its SSC AMP is ongoing and is constantly being improved and upgraded, thereby ensuring the highest level of nuclear safety. SNSA decision no. 3570-6/2009/32 of 20 June 2012 confirmed that the condition of equipment at Krško NPP was adequate, despite aging, and that all necessary time-limited studies were appropriate. Since 2012, the AMP has been constantly updated and adapted to new scientific findings in the field of aging. Time-limited aging analyses (TLAA) ensure that all time constraints allow the SSCs to operate for 60 years.
In accordance with Slovenian legislation (ZVISJV-1), Krško NPP conducts Periodic Safety Reviews to demonstrate that its processes (including aging management) have been updated in line with global practice and ensure the highest level of nuclear safety.
The EIA Report has been prepared in accordance with the Slovenian Decree on the method of drafting and on the content of the report on the effects of planned activities affecting the environment, which complies with Directive 2011/92/EU of 13 December 2011 and Directive 2014/52/EU of 16 April 2014 amending Directive 2011/92/EU, and sets out in detail the content of a report on the assessment of the effects of a planned activity and on the method of its preparation. The information requested and the procedure for processing the results go beyond the scope of the EIA.
The purpose of the international missions and the PSR is for external assessors to examine processes and suggest improvements. Improvements are proposed at every mission because the pursuit of excellence is constant and unwavering. Work on implementing the improvements suggested by the pre-SALTO mission is under way, under the supervision of the SNSA, which is also the entity responsible for granting Krško NPP's operating licence. The third PSR is currently being prepared and will be completed in 2023. Preliminary results showed that there are no significant safety anomalies and no negative findings. The results of the PSR are reviewed and approved by the SNSA, and any changes and improvements resulting from the approved PSR report are verified.

<u>Question 5</u>: Zelena Akcija also believes that seismic safety has not been adequately addressed and that Krško NPP is the only nuclear power plant in Europe that operates in an active seismic zone. The EIA Report accommodates the findings of a number of older studies, and the following conclusion is

drawn in Section 4.1.11 (Seismic hazard, p. 176) on the basis of the latest seismic hazard analysis of 2004 (PSHA 2004, horizontal PGA = 0.56 g): "This research, which has been carried out in the last ten years, has not confirmed the existence of such new faults or geological structures that could, in the event of an earthquake, permanently deform the surface of the location ('capable faults'), nor have there been any new findings that could significantly change the existing estimate of seismic hazard at the Krško NPP site [271] produced between 2002 and 2004 after ten years of previous research." We consider these conclusions to be problematic because the PSHA 2014 study presented and used in the EIA Report has been questioned in several recent studies and publications. For example, the Peer Review Country Report: Stress Tests Performed on European Nuclear Power Plants – Slovenia (ENSREG, 2012), finds the following: In accordance with US nuclear regulatory requirements and standards, the safe shutdown earthquake (SSE) was set at a peak horizontal ground acceleration (PGA) of 0.3 g. New seismic risk analyses led to an increase in the assumed PGA values to 0.42 g in 1994 and to 0.56 g in 2004, i.e. almost double the original assumptions (summarised from ENSREG, 2012, pp. 7–9).

On the basis of Krško NPP's comments, the ministry responds by saying that the EIA Report adequately addresses seismic safety and that it accommodates all the latest methods and knowledge. It notes that the peak horizontal ground acceleration values mentioned by Zelena Akcija are not comparable, as they may refer to different types of ground and different depths. The PGA of 0.3 g relates to the level of the foundations of the Krško NPP building, which are 20 m below the surface, while the PGA of 0.56 g (from the Probabilistic Seismic Hazard Analysis/PSHA of 2004) relates to the surface. PGA decreases with depth. Consequently, the claim that the PGA value from the PSHA from 2004 is almost twice that of the design PGA value is not accurate.
Krško NPP was designed to withstand earthquakes. The seismic design load of Krško NPP comprises the spectrum of accelerations in accordance with the American RG 1.60 guidance, scaled to a PGA of 0.3 g at the depth of the foundations (approx. 20 m below the surface). As the PGA during an earthquake decreases with depth, the design peak acceleration at the depth of the foundations cannot be directly compared with the PGA at surface derived from the PSHA. In order to compare the seismic design load of Krško NPP with the seismic load from the PSHA, the uniform hazard spectrum at surface must be transformed to the level of the foundations. That comparison shows that the spectral acceleration for a frequency of 3.33 Hz from the uniform hazard spectrum (PSHA, 2004) is approx. 12% lower than the corresponding value of the design spectral acceleration for 5% attenuation. On the basis of the spectral accelerations, which are more directly connected to the seismic forces than the PGA, it has been estimated that the original seismic forces taken into account when Krško NPP was being designed are roughly comparable to the seismic forces on the facility resulting from an earthquake with a PGA of 0.6 g on the open surface, which roughly corresponds to a PGA with a recurrence interval of 10,000 years (PSHA, 2004). The favourable impact of the interaction between the Krško NPP structure and the ground (which scatters a significant amount of the energy) was also taken into account in this transformation. The calculations from 2013 also showed that the floor spectral accelerations resulting from an earthquake with a PGA of 0.6 g at surface were roughly equal to or less than the original acceleration values for equipment with their own frequencies of between 4 and 16 Hz, which covers a wide range of engineered safety features and equipment at Krško NPP.
A project to update the PSHA for the immediate vicinity of Krško NPP is currently under way. As part of this project, a new non-ergodic ground-motion model was developed for the location of the second nuclear power plant block at Krško in 2021. The new non-ergodic ground-motion model takes into account the local characteristics of earthquakes on the basis of the ground-motion measurements that have been provided by ARSO for more than 20 years. This has a positive impact on the results of the PSHA. It has been shown, for the immediate vicinity of Krško NPP, that the PGA and spectral acceleration at higher frequencies and for long recurrence intervals decrease relative to the values determined using the conventional ground-motion model.
The statements in Section 4.1.11 (Seismic hazard, p. 176) of the EIA Report, which are the subject of the question, do not refer to the period after 2004. It is becoming apparent that the preliminary results show that no new faults or geological structures have been confirmed in the last ten years that could

permanently deform the surface of the site in the event of an earthquake ("capable faults"), or that there are no new findings that would significantly change the existing seismic hazard analysis of the Krško NPP site from 2004. Nevertheless, in 2013 GEN conducted a ground-motion hazard study that showed that there was no risk of large permanent ground displacements, while the risk of very small permanent ground displacements was negligible (recurrence interval of more than one million years).

Question 6: Zelena Akcija points out that the ENSREG report also states that seismic events with a PGA greater than 0.8 g in the Krško area are classified as very rare, with a frequency of recurrence of 50,000 years or more. Earthquakes with a PGA greater than 0.8 g present a danger to the reactor core: mechanical damage can interfere with the geometry of the core and lead to the retraction of the control rods. In such a case, a partial core meltdown cannot be ruled out. In this seismic acceleration zone, the containment spray system and the low-pressure emergency cooling system would not be available. Radioactive releases resulting from damage to the reactor core cannot be ruled out.

After studying Krško NPP's expert comments, the ministry responds by saying that a distinction must be made between a design earthquake and an actual earthquake. A design earthquake is not determined by PGA alone but also by the default elastic spectrum of accelerations, which is smooth and has high spectral accelerations at a wider interval of frequencies. This generally does not occur during a single actual earthquake. This means that spectral accelerations in the event of an earthquake with a PGA of 0.8 g will very probably be lower within a wider interval of frequencies than those considered in the Krško NPP seismic hazard analysis. In an actual earthquake with a PGA of 0.8 g, the seismic load in terms of spectral accelerations for a wider spectrum of frequencies is very likely to be lower than the seismic load that was considered in the analysis of the safety margins. In addition, there are design factors that increase capacity in relation to the PGA. The seismic capacities given in the ENSREG report, and mentioned in the above statement, are represented by the HCLPF PGA values ("high confidence low probability of failure PGA"). The capacities expressed in this way represent the ground accelerations at surface for which there is a certain minimum probability of the selected adverse event occurring. In order to understand what would happen in the event of an earthquake with a PGA of 0.8 g, it is therefore important to know that even with such a powerful earthquake, the probability that the adverse events described above would not occur is very high.
The seismic capacities in terms of the HCLPF PGA values mentioned in the ENSREG report do not take into account the positive impact on seismic and nuclear safety of the additional engineered safety features installed at Krško NPP over the last ten years as a result of the SUP. The upgrades covered the construction of new flood-protection systems, the reliability of electricity supply, the cooling of the reactor, the containment and the spent fuel pool, alternative control and plant management systems, and the construction of spent fuel dry storage (currently under construction). These systems have been designed to withstand very powerful earthquakes. The maximum design acceleration was 0.6 g for systems on the main island and 0.78 g for new systems away from the main island. For the construction of the new bunkered building, the operational support centre and the spent fuel dry storage, the safety acceptance criterion in the seismic vulnerability analysis was also determined by the HCLPF PGA.
The impacts of various earthquakes and the adverse events associated with them are taken into account when the core damage frequency (CDF) is being determined. For Krško NPP, this is estimated with respect to the value acceptable under Slovenian law. Krško NPP's seismic safety is therefore adequate.

Question 7: Zelena Akcija believes that a new seismic analysis of the location should have been drawn up during the planning of the second Krško-2 reactor at the same site. The SNSA raised questions about the possible impact of the Libna tectonic fault, and requested an update of the seismic risk assessment for the existing Krško NPP reactor. The French Institut de Radioprotection et de Sûreté Nucléaire (Radioprotection and Nuclear Safety Institute, IRSN) also sent an open letter on 9 January 2013 to GEN energija, d.o.o. and the SNSA asking them to provide further clarifications: IRSN suggested that GEN energija d.o.o. collect sufficient local data for a study on the impact of the Libna tectonic fault to minimise the uncertainties identified.
A study by Slovenian experts emphasises that the results of the load test report, such as the effects of

a PGA greater than 0.8 g, should be evaluated in the light of the known expected accelerations resulting from an earthquake of moderate magnitude and with reference to the seismotectonic conditions in the area. The study concludes that the SNSA statement that “the frequency of recurrence of seismic events with a PGA greater than 0.8 g is considered to be more than 50,000 years” is not consistent with the revised Probabilistic Seismic Hazard Analysis (PSHA) or Seismic Probabilistic Safety Assessment (SPSA).

In relation to the comments, the ministry responds by saying that the studies for the second new location, although in the vicinity, are not the subject of the EIA procedure for extending the operational lifetime of the existing plant at the existing location, which in its existing state already ensures safe operation. All the PSHAs carried out so far at Krško NPP have considered the impacts of active faults in the wider surrounding area of the plant.

The project to update the PSHA, which is under way and is being financed by GEN, will examine 12 active seismic source lines and several planar seismic sources, followed by four mutually independent seismic source models. It is assumed that the epicentre of a powerful earthquake could appear anywhere within a wider radius of Krško NPP. The new PSHA, which is being drawn up, examines the potential for an earthquake to be caused by the Libna fault. The new study also developed a new non-ergodic ground-motion model for the immediate vicinity of Krško NPP that took into account local seismic features based on ground-motion measurements that have been carried out by ARSO for more than 20 years.

Regarding the issue of the Libna fault, the IRSN issued a separate interpretation at the beginning of 2013 that contradicted the interpretations of the other partners (BRGM, GEOZS, ZAG) of the consortium that carried out the first phase of the project to update the PSHA for the immediate vicinity of Krško NPP. Based on the preliminary results produced up to that point, the consortium found that the Libna fault could not, without further evidence, be defined with any certainty as a seismic source that could lead to permanent ground displacement on the surface of the current or future location of Krško NPP. The results of the PSHA for ground displacement, which considered 11 faults, including the Libna fault, showed that there was no danger of major permanent ground displacement, while the danger of very minor permanent ground displacement was negligibly low. The seismic analysis also showed that Krško NPP’s structures and systems could withstand significantly greater ground displacement than followed from the Probabilistic Fault Displacement Hazard Analysis for a recurrence interval of 10 million years (Krško NPP, 2013).

According to the PSHA from 2004, the median recurrence interval for seismic events with a PGA greater than 0.8 g is estimated to be approximately 50,000 years. The results of the updated PSHA, which is currently being drawn up, will provisionally be available at the end of 2022, with an independent review following in 2023. Based on the preliminary results of this study, no significant changes in the results are expected in relation to the currently valid PSHA from 2004.

Question 8: Zelena Akcija believes that Krško NPP currently only meets the requirements of the original design basis of a maximum design acceleration (PGA) of 0.3 g. Only the additional systems, structures and components implemented under the Safety Upgrade Programme (SUP) are designed and implemented under the design-extension conditions (DEC) specific to this reactor design and site. DEC systems, structures and components will be installed in two newly built bunkered buildings.

The PGA value under DEC is 0.6 g. This value provides almost no safety margin, a mere 0.04 g, compared to the currently established value for a safe shutdown earthquake (SSE), which is 0.56 g. The EIA Report does not mention any updated reassessment of the seismic hazard in the area. The last seismic risk analysis was carried out in 2004. The fact that the seismic hazard at the Krško site is significantly higher than the plant’s original design basis of 0.3 g is fairly problematic.

Even though all planned measures have been implemented, the resilience of the plant remains problematic: first, the maximum possible earthquake magnitude is not yet sufficiently known; second, the increase in the assessed seismic risk has not led to a change in the design basis (instead, only the systems additionally installed as part of the SUP are designed for an updated PGA of 0.6 g); and third, the seismic safety margins are very low, even though the likely consequences of a powerful earthquake

are known.
After studying Krško NPP's explanations and the SNSA opinion, the ministry responds by saying that it believes that the resilience of the plant is not problematic. As explained in the response to Question 6, the peak horizontal ground acceleration values (PGA) are not always mutually comparable, as they can relate to different types of ground and different depths. Moreover, they can also relate to actual or to design earthquakes. On the basis of the spectral accelerations, which are more directly connected to the seismic forces than the PGA, it has been estimated that the original seismic forces taken into account when Krško NPP was being designed are roughly comparable to the seismic forces on the facility resulting from a design earthquake with a PGA of 0.6 g on the open surface, which roughly corresponds to a PGA with a recurrence interval of 10,000 years (PSHA, 2004). In the planning of the new facilities, which are away from the main nuclear island, the design PGA was increased by 30% regardless of the fact that the preliminary results of the seismic hazard analysis, taking into account the new non-ergodic ground-motion model, show that no significant changes are expected from the PSHA from 2004.
The claim that the safety margin is a mere 0.04 g is misleading, and it is a misunderstanding to think that a sufficiently high PGA is the only factor that ensures seismic safety. Seismic safety is also ensured by an appropriate spectral acceleration and by other appropriate safety or design factors within the earthquake-resistant design standards that are taken into account during the design process itself and that increase capacity in PGA terms relative to the design PGA value.
It is not true to say that the maximum possible magnitude is not sufficiently explained. In the PSHA, the magnitudes are determined in relation to the characteristics of the individual seismic sources and incorporated into the PSHA for the Krško NPP site (PSHA 2004). In the updated hazard analysis, which is in the final stages of implementation, three branches of the logic tree are considered for the maximum magnitude values for each individual seismic source; this ensures that the uncertainty involved in determining the maximum magnitudes is taken into account.
The impacts of various earthquakes and the adverse events associated with them are taken into account when the CDF is being determined; for Krško NPP, this is estimated with respect to the value acceptable under Slovenian law. It therefore follows that Krško NPP's seismic safety is adequate.

Question 9: As Krško NPP has only one water supply source, an additional, earthquake-resistant main cooling source was planned independently of the Sava (ultimate heat sink, UHS). As the stress-test report states: "The Krško NPP does not have an alternative ultimate heat sink. The installation of a new water line from the Krško HPP was mentioned in the report, but this project was abandoned. Rather, the construction of a seismically-qualified cooling tower has been proposed as an alternative to the UHS" (ENSREG, 2012, p. 21).
However, in line with the 2019 update of the national action plan, the planned installation of an additional cooling source (UHS) has been abandoned. Therefore, only additional cooling using a steam generator cooling system has been introduced: To ensure cooling of the reactor core in the event of a power failure and/or failure of the main cooling source (UHS), an additional high-pressure pump to supply the steam generators was planned for 2015, to be installed in a separate bunker with its own water supply. In addition, the design value of the bunkered building complies with DEC requirements, which do not provide for sufficient safety margins.
For all these reasons, we consider it necessary to carry out an updated international study on seismic risk and to take the results into account in the EIA Report.

On the basis of the explanations provided by Krško NPP, the ministry responds by saying that BB2 (Bunkered Building 2, a reinforced safety structure) is designed to accommodate an alternative safety injection system (ASI), an alternative auxiliary feedwater system (AAF) and safety power supply to the building. The AUHS is ensured by the construction of BB2 and the installation of the ASI and AAF systems.
The BB2 facilities and systems from the Safety Upgrade Programme, which were built away from the foundations of the main Krško NPP island, were designed for a PGA of 0.78 g at the level of the foundations. During the construction of the new facility, the safety acceptance criterion with regard to the analysis of seismic vulnerability was also determined using HCLPF PGA. As has been pointed out

on several occasions, additional safety factors are used when designing nuclear facilities so that the likelihood of component failure (including in BB2) is approx. one or two orders of magnitude lower than the likelihood of the occurrence of the design ground acceleration. It should also be pointed out that the design PGA for BB2 and its systems exceeds the value corresponding to the recurrence interval of 10,000 years set out in the PSHA from 2004. According to the preliminary results of the updated PSHA study, which is currently being prepared, the new value of a recurrence interval of 10,000 years is also lower than the design acceleration taken into consideration for BB2.

<u>Question 10</u>: Unresolved and uncompleted radioactive waste storage facility
The final disposal of high-level waste from Krško NPP is still completely unresolved 40 years after the plant came into operation. According to Section 4.4.11.3 (p. 258), a total of 1,553 spent fuel assemblies with highly radioactive isotopes will have been produced by the end of the regular operating period in 2023. This rises to 2,281 spent fuel assemblies if the operating period is extended by 20 years.
On page 259 it states: "The decision to extend the operational lifetime was made at the same time as the owners' decision on the joint provision of SF disposal. There are plans to build a joint deep geological repository in the territory of Slovenia or Croatia." Section 6.3.5 (p. 342) states that there is no concrete plan for the final disposal of the high-level radioactive waste: "The exact location of the final disposal is not known at the time of writing".

On the basis of Krško NPP's comments, the ministry responds by saying that the dry storage issue has been resolved and a plan for the disposal of LILW drawn up. However, the issue of the long-term storage of HLW remains unresolved. The spent fuel (SF) elements produced during the lifetime extension will be safely stored in SF dry storage or partly in a spent fuel pool, just like the other SF already present at the Krško NPP site. Dry SF storage involves passive and safe SF storage, and additional safety improvements in the SF pool area have increased the level of nuclear safety and significantly reduced all risks associated with storage. The final location of the SF repository will be determined by the two countries in due course, possibly with a view to an agreement on an interregional repository.

<u>Question 11</u>: The completion of the spent fuel dry storage by 2023 has been delayed and the facility is not being used for the complete transfer of the 1,323 fuel elements (end of 2020), although even the EIA Report clearly admits that continued storage in the wet storage facility is risky (Section 2.7.12, p. 76): "Next to the reactor core, the spent fuel pool at Krško NPP is the most significant potential source of radiological threat to the surrounding area in the event of a nuclear accident."

After studying Krško NPP's explanations, the ministry responds as follows: One very important part of Krško NPP's safety upgrade is the construction of spent fuel dry storage at the plant site. Due to the complexity of the procedures for acquiring licences and permits, the start of construction has been slightly delayed, but is still on schedule. In this context, the procedure of amending the Krško NPP Development Plan was successfully completed in March 2020. It included a comprehensive EIA and transboundary consultations with Croatia and Austria. At the end of 2020, the Ministry of Environment and Spatial Planning therefore issued a building permit for the construction of a spent fuel dry storage within the existing Krško NPP. Construction of the spent fuel dry storage began in March 2021 and is proceeding according to schedule. The building has been completed and the first 592 fuel elements will be moved from the spent fuel pool to dry storage in the first half of 2023.
Dry storage is a new, technologically safer way of storing spent fuel, and one that will gradually reduce the number of spent fuel elements in the pool and increase nuclear safety. When the dates of the envisaged campaigns of relocation to dry storage were being planned, consideration is given to the factors of technical feasibility, radiation and nuclear safety, and cost-effectiveness. The date of the campaigns and the number of fuel elements to be relocated are acknowledged as optimal. Krško NPP will continue to review the timetable of the relocation of spent fuel from the spent fuel pool to dry storage, and adjust it as required to minimise the risks associated with spent fuel.
Krško NPP's spent fuel pool and the reactor core are the major potential sources of radiological hazard to the surrounding environment in the event of a nuclear accident. The spent fuel storage strategy has

been changed in response to the latest events and findings from the Fukushima accident, and to the revised Resolution on the National Programme for Radioactive Waste and Spent Fuel Management 2016–2025. The dry spent fuel storage project will be completed in 2023 and the first 592 fuel assemblies will be moved from the spent fuel pool to dry storage. this will further enhance nuclear safety and minimise the risk of potential accidents in the spent fuel pool.
Section 3.7.12 of the EIA Report states, *inter alia*, that the European Commission published a final report containing the results of the extraordinary safety reviews of all power plants in August 2013. The report confirmed that Krško NPP was achieving excellent results and was adequately prepared for extreme events. The report also included an overview of recommendations for safety improvements at individual nuclear power plants. According to this overview, Krško NPP is the only nuclear power plant that did not receive a single recommendation, one of the reasons being that it had already carried out B.5.b actions (in response to WTC attack on 11 September 2001). It had drawn up a draft SUP and was able to prove large integrated safety margins in terms of both seismic and flood safety.
The modernisation of safety solutions at Krško NPP, which was carried out in 2021, includes the best available technological solutions and follows international practice (e.g. Switzerland, Belgium, Sweden and France). This applies in particular to the reliable cooling of the core in order to ensure the integrity of the containment, the management of severe accidents and the cooling of spent fuel.
Krško NPP has been in commercial operation since 1983. Since then, it has operated safely and reliably, with no impact on the environment. We expect the plant to be able to continue to operate as before, i.e. safely and in compliance with the environmental emission limits, until the end of its operational lifetime in 2043. The safety culture and the proficiency and commitment of employees are core elements of Krško NPP's organisational and business structure, and will continue to be the guiding principle that ensures that the plant operates in the safest and most environmentally-friendly way going forward. As has been the case up to now, Krško NPP will implement the necessary safety and other improvements regularly and on time.
It devotes considerable care and attention to environmental protection, which means that environmental protection is integrated into all processes.

<u>Question 12</u>: The IAEA guidelines "Safe and Effective Nuclear Power Plant Life Cycle Management Towards Decommissioning" (IAEA, 2002, p. 16) state that longer-term decisions affecting waste storage taken to address safety requirements and limit costs at the end of electricity generation should not be taken if information is not available regarding the disposal facility. Article 121 of the Ionising Radiation Protection and Nuclear Safety Act (ZVISJV-1) provides: "The holder of radioactive waste and spent fuel shall ensure that [...] the burden of radioactive waste management is not transferred to future generations as far as possible" and "An evidence-based and documented decision-making process shall be applied at all stages of radioactive waste or spent fuel management". The National Programme for Radioactive Waste and Spent Nuclear Fuel Management 2016–2025 also states that "Radioactive waste and spent fuel should be managed in a way that does not transfer the burden to future generations."
In view of this, the author of the comment believes that a detailed plan for the permanent disposal of the resulting high-level radioactive waste should be presented before approval is given to the extension of Krško NPP's operational lifetime. The plan should not only include a siting and public participation plan, but also a financial plan, as provided in Directive 2011/70. As the currently available funds of EUR 0.2 million are way below what is required (repository costs in Finland are EUR 5 billion), a decision must be taken to increase the levies paid into the Slovenian nuclear waste fund.

After studying Krško NPP's comments, the ministry responds by saying that Article 10 of the Treaty between the Government of the Republic of Slovenia and the Government of the Republic of Croatia on the Regulation of Status and Other Legal Relations Regarding Investment in and the Exploitation and Decommissioning of Krško Nuclear Power Plant (Official Gazette of RS [Mednarodne pogodbe], No. 5/03, hereinafter: Intergovernmental Treaty) provides that both contracting parties shall agree to provide an effective solution to decommissioning and to the disposal of radioactive waste and spent fuel from the economic and environmental protection standpoints. The final location of the permanent spent fuel

repository will be determined by the two countries in good time prior to decommissioning, possibly with a view to reaching agreement on an interregional repository.
Under the Intergovernmental Treaty, the Intergovernmental Commission tasked with monitoring the Treaty and performing other tasks in accordance with the Treaty (hereinafter: Intergovernmental Commission) approved the Third Revision of the Krško NPP Decommissioning Programme and the Programme for the Disposal of Radioactive Waste (RW) and Spent Fuel (SF) from Krško NPP on 14 July 2020. Every five years at least, periodic revisions of the programme are carried out with the aim of updating the reference disposal concept in line with the latest technical solutions and information. Under the third and fourth paragraphs of Article 10 of the Intergovernmental Treaty, the Krško NPP Decommissioning Programme and the Programme for the Disposal of RW and SF from Krško NPP are the two relevant documents that contain an estimate of the funds required to carry out the activities that the programmes deem to be necessary.
In order to ensure that sufficient financial resources are available, the Krško NPP Fund was established in Slovenia with the main task of raising sufficient funds in time to enable the safe management of radioactive waste and the completion of all phases of decommissioning. Based on the adopted programmes, the Slovenian government set the amount of the contribution to be paid into the Krško NPP Fund by GEN energija. From 2004 to September 2020, the contribution was EUR 0.003/kWh, rising to EUR 0.0048 for each kWh of electricity produced at Krško NPP and sold in Slovenia. On 13 January 2022 the Slovenian government adopted a decision instructing GEN energija d.o.o.
to pay EUR 0.012 for each kWh of electricity generated at Krško NPP into the Fund for Financing the Decommissioning of Krško NPP and the Disposal of Radioactive Waste from Krško NPP, starting from 1 January 2022.
In Croatia the Fond za financiranje razgradnje i zbrinjavanja radioaktivnog otpada i istrošenoga nuklearnog goriva Nuklearne elektrane Krško (Fond) (Fund for Financing the Decommissioning of and the Management of Radioactive Waste and Spent Fuel from Krško Nuclear Power Plant) is responsible for collecting funds. The Fund Act (Zakon o Fondu, Official Gazette of the Republic of Croatia, Nos. 107/07 and 21/22) provides for quarterly payments into the Fund until Krško NPP ceases to operate or sufficient funds as set out in the approved decommissioning programme have been collected. The Decree on the amount, timing and method of disbursement of funds for financing the decommissioning of and the management of radioactive waste and spent fuel at Krško Nuclear Power Plant (Official Gazette of the Republic of Croatia, No. 155/08) provides that Hrvatska elektroprivreda (HEP) shall pay EUR 14.25 million into the Fund every quarter, on the understanding that this amount may change in line accordance with the revised version of the Decommissioning Programme and the Programme for the Disposal of Radioactive Waste and Spent Fuel from Krško NPP, approval for which shall be given by the Intergovernmental Commission.
The financial plan for the disposal of HLW and LILW is therefore determined with every adoption of the disposal and decommissioning programmes, which estimate the financial resources required. The Slovenian and Croatian governments then determine, on the basis of the estimates, the amount and form of the contributions to both dedicated funds required to ensure that the estimated amounts are provided.

Question 13: Alternative technologies
According to the EIA Report, extending the operational lifetime of the Krško reactor for another 20 years is “the most favourable alternative of all the technologies” (Section 3.1, p. 148):
Energy, system, environmental protection and economic studies have shown that the lifetime extension of Krško NPP constitutes the most favourable alternative of all the technologies suitable for the generation of electricity in base-load mode and matured for commercial use by 2023.
The Krško reactor is a year-round generator of electricity in base-load mode (Section 2.1, p. 55): “In accordance with its operating characteristics, Krško NPP operates in base-load mode throughout the year.”
This statement on the “year-round” load capacity of the base load runs contrary to the effects of the climate crisis and the changed operational management resulting from the heating of the Sava, as the EIA Report itself mentions (Section 4.1.4.2, p. 186): “The average monthly temperature of the water that

enters the HPP chain (into the Vrhovo Basin) has increased by between 1.5 and 2°C in the summer months over recent decades, while the highest temperatures in the same period have also increased by between 3 and 4°C. This means a significantly higher 'natural temperature background' for Krško NPP operation."

In the tables showing the average daily and monthly temperatures of the Sava, which are printed at Krško, it is already 27.5°C. According to Section 4.4.4.1 (p. 229), over a few days in 2020 full use was made the of highest permitted temperature increase of 3°C, even in summer months with a "higher temperature background".

According to Section 5.6.1 (p. 328), reactor power should be reduced "if the temperature difference ΔT cannot be maintained below 3°C even when the cooling towers are in operation". The average temperature increase cannot be maintained below 3°C even when the cooling towers are in operation.

According to Table 115 (p. 332) in the same section, because of the advancing climate crisis the "availability of water (drought)" is contributing to the "future vulnerability of electricity generation" from Krško NPP. Also highlighted on p. 334: "It is also a fact that the intensity of climate change has increased in recent years. The temperature of the Sava River rose from an average of 10.9°C in the 1984–1993 period (Table 31) to an average of 12.6°C in the 2011–2020 period."

According to Table 121 (p. 337), the number of days on which the cooling tower is expected to operate is set to rise from the current average of 122 days a year to an average of 138.9 days a year and, in years with low Sava flow rates, to up to 229.3 days a year (or two thirds of the year). This will have a negative impact on electricity generation in the reactor because of the consumption of electricity by the cooling towers.

The targeted reduction of power in order to be able to meet the authorised parameters is an even stronger measure. Page 339 contains this statement:

"One can conclude from the table (Table 123) that even though it is not possible to rule out the need to lower capacity because of climate change, the likelihood, given the climate change projections currently available, is relatively low." And p. 340:

"Climate change could only rarely cause the occurrence of such situations, on average 1–2 days a year in 2043. If an unfavourable year occurs (2019 projection into the future), the number of days on which power has to be reduced could be up to ten times higher."

In other words, even according to the modelling available to the operator, the reactor will have to undergo unplanned power reduction on up to 20 days, which contradicts the statement on the reliable year-round operation of the base load.

Moreover, consideration is not given to the fact that according to the Ordinance on the emission of substances and heat from the drainage of effluent from pollution sources, the maximum permitted temperature of river water is 30°C (this value will probably be exceeded during the planned lifetime extension of the reactor because of the current climate crisis, meaning that it will not be possible to ensure the continuous base load of the reactor, as has happened with comparable nuclear power plants in France and elsewhere because of the climate crisis, particularly in the summer months).

Alternative technologies for the proposed lifetime extension of Krško NPP are not presented in relation to the state of the art and the costs, as the next example from Section 3.2.2 (p. 150) shows: Here it is calculated that 655 wind turbines with a nominal power of 2.3 MW would be required to provide the equivalent amount of electricity from the Krško reactor.

This does not correspond to the state of the art in 2022, where wind turbines have been installed with a power of 4.2 MW and more. Assuming systems with 4.2 MW, an energy yield of 10–12 GWh/a at 3,000 hours of full load would require only 242 wind turbines a year with a total investment cost of EUR 1.6 billion.

While the undoubtedly possible negative impacts of renewable energy sources from the environmental point of view are given full consideration in the EIA Report, the negative effects and the possible lifetime extension of Krško NPP are shown in a much more positive light. Section 3.2.3 (p. 153) contains a table that shows in detail the "possible negative effects" of renewable energy sources, including "solar energy" and the "creation of dangerous pollutants during dismantling".

The study by the Energy Economics group at Vienna University of Technology came to this conclusion based on the current technical data on the available technologies and on the current costs of electricity

generation.
“A more detailed review of potentials in Croatia and Slovenia shows that the domestic potentials of renewables do perhaps suffice to compensate for the shortfall in supply arising from the early exit from coal and nuclear energy.” “The strong use of renewable energy sources as envisaged in the just transition scenarios will lead to a fall in electricity prices on the wholesale market in the coming years, which is a result of the proactive gradual abandonment of electricity supply using fossil fuels in Slovenia and Croatia and across the whole of the European continent. Variable renewable sources such as hydroenergy, wind power and solar photovoltaics have lower operating costs, which will lead to a fall in wholesale prices.”

On the basis of Krško NPP’s comments, the ministry responds by saying that the EIA does not compare renewable energy sources and lifetime extension, as both energy sources are necessary for a robust energy system, and can complement each other and develop side by side. The ministry stresses that this procedure examines the environmental impact of the extension of Krško NPP’s operational lifetime on the basis of the documentation submitted.
Nevertheless, the ministry responds as follows: Slovenia’s 2021 Integrated National Energy and Climate Plan (NECP) and Croatia’s 2020 Integrated National Energy and Climate Plan were drawn up and presented to the European Commission in accordance with Regulation (EU) 2018/1999 of 11 December 2018 on the Governance of the Energy Union and Climate Action. All scenarios of future energy use and supply defined in the national energy and climate plans are based on the lifetime extension of Krško NPP in order to enable the energy and climate policy targets to be met. The analyses carried out as the basis for the National Energy and Climate Plans have shown that increasing the use of renewable and non-carbon resources and increasing energy efficiency are not in themselves sufficient to enable the targets to be met if we take the estimated electricity needs and the increased requirements for reducing greenhouse gas emissions into account.
A study titled “Energy, systemic, economic and ecological aspects of the extension of the operational lifetime of Krško NPP”, which was drawn up by Elektroinštitut Milan Vidmar and the Faculty of Electrical Engineering at the University of Zagreb, showed that Krško NPP would be irreplaceable during the period of the proposed lifetime extension. Without Krško NPP, both countries will be reliant on electricity imports, where and if available. EU Member States’ national energy and climate plans show a net energy deficit, meaning that electricity imports will not always be available and that reducing consumption will be the only alternative in crisis situations. This runs contrary to the first dimension of the energy Union: “Energy security, solidarity and trust – diversifying European energy sources and ensuring energy security through solidarity and cooperation between Member States”. Extending Krško NPP operation to 2043 is the starting point on the path to decarbonisation and long-term energy independence. It will not be possible for either country to maintain short-term energy security without Krško NPP. Due to the planned increase in electrification of traffic (use of electric vehicles), heating (use of heat pumps), and the electrification and phasing out the use of fossil fuels in other sectors, both countries will require an ever-increasing share of stable energy in the form of electricity. According to estimates, the electricity deficit will continue to rise in Slovenia (for several years now, Slovenia has been importing electricity to cover about 20% of its consumption). By 2030, Slovenia will have a deficit of at least 1 TWh/year of electricity if Krško NPP continues to operate, regardless of development of technology, significantly more efficient consumption of electricity and the intensive introduction of new renewable energy sources. The gradual reduction in the use of fossil fuels therefore further highlights the role of nuclear energy, which is a seasonally stable, low-carbon source of energy. Current and projected developments do not show that we are yet at the point where current electricity production capacities can be met entirely by energy from renewables while satisfying the need, today and in the future, for energy supply that is reliable, secure, environmentally sound and cost-effective. The need to work within spatial restrictions and preserve natural and other assets hinders the development of the new renewable energy sources that could otherwise replace Krško NPP in the next 20 years. Based on the analysed scenarios, the energy balance sensitivity analyses and the projected required power, the lifetime extension of Krško NPP is shown to be the most favourable solution from the technical, environmental and economic standpoints. Events in recent months, which have seen a steep rise in fuel and electricity

prices, are further confirmation of the urgency of maintaining production at Krško NPP, as it guarantees affordable and sufficient supply of the electricity that industry and commerce so desperately need. If the operational lifetime of Krško NPP is not extended, Slovenia and Croatia will no longer be able to meet the requirements of the strategies and commitments referred to above. Moreover, it will endanger the stability and reliability of operation of the electricity system, which could lead to slower progress towards climate neutrality.

The overheating of the Sava River is prevented by means of a number of measures, including a combined cooling system and the activation of the cooling towers. In 2008 Krško NPP expanded its cooling capacity with the construction of a third block of cooling towers, leading to a total cooling capacity of 627.8 MW. The upgrading of the cooling towers in 2008 increased cooling capacity by 36%, This has reduced the likelihood of situations in which the plant is required to reduce power in response to a possible exceeding of the 3°C level. Section 5.6.1 of the EIA Report gives an estimate of the days in which the need could arise for the plant's power to be reduced. As the likelihood of such events is extremely small, additional measures are not required (Table 123) – indeed, plant power has not had to be reduced on a single occasion since the cooling towers were upgraded in 2008. The cooling towers can disperse 49.5% of the power plant's total waste heat, which means it has large reserve capacity for heat removal. Between 2010 and 2020, the average temperature of the Sava at the point of full mixing rarely exceeded 27°C in one day (four times in July 2015, once in August 2017 and four times in August 2018), but it never exceeded 28°C. The projected trend in the rise of the average temperature in the summer months is between 0.3 and 0.4°C per decade for the area of the Lower Sava ("Estimate of climate change in Slovenia up to the end of the 21st century". Synthesis report – Part One, ARSO, November 2018). In relation to the measurements contained in the study titled "Energy buildings along and on the Sava – Analysis of river temperatures in the Lower Sava in July and August 2019 and the verification of previous studies" (Revision A, IBE, April 2020), the reservoir of the Brežice hydropower plant has an additional cooling effect on the water.

The reduction in power due to ΔT does not mean that the plant has to stop operating, but there may be a small loss of power because the cooling towers take over some of the cooling tasks. This means that Krško NPP will continue to be a stable supply power source ("base load power source").

The alternative to lifetime extension is presented in Section 3 of the EIA Report. The Espoo Convention requires an assessment to be made of the possible alternatives to a proposed activity, while the EIA Directive requires reasonable alternatives to be examined. Possible (i.e. reasonable) alternatives must be capable of satisfactorily achieving the objectives of the proposed activity, and must also be feasible in terms of the technical, economic, political and other relevant criteria. It must be realistic to realise the alternatives at the time the decision on the project is taken. Constructing a power plant or plants (including those that use renewables in combination with other sources) to replace production at Krško NPP is currently not a realistic proposition. In addition, the UNECE Good Practice Recommendations on the Application of the Convention to Nuclear Energy-Related Activities, Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention), explain that alternative means of energy production are national issues of the party of origin and are therefore more properly addressed at the political and strategic level, as they are in the Integrated National Energy and Climate Plan.

The conclusions of a study produced by Vienna University of Technology, which sets out the options for the future use of renewables for energy purposes, highlight the natural conditions, such as solar radiation and the presence of wind, in Slovenia and Croatia. Unfortunately, they do not take into account any other equally important environmental or social factors.

The new EU Strategy for Biodiversity 2030 requires Member States to redouble their efforts to preserve biodiversity and to protect 30% of their land and sea areas (10% under strict protection conditions) by 2030. The Convention on Biodiversity (CBD), which is the global framework for biodiversity, will have similar coverage requirements after 2020. This means that the network in the EU will have to be expanded over the next decade, by approximately 4% on land and by 19% on sea.

Slovenia and Croatia are, in European terms, two countries with an above-average percentage of land area given over to protected and Natura 2000 areas (and an above-average number of such areas). In Slovenia, 40.5% of the land surface is covered by protected areas (compared to 28.9% in Austria, which

is close to the EU average of 26.4%, source: EEA, land, situation as at May 2022)
Background documents have been produced for the use of wind energy in Slovenia. They conclude that: Slovenia has fairly limited wind power potentials. Average wind speeds are relatively low, while the small number of areas suitable for wind power largely coincide with extensive and multi-layered areas of protected and endangered areas; these are seen as exclusionary or limiting criteria for the siting of wind farms. When the minimum distance between a wind turbine and a settlement is taken into account, the number of potentially suitable locations falls still further because of Slovenia's highly dispersed settlement pattern.
Compared to the installation of solar farms on farmland, obtaining electricity from the sun using photovoltaics mounted on the roofs of buildings outside areas of settlement and building heritage does not have any noticeable negative impacts. Instability of generation remains a problem that can partly be predicted sufficiently far in advance (day/night, summer/winter) and partly not (variable weather conditions over a day or season).
The generation of electricity from renewable energy sources, which is expected to bring about a reduction in (financial) costs in the future, will have to take account of all costs, including environmental and social.

Reply to the response by Greenpeace Hrvatska to the documentation in the Environmental Impact Assessment for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years, 9 June 2022

Question 1: Greenpeace welcomes the fact that Slovenia has finally required the competent authorities and Krško NPP to submit the project to extend the operational lifetime of Krško NPP from 40 to 60 years to an EIA procedure. An EIA of this type is an international obligation under the Espoo Convention and the EU's EIA Directive, while public participation in decision-making on whether to extend the operational lifetime of nuclear energy before the regular ten-year safety review is an obligation under the Aarhus Convention. We welcome the fact that Slovenia is following the "Guidance on the applicability of the Convention to the lifetime extension of nuclear power plants", and urge it to follow the case-law laid down within the framework of the Aarhus Convention in case no. ACCC/C/2014/104 Netherlands and as set out in the Aarhus Convention Compliance Committee report on general issues of compliance, which was adopted at the 7th Meeting of the Parties to the Convention in October 2021.

The ministry notes that the notification of application of the Espoo Convention was sent to the specific contact points of the potentially affected parties in order to ensure adequate and effective consultation. Some of the affected parties that replied that they intended to take part in the transboundary EIA, including Croatia, also requested that a public consultation be held in their country. At the request of these parties, public consultations were held and the public informed in line with the relevant conventions and national laws. The public consultation procedure in Croatia took place between 12 May and 10 June 2022, with a public presentation in Zagreb on 27 May 2022.
On 21 February 2022, in accordance with the Environmental Protection Act and the Aarhus Convention, the ministry published a public announcement of the issuing of an environmental protection consent for the activity: "Extension of Krško NPP's Operational Lifetime From 40 to 60 Years" at Krško administrative unit, at the offices of the Municipality of Krško and on the ministry's website. The EIA documentation was publicly unveiled between 22 February and 23 March 2022 at the offices of Krško administrative unit and the City of Krško, as well as on the ministry's website. During the public consultation procedure, the general public and interested organisations were invited to submit their opinions and comments in writing to the Ministry of the Environment and Spatial Planning, or by email to gp.mop@gov.si. Under the provisions of the ZVO-1, permanent residents and owners of property in the area of the proposed activity, as well as the non-governmental organisations referred to in the first paragraph of Article 153 ZVO-1, were invited to submit opinions and comments and to request participation in the procedure. Responses were drafted to the opinions and comments submitted in the course of the public consultation, and an oral hearing attended by Krško NPP and third-party participants was also held at the offices of the Ministry of the Environment and Spatial Planning on 28 June 2022.

Question 2: Acceptable risk between 2023 and 2043 – The documentation states that "the extension of Krško NPP's operational lifetime […] does not change the dimensions or design bases of the power plant; […] does not entail the construction of new facilities that would change the physical characteristics of Krško NPP." This shows that Krško NPP activities will not be sufficiently adjusted in these vital areas: the aging of the reactor and developments in relation to acceptable risk, the state of the art and best legislative practice, and changes to the environment.
Accordingly, research should be carried out to determine whether the degree of risk that Krško NPP could present between 2023 and 2043 really is acceptable in the light of the current presentations on acceptable risk, and whether any increase in risk can be properly prevented. Our finding is that this has not been properly researched. We therefore expect the risk to be currently higher than envisaged by Krško NPP and that all the measures taken and measures proposed will not suffice to reduce the risk presented by Krško NPP to an acceptable level.

After studying Krško NPP's comments and the SNSA opinion, the ministry responds by saying that there is enough information indicating that the risks are small and that a large number of safety upgrades have been put in place. The ministry also notes that the facility will not be physically modified and that it is "robust" and up to date, and therefore that there will be no risk from normal operation and that the risks resulting from an accident are small. The ministry points out that Krško NPP is committed to carrying out constant safety upgrade measures and making constant improvements to operations, that considerable investments have been made in updates, and that it follows international good operating practice, as the pre-SALTO mission of 5–10 October 2021 indicates.
Furthermore, in accordance with the requirements of the Ionising Radiation Practice and Nuclear Safety Act and the Rules on the operational safety of radiation and nuclear facilities, Krško NPP conducts a Periodic Safety Review (PSR) every ten years that includes checks and evaluations of compliance with applicable international standards and international best practice. The PSR also assesses compliance with operating experiences gained from the operation of Krško NPP and from abroad, new findings acquired from technical studies, the progress made, and the operation of other radiation or nuclear facilities.
The safety culture and the knowledge and professionalism of employees are core elements Krško NPP's organisational structure, and will continue to be the guiding principle and assurance of the future safe operation of the plant. We will continue to introduce the necessary safety and other improvements on a regular and timely basis. Krško NPP will carry out regular maintenance on all its technical systems, particularly those related to safety, and will regularly upgrade them in line with operating experiences from Slovenia and around the world.

Question 3: The statements that follow on p. 48 must therefore be understood as objectives rather than as actual statements of fact: "Until the end of the envisaged lifetime extension (2043), Krško NPP will continue to operate as it has done up to now, i.e. reliably, safely and with due attention to the limits placed on emissions into the environment." Up to today, nuclear power plants have always presented a certain risk, whether from human error, technical error, malicious attack (sabotage, terrorism, acts of war) or a combination of these. Technical and operational measures can reduce the possibility of such types of error occurring to some extent, but can never completely be ruled out. Failing to mention this gives the impression that these real possibilities are somewhat underplayed in the reports – and this is in fact the case, as we will see in the rest of this response.

After studying Krško NPP's explanations and the SNSA opinion, the ministry explains that technical and operational measures at Krško NPP (or in any other energy facility) can considerably minimise the possibility of damage, and significantly minimise the possible consequences of damage in the case of a (highly unlikely) event. Section 2.7.3 of the EIA Report (Emergency preparedness and emergency situations at the power plant) describes the existing plans and measures to deal with plant failure.
The Krško NPP Protection and Disaster Relief Plan (PDRP) deals with a nuclear and radiological accident at the plant. The main aim of planning and maintaining emergency preparedness is to protect the nearby population and staff at the plant and ensure their health and safety by preventing the

emergency situation from deteriorating further, removing or mitigating the effects of the emergency, and putting conditions in place for restoring normality. Krško NPP is responsible for maintaining a state of preparedness, taking measures in response to an emergency at the site of the plant and notifying the competent institutions of the emergency at the plant, thereby ensuring that protective measures are taken in the surrounding area.

Krško NPP plans and maintains preparedness for the entire range of emergencies that could or would jeopardise nuclear safety at the plant and lead to the release of radioactive substances into the environment. These include radiological accidents, events or situations at the plant that could have an indirect impact on nuclear safety, nuclear accidents with minimal radiological consequences for the environment, and highly unlikely design-basis and beyond-design-basis accidents with radiological consequences at the plant and the surrounding area.

A series of analyses of the Fukushima disaster produced by Krško NPP have been incorporated into the design-extension conditions (DEC). These disasters were not addressed in the original power plant design and/or as part of design-basis accidents.

The analyses have addressed combinations of accidents and formed the basis for further upgrades to the plant (DEC). The upgrades have taken place within the context of the Safety Upgrade Programme. The additional systems that have been installed ensured that Krško NPP is able to manage beyond-design-basis accidents with an expanded set of equipment and with upgrades. The equipment has been divided into DEC-A and DEC-B equipment.

Using DEC-A equipment, Krško NPP is able to prevent reactor core meltdown, while DEC-B equipment has been designed to manage the highly unlikely occurrence of core meltdown and focuses on the protecting the final barrier before release, i.e. containment integrity. The passive containment filtered venting system (PCFVS) serves to release pressure in the containment while ensuring that substances harmful to the environment remain caught in the filters. Indirect release into the environment from core meltdown is therefore highly unlikely.

The estimated doses at different distances from Krško NPP and resulting from an emergency that would require use of the PCFVS are set out in the FER-MEIS report "Calculation of doses at certain distances for design-basis (DB) and beyond-design-basis (BDB) accidents at Krško nuclear power plant" and in the EIA Report (Section 6.4, Transboundary impacts in the event of an emergency/accident).

Question 4: The Periodic Safety Review (PSR1) and the Aging Management Programme (AMP) were not submitted for an EIA with public participation prior to being implemented. It is therefore not clear whether they suffice to meet the level of acceptable risk referred to under our point 2.

After studying Krško NPP's comments and the SNSA's opinion, the ministry points out that the Periodic Safety Review and the AMP are not part of the EIA procedure, that they are the responsibility of the SNSA, and that the requirements are laid down in Slovenian nuclear safety legislation. The SNSA was nevertheless requested to provide an opinion in the procedure. It drafted that opinion with reference to the safety reviews, its own documentation and all existing nuclear safety knowledge. The ministry has therefore incorporated the opinion into the EIA. However, the PSR and AMP are technical documents under nuclear legislation that are not the subject of the EIA and to which public participation does not apply. Public participation takes place on the basis of the EIA Report, the preparation of which makes use of all existing knowledge and practices.

Here the ministry explains that the issue here is the relationship between environmental protection and nuclear safety, which is specific to the nuclear field and which needs to be explained, as two regulatory authorities with legally defined tasks are involved in parallel, with nuclear safety findings being inserted into the EIA Report. However, activities for ensuring nuclear safety do not cease with the issuing of an environmental protection consent. On the contrary, improvements must continually be made in a controlled manner so as to ensure compliance with all national and international standards.

In relation to the PSR, as laid down in Slovenian nuclear safety legislation and in accordance with the IAEA Specific Safety Guide SSG-25 (Periodic Safety Review for Nuclear Power Plants), the SNSA is responsible for: setting and approving requirements for the implementation of a PSR; reviewing the actual scope, implementation and findings of the PSR and the resulting safety improvements; assessing the possibilities for safe operation for the period until the next PSR; monitoring the relevant licensing measures; and providing information on the results of the PSR and the resulting safety improvements. In accordance with the requirements, Krško NPP successfully completed two PSRs: the first in 2003 and the second in 2013. Both were approved by SNSA decision. The comprehensive safety assessments that form part of the PSR have confirmed that Krško NPP is safe and capable of operating safely until the next PSR. A third PSR is under way and will be completed in 2023. The Krško NPP PSR is conducted by independent external experts whose work is impartial, independent and objective. The SNSA assesses and reviews the report on the review of specific content (safety factor) and the comprehensive/global assessment of and plan for the implementation of measures, and makes recommendations that must be taken into consideration. The implementation plan must contain a precise description of all measures and the deadlines applying to each of them. Under Slovenian law, any deviations established in the course of a PSR must be eliminated without delay, with due regard to their importance to nuclear safety. Any deviations that could threaten the nuclear safety of the facility must be eliminated without delay. The preliminary results, which are currently being assessed by the SNSA, show that there are no major safety-related deviations or findings that would require immediate action. The deviations that have been found relate mainly to improvements to procedures and programmes and do not directly concern nuclear safety.

Requirements relating to the AMP are also laid down by Slovenian nuclear safety legislation. The AMP must be sent regularly to the SNSA for review. In addition to the review conducted by SNSA experts, a large number of reviews have been performed by independent international experts to ensure that Krško NPP's AMP is compliant and comprehensive: WANO (2014 and 2019); the IAEA Operational Safety Review Team (2017); the ENSREG Topical Peer Review on Aging Management pursuant to the requirement set out in Nuclear Safety Directive 2014/87/Euratom (2017–2018); and the IAEA pre-SALTO (Safety Aspects of Long Term Operation) mission (2021). During every PSR, the AMP is also reviewed independently in relation to Safety Factor 2 (Actual conditions of SSCs important to safety), Safety Factor 3 (Equipment qualification) and Safety Factor 4 (Aging). All missions and the SNSA review have demonstrated that the AMP complies with international recommendations and Slovenian law.

Question 5: Aging of the reactor – It is common knowledge that the chance of failure in nuclear power plants during their lifetime follow what is known as the "bathtub curve": a large number of failures when the plant first starts up, a rapid fall in their number, and then a slow but exponential increase towards the end of the plant's lifetime. Aging management is designed to reduce the effects of these increases; and although the increases can be reduced for a time, the ability of aging management to do so is limited in scope and time. An AMP is essentially based on a stable level of opportunity for ensuring that severe failure does not occur with improvements that are feasible within the ALARA principle, with economic arguments also playing a role. The documentation limits its description of the risk level to core damage frequency per operating year and shows only a downward trend. The documentation does not make clear whether the AMP and the measures resulting from PSR1 really are able to maintain the level achieved in 2021 or whether we should expect an increase along the lines of a "bathtub curve".

After studying Krško NPP's comments, the ministry responds by saying that nuclear power plants are subject to more stringent requirements than normal electricity-generating power plants when it comes to equipment operation, testing and maintenance. The reliability required of equipment is therefore very high.

Krško NPP carries out three types of maintenance: predictive, preventive and corrective. The aim of the first two types (predictive and preventive) is to uncover and preventively eliminate any deficiencies that could lead to equipment failure. If any type of corrective maintenance is required, consideration must be given to whether an adequate amount of time is available for it.

Krško NPP has also implemented an Equipment Reliability Programme in accordance with INPO AP-913. Systems engineers are responsible for checking systems operation by issuing quarterly reports on the condition of a system. These reports cover the current condition, the activities under way, the plan of improvements, deficiencies, priorities, aging management and the important activities carried out since the last report.

Indicator of plant performance

Krško NPP introduced a Plant Performance Monitoring Programme in 2007. The aim of this programme is to determine and ensure the consistent collection, analysis and use of the plant's predefined relevant operational data so as to ensure that the plant's performance can be presented in quantitative terms.

The high level of safety is the result of a complex interplay between good design, operational safety and staff competence. This is also the reason why a set of power plant operational safety indicators has been established: to enable the plant's performance and progress to be monitored, to set exacting objectives and improvement targets, to obtain an additional overview of performance as it compares to that of other plants, and to highlight any possible requirement to adjust the priority tasks and resources in order to improve the general efficiency of plant operations.

The trend in a specific indicator in a specific period can ensure that sufficiently early warning is provided to plant management so as to enable it to examine the reasons for any changes observed. In addition to monitoring changes and trends, the indicators must also be set against the defined objectives for evaluating strengths and weaknesses in performance.

Each department is responsible for defining, collecting and monitoring its own set of strategic indicators for improving performance at departmental level. The safe, conservative, cautious and reliable operation of Krško NPP is the goal shared by every member of staff at the plant, and continually ensures the health and safety of residents and staff in accordance with the plant's policy as laid down in the overall programme. The establishment of a monitoring programme and of the assessment of operational safety indicators is a reflection of the effective safety culture maintained by staff at the plant.

The Krško NPP maintenance service has implemented 26 operational indicators for identifying early equipment failure trends, and set specific operating targets for each indicator.

In addition, Krško NPP's system of work orders requires the maintenance service to determine the current condition of equipment in order to facilitate the additional monitoring of trends. This monitoring is performed by an independent long-term operation team within the engineering department that monitors the additional operational indicators for aging and degradation processes.

Aging management is an additional process carried out in order to monitor SSCs for any possible degradation resulting from aging. It is carried out in accordance with the requirements applicable in the USA, such as 10 CFR 54 (Requirements for Renewal of Operating Licenses for Nuclear Power Plants) and 10 CFR 50.65 (NEK Maintenance Rules), for passive and active SSCs. Aging management covers a definition of the SCOPE of components, which are monitored for aging, materials, stress factors and potential mechanisms for their dismantling. The AMPs carried out are based on NUREG-1801 Rev. 2 – GALL (Generic Aging Lessons Learned) and define ten attributes for determining aging management. These attributes define preventive action, the parameters monitored or inspected, the detection of aging effects, the acceptance criteria, corrective actions, operating experience, etc.

As mentioned above, all these activities are performed to eliminate the third part of the "bathtub curve" (defects caused by wear).

<u>Question 6</u>: Development into acceptability of risk – state of the art

The author of the comment believes that, in the light of the statements on p. 48 and the description of the AMP and PSR1 in Section 3, one must conclude that Krško NPP has striven for a stable level of failure probability (in the case of a core damage frequency level for Generation II reactors of $1.00E^{-05}$), instead of aligning the plant with the latest state of the art. The latest state of the art can be understood from the guidance issued by WENRA for new Generation III nuclear reactors* such as EPR in France. Measures to reduce the risk of such plants include, *inter alia*, increased redundancy, core catchers, greater solidity of containment structures, etc. France has already adopted a decision ordering older nuclear power plants to take technical measures after 40 years of operation to bring them closer to this level of technical condition. It is clear that Krško NPP has not done this. Krško NPP essentially presents a greater risk than it did at the time the original decision on operational lifetime was taken. After 40 years, it should be closed and replaced by a new reactor that meets the WENRA guidance. Extending Krško NPP's operational lifetime therefore does not achieve an acceptable level of risk given the state

of the art.
After studying the comments, the ministry responds by saying that there are two sets of WENRA SRL requirements: one for existing reactors and one for new reactors. Krško NPP is required to follow (and meets) the WENRA SRL requirements for existing reactors, but has already carried out a review in line with the WENRA SRL for new reactors as part of the current PSR, which established that it meets the main set of requirements. It should be understood that nuclear practice covers a variety of approaches to the prevention of events with major consequences, and not only the solutions provided by French nuclear power plants – for example, not all new models have core catchers, and there are other methods for preventing interaction between melted core and concrete.
Regarding risks, Krško NPP is first and foremost committed to safe operation and to improving the safety of the plant. The risk of a power plant, calculated by means of a probabilistic safety assessment, is a universal tool for measuring plant risk/safety, and Krško NPP's safety is very close to $1E^{-05}$/year, which is the IAEA recommendation for Generation III nuclear power plants. Based on the state of the art of nuclear design, Krško NPP therefore meets an acceptable level of risk,
something that was also confirmed by the EU stress tests. The EU stress tests were the first time expert reviews were placed at the service of a joint inspection of all nuclear power plants in Europe. No findings were produced in relation to Krško NPP, nor were any recommendations for improvements issued.

Question 7: Development towards acceptability of risk – changes in the environment
The author of the comment believes that the documentation shows that only the possibility of error was taken into consideration in the definition of the AMP and during PSR1. However, in order to maintain risk at a stable level (which is already too high from a technical standpoint), an assessment must also be made of the development of potential impacts. For example, when there are twice as many inhabitants that could be affected by a severe accident than there were when Krško NPP began operating, then the possibility of a severe accident must be halved if we wish to maintain the risk at the same level. The same applies to economic activity (a doubling of economic activity should halve the possibility), the presence of important natural areas and important biodiversity, and so on. The documentation does not make clear how the important environmental parameters (number of potentially affected inhabitants, economic activity, natural habitats, etc.) have developed since Krško NPP began operating in 1981. Are there reasons why further technical measures are required to reduce the possibility of a severe accident? Are they carried out in order to balance the increase in the potential impacts? There is also no assessment of the development of these important environmental parameters over the next 20 years. Are there reasons why further technical measures are required to reduce the possibility of a severe accident? Is it to prevent increased potential impacts during the future operational lifetime of the plant?
As these assessments have not been carried out, it is likely that Krško NPP already fails to meet acceptable levels of risk and that these levels will continue to deteriorate in the next 20 years, including on account of the growing number of potential risks.

The ministry explains that the claim regarding the number of inhabitants is not completely accurate. The population potentially directly affected is the population of Slovenia as a whole, whose numbers have risen only slightly: 1.922 million in 1983 vs. 2.107 million in 2022. The same applies to neighbouring countries: Austria: 7.5 million vs. 8.9 million, Italy: 56 million vs. 61 million, Hungary: 10.7 million vs. 9.7 million, Croatia: 4.6 million vs. 3.8 million. As we can see, the populations of some countries have fallen during the plant's operational lifetime.
Krško NPP is committed to increasing plant and operational safety by a factor of 17. The risk today is 17 times lower than it was when Krško NPP began operating; the claim that the plant is not suitable for continued operation from the safety aspect is therefore simply not true. If the plant were to operate in accordance with its original plan of 40 years, its risk probability would be integrated into $9.6E^{-03}$. The CDF value has fallen considerably over the years on account of the safety improvements made to the plant. If we estimate the integrated risk probability for a hypothetical 40-year lifetime extension (i.e. a total operational lifetime of 80 years), the risk probability is less than $7E^{-03}$, i.e. a great deal lower than the original figure for 40-year operation.

We believe, given these above statements, that the safety and design of the plant are at an adequate level for the lifetime extension.

Question 8: Lessons that should be learned from the war in Ukraine
Between the Chernobyl exclusion zone, the Zaporizhzhia nuclear power plant and the missiles that have also flown over other nuclear facilities, the war currently being prosecuted in Ukraine by Russia has led to an unprecedented threat to nuclear safety. Despite decades of pleas to take the threat of malicious attacks (including acts of war) seriously when assessing the potential risks to nuclear power plants, the current war clearly shows that there are large gaps in safety measures and regulatory practice when it comes to potential conflict situations. Krško NPP has also failed to learn these lessons, even though it is one of the few nuclear power plants to have actually been exposed to the threat of military attack (in 1991). The lessons that should be learned from the war in Ukraine will probably give rise to a need for further upgrades and further financial investment. Understandably, this does not make an appearance in the current documentation, but should be added to it before any decision is taken on extending Krško NPP's operational lifetime.

After studying Krško NPP's statements, the ministry responds by saying that the plant drew up an analysis of the impact of an aircraft crash and of other terrorist attacks and acts of sabotage on the basis of the NEI 06-12 B.5.b Phase 2 & 3 Submittal Guideline requirements (Rev. 2) and the US NRC B.5.b requirement, which was issued in 2002 (in response to WTC attack on 11 September 2001), which requires nuclear power plants to be prepared for such an event by enhancing safety in the event of explosions or fires. An action plan was drafted and various safety improvements made in response to the analyses. The ENSREG stress tests and the comprehensive and detailed review of safety at Krško NPP have shown that the plant is well-designed and constructed. It is also well-prepared for such events because of the additional equipment for managing severe accidents available on-site.
Krško NPP has redundant engineered safety features that are physically separate from each other. As part of the Safety Upgrade Programme, Krško NPP installed additional engineered safety features in two bunkered buildings that are physically separate and adequately distanced from the plant's main island, where the reactor is located in a double-shell containment. This ensures that the plant can be safely halted even in the event of a large commercial airliner crashing into it. Krško NPP is also protected against other malicious attacks, terrorist attacks and acts of sabotage. However, because of its sensitive nature, information on the safety aspects and the plant's physical protection is classified; this means that it cannot be accessed without security clearance and therefore cannot be disclosed in the EIA Report.

Question 9: Comparable with the "no-action" and other alternatives
The author of the comment believes that the "no-action alternative" has not seriously been assessed and that it is not comprised of "closure of the plant and doing nothing else", but of (several) alternative scenarios under which Krško NPP is closed. These scenarios must meet basic criteria such as reliability of supply, decarbonisation, and environmental and economic development. The assessment of alternatives is made up of reports that mention only the negative sides of alternative technologies. There have been no objective analyses by expert institutions well-versed in the topics of renewable energy source technologies, energy-efficiency technologies and issues round climate change mitigation, nor has there been any modelling of scenarios. We request that serious "no-action alternatives" be included in the final EIA.
The "no-action alternative" that is used does not allow this and therefore cannot be taken seriously. Alternative scenarios should also show the various paths of development that could be taken by the nuclear power plant, including investments in safety, so that the reactor achieves an acceptable level of risk (including the state of the art, compliance with changes in the environment, etc.).
The comparisons with the alternatives have not been made in a qualitatively acceptable manner, nor are they sufficient.

The ministry responds by saying that all the expert alternatives listed, the modelling and the quantitative

comparisons between scenarios were drawn up at strategic document level in the strategic EIA for the national energy programme (https://www.gov.si/zbirke/projekti-in-programi/nacionalni-energetski-in-podnebni-nacrt/).
The alternative to lifetime extension is presented in Section 3 of the EIA Report. The Espoo Convention requires consultation about alternatives, while the EIA Directive requires an examination of reasonable or realistic alternatives. The possible (i.e. reasonable) alternatives must be capable of satisfactorily achieving the objectives of the proposed activity, and also be feasible in terms of technical, economic and other important criteria. It must be realistic to realise the alternatives at the time the EIA is implemented. Constructing a power plant or plants (including those that use renewables in combination with other sources) to replace production at Krško NPP is currently not a realistic proposition, although it is covered by the strategic national scenario. Moreover, alternative methods of producing energy or balancing supply and demand are national issues of the party of origin and are therefore more properly addressed at the strategic level (for example, an Integrated National Energy and Climate Plan). Accordingly, Slovenia and Croatia have developed their National Energy and Climate Plans (NECP) based on extensive analyses and modelling carried out by leading institutes, universities and companies in the fields of energy efficiency, renewable energy, greenhouse gas emission reduction, mutual connections, research and innovation. Slovenia's 2021 Integrated National Energy and Climate Plan (NECP) and Croatia's 2020 Integrated National Energy and Climate Plan were drawn up and presented to the European Commission in accordance with Regulation (EU) 2018/1999 of 11 December 2018 on the Governance of the Energy Union and Climate Action. The Integrated National Energy and Climate Plans drawn up by both countries set out the objectives, policies and measures for five dimensions of the Energy Union up to 2030 (with an outlook to 2040), and cover, among other things: decarbonisation (greenhouse gas emissions) and renewable energy sources, energy efficiency and energy security. All scenarios of future energy use and supply defined in the Integrated National Energy and Climate Plans are based on extending Krško NPP's operational lifetime in order to enable the energy and climate policy targets to be met. The analyses that formed the basis for the National Energy and Climate Plans have shown that increasing the use of renewable and low-carbon-emission sources and increasing energy efficiency are not in themselves sufficient to enable the targets to be met if we take estimated electricity consumption and the increased requirements to reducing greenhouse gas emissions into account.
A study titled "Energy, systemic, economic and ecological aspects of the extension of the operational lifetime of Krško NPP", which was drawn up by Elektroinštitut Milan Vidmar and the Faculty of Electrical Engineering at the University of Zagreb, showed that Krško NPP would be irreplaceable during the period of the proposed lifetime extension. Without Krško NPP, both countries will be reliant on electricity imports, where and if available. EU Member States' national energy and climate plans show a net energy deficit, meaning that electricity imports will not always be available and that reducing consumption will be the only alternative in crisis situations. This runs contrary to the first dimension of the energy Union: "Energy security, solidarity and trust – diversifying European energy sources and ensuring energy security through solidarity and cooperation between Member States". Extending Krško NPP operation to 2043 is the starting point on the path to decarbonisation and long-term energy independence. It will not be possible for either country to maintain short-term energy security without Krško NPP. The situation is even more serious when it comes to future energy use, as electricity is considered the predominant form of energy in the economy (industry, transport, services) and for most of the population's energy consumption. Current and projected developments do not show that we are yet at the point where current electricity production capacities can be met entirely by energy from renewables while satisfying the need, today and in the future, for energy supply that is reliable, secure, environmentally sound and cost-effective. The need to work within spatial restrictions and preserve natural and other assets hinders the development of the new renewable energy sources that could otherwise replace Krško NPP in the next 20 years. Based on the analysed scenarios, the energy balance sensitivity analyses and the projected required power, the lifetime extension of Krško NPP is shown to be the most favourable medium-term solution from the technical, environmental and economic standpoints. Events in recent months, which have seen a steep rise in fuel and electricity prices, are further confirmation of the urgency of maintaining production at Krško NPP, as it guarantees affordable and sufficient supply of the electricity that industry and commerce so desperately need. If Krško NPP's

operational lifetime is not extended, the stability and reliability of the electricity systems of Slovenia and Croatia will be at risk, which could slow its progress towards climate neutrality.

Question 10: Regarding investments in safety for achieving acceptable levels of risk for the reactor, Krško NPP has, as the EIA Report shows, completed an extensive Safety Upgrade Programme covering a large number of improvements and additional engineered safety features for managing severe accidents and highly unlikely external events. The SUP was drawn up on the basis of a national action plan in response to the EU stress tests. Essential upgrades have therefore been made in the areas of seismic safety, flood protection, mitigation of the impact of fire, and the provision of additional sources of supply in the event of emergencies or the failure of external electricity supply (EIA, Sections 2.7.12 and 2.8). In August 2013 the European Commission published a final report containing the results of the stress tests and the safety inspections carried out at all nuclear power plants. The report confirmed that Krško NPP was achieving excellent results and was adequately prepared for severe accidents and extreme events. The modernisation of safety solutions at Krško NPP includes the best available technological solutions and follows international practice (e.g. Switzerland, Belgium, Sweden, and France). This applies in particular to the cooling of the core by ensuring containment integrity, the management of severe accidents and the cooling of spent fuel.
The core damage frequency has fallen sharply in the last 20 years as a result of the major investments made in safety upgrades at the plant. Essential upgrades have been made in the areas of seismic safety, flood protection, mitigation of the impact of fire, and the provision of additional sources of supply in the event of emergencies or of failures outside the plant site, etc. The Krško NPP SUP has led to a reduction in risk in the last few years.
The SUP took into consideration the changes in environmental conditions (i.e. climate change), which are also assessed in the Periodic Safety Reviews conducted every ten years pursuant to the ZVISJV-1 and the Rules on the operational safety of radiation and nuclear facilities.
Compliance with and the fulfilment of safety requirements in the nuclear industry is subject to well-established national regulatory reviews and inspections by the SNSA and to international expert inspections. Krško NPP is monitored on a regular basis by a large number of international missions; these focus on all aspects of operation, with greatest emphasis given to ensuring nuclear safety. Inspections are carried out by the International Atomic Energy Agency (IAEA), the World Association of Nuclear Operators (WANO or INPO) and others. Following the WANO safety review, Krško NPP was placed in the first operating class as one of the world's best nuclear power plants.

Question 11: Relationship to future emissions – no comparison with the "no-action alternative"
The documentation states as follows: "No new discharges into waters are envisaged with the extension of Krško NPP's operational lifetime from 40 to 60 years. The types and concentrations/activities of the discharges of substances into waters that are envisaged remain unchanged. The quantity of annual discharges of substances and heat into waters will remain unchanged and within the limits set by the environmental protection permit [4] and RETS [11]."
This quotation is used as an illustration, but in fact the report only addresses changes to emissions. Extending Krško NPP's operational lifetime does of course entail new discharges of radioactive substances into waters (and into the atmosphere and soil), i.e. new in comparison with previous discharges. The continuation of pollution is still pollution regardless of whether the quantities change. This fact greatly undermines the quality of the report. Comparisons with feasible alternatives must be drawn up; at the moment, however, they are being done so on the basis of ideology.

After studying Krško NPP's statements, the ministry responds by saying that an EIA is, under the provisions of the Decree on the method of drafting and on the content of the report on the effects of planned activities affecting the environment, required to show the difference in impacts that modifications to operations will cause. Operating power could be reduced, which might lead to different emission levels. However, the report has concluded that the impact will be the same. The ministry, which obtained all the monitoring data, checked the data supplied by the Slovenian Environment Agency and approved the report because it was based on measurements. The ministry also relied on the

environmental protection permit (already issued) and the water consent.
Krško NPP has operated within the relevant conditions and limits, and the EIA Report shows that it will continue to do so during the lifetime extension. The EIA Report assessed the impacts of NEK operation as "not significant" and not as "non-existent". Radioactive discharges are significantly below the officially determined limit values (Section 4.4.6, Ionising radiation).
Scenarios for the continued use of nuclear energy until 2043 have been set out in the Slovenian National Energy Concept, as set out in the Strategic Energy Policy up to 2030 (with an outlook to 2050), and in the Slovenian Integrated National Energy and Climate Plan (NECP).

Question 12: Insufficient attention given to emergency preparedness and response
The author of the comment believes that insufficient attention is paid to the impact of emergencies outside the nuclear power plant. The current emergency preparedness and response arrangements are inadequate (regardless of what the international missions say during their visits: if a severe accident with large radioactive releases were to happen at Krško NPP, it would cause chaos) and not addressed, nor is consideration given to the fact that extending the operational lifetime would prolong this unsatisfactory situation for a further 20 years. There are no suggestions for improvement and no assessment of the costs.

The ministry has studied Krško NPP's statements and replies that the EIA Report contains a description of the Krško NPP Protection and Disaster Relief Plan (PDRP), which ensures emergency preparedness and response. This, together with the protection and disaster relief plans for a nuclear accident drawn up by the municipalities of Krško and Brežice, the Posavje region and Slovenia as a whole, ensures the coordinated management of an accident at the plant and in the wider environment. Krško NPP is responsible for emergency preparedness and response at the site, including control of the exclusion zone (radius of 500 m from the reactor core). Emergency preparedness and response beyond the site is the responsibility of local and national authorities.
Protection and disaster relief plans, the entities tasked with planning, and the content, criteria for preparation and method of preparation of protection and disaster relief plans in the event of a natural or other disaster are regulated by the Decree on the content and production of protection and disaster relief plans (Official Gazette of RS, Nos. 24/12, 78/16 and 26/19), which complies with EU Directives relating to emergency preparedness and response. Supervision of protection and disaster relief plans and documents for the performance of protection, rescue, relief and protective tasks and measures is exercised by the Inspectorate of the Republic of Slovenia for Protection Against Natural and Other Disasters.
The claim that "the current emergency preparedness and response arrangements are inadequate (regardless of what the international missions say during their visits: if a severe accident with large radioactive releases were to happen at Krško NPP, it would cause chaos)" is not supported by the evidence and is therefore groundless.
An IAEA Emergency Preparedness Review (EPREV) was carried out at Krško NPP in 2017. This is a service provided by the IAEA to Member States at their request, with the IAEA assessing their level of preparedness for a nuclear or radiological emergency in accordance with the applicable international standards and practices. The EPREV team at Krško NPP comprised international EPR experts from IAEA Member States, and a team coordinator and deputy coordinator from the IAEA Secretariat. The IAEA (the organisation itself and the experts involved in the review) cannot be regarded as insignificant, which is what the author of the comment suggests with the words "regardless of what the international missions say".
The EPREV concluded as follows: "The Slovenian government should be commended for earmarking considerable funds for EPR at all national levels. Most emergency response organisations have developed comprehensive arrangements for fulfilling the tasks and responsibilities allocated to them. In many cases the arrangements had been tested in training and exercises, particularly for emergencies at the nuclear power plant.
The team observed many separate examples of good practice and the excellent cooperation between all emergency response stakeholders and organisations during the mission and during detailed

discussions of the country's protection and disaster relief arrangements. They also noted several areas for improvement, with an action plan being drafted to implement the recommendations and suggestions. The recommended improvements were made, and were then independently reviewed as part of the regular safety review.

Question 13: Increased generation of radioactive waste – no final solution
It is acknowledged that the funds for managing existing radioactive waste are insufficient, and there is merely a vague "promise" that Croatia and Slovenia will make up for the shortfall in the next ten years. There is no process to ensure this, which means that radioactive waste is a problem from the cost point of view – and an even greater one when the increased amounts of radioactive waste that will be generated by extending Krško NPP's operational lifetime are considered. The funds available today are insufficient, the future envisaged costs will probably not suffice, and a further 20 years of operation will likely not bring in the necessary funds from levies. This means that Slovenian and Croatian electricity consumers/taxpayers will, at some point, have to shell out quite a lot of money to keep radioactive waste management in check. The less waste there is, the easier it will be to manage the situation.
There is no feasible plan for the final disposal of high-level radioactive waste and spent fuel. Without any fanfare at all, this is simply left for the next two or more generations to deal with. From the point of view of the generation of radioactive waste, the extension of Krško's operational lifetime is unjustified.

After studying Krško NPP's statements, the ministry responds by saying that the Treaty between the Government of the Republic of Slovenia and the Government of the Republic of Croatia on the Regulation of Status and Other Legal Relations Regarding Investment in and the Exploitation and Decommissioning of Krško Nuclear Power Plant (Official Gazette of RS [Mednarodne pogodbe], No. 5/03, hereinafter: Intergovernmental Treaty) clearly sets out all the obligations applying to the financing of the safe disposal of radioactive waste and spent fuel generated during the operation and decommissioning of Krško NPP. Moreover, the two countries have ratified the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (Official Gazette of RS [Mednarodne pogodbe], No. 3/99), which requires the signatories to take appropriate steps to avoid imposing undue burdens on future generations. They have also ratified Council Directive 2011/70/Euratom of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste, which has been transposed into Slovenian and Croatian law. The aim of the Directive is to ensure the safe management of radioactive waste and spent fuel in order to avoid imposing undue burdens on future generations.
On 14 July 2020, pursuant to the Intergovernmental Treaty, the Intergovernmental Commission tasked with monitoring implementation of the Treaty (hereinafter: Intergovernmental Commission) approved the Third Revision of the Krško NPP Decommissioning Programme and the Programme for the Disposal of Radioactive Waste and Spent Fuel from Krško NPP. Every five years, periodic revisions of the programme are carried out with the aim of updating the reference disposal concept in line with the latest technical solutions and information. Under the provisions of the third and fourth paragraphs of Article 10 of the Intergovernmental Treaty, the Krško NPP Decommissioning Programme and the Programme for the Disposal of Radioactive Waste and Spent Fuel from Krško NPP is the relevant document that gives an assessment of the funds needed for performance of the activities set out in the programme. In accordance with the provisions of the Intergovernmental Treaty, costs are funded by regular payments into two special funds: "Sklad NEK" in Slovenia and the "Fond za financiranje razgradnje i zbrinjavanja radioaktivnog otpada i istrošenoga nuklearnog goriva NEK" in Croatia. Pursuant to the adopted programme, the Slovenian government set a new amount of the contribution into the fund,
with the costs of decommissioning NEK and disposing of radioactive waste and spent fuel being included in the cost of electricity. Funds for financing decommissioning and RW and SF management are collected within the Slovenian and Croatian funds and will not impose a burden on future generations.
Spent fuel from Krško NPP will be safely stored in the spent fuel dry storage, which is under construction and will be completed in 2023. The dry storage is expected to operate for 60 years, with the possibility of extension. After dry storage, it is expected that the spent fuel will be deposited in a deep geological repository. Consideration is currently being given to a national, regional or multinational repository.

Question 14: Seismic threat
The comment's author believes that the report labels extreme earthquakes as a "highly unlikely risk". However, with the exception of Metsamor in Armenia, Krško is Europe's most seismically vulnerable power plant. Historical concerns (as expressed, for example, by the French IRSN) have not been properly dealt with, not even after the most recent PSR and the post-Fukushima stress tests.

After studying Krško NPP's comments, the ministry points out that the above two claims are untrue. While it is true that the seismic hazard of the Krško NPP location is the largest of all nuclear power plant locations in Europe, this does not mean that it is the most vulnerable; this is because the seismic safety of the facilities, including the plant itself, has been secured by an adequately high seismic design load (in our case, with a design PGA) and adequately standardised and conservative planning and construction. It is not true that Krško NPP did not respond to the report issued by the IRSN. Krško NPP is earthquake-resistant. The seismic design load of Krško NPP comprises the spectrum of accelerations in accordance with the American RG 1.60 regulatory requirements, scaled to a PGA of 0.3 g at the depth of the foundations (approx. 20 m below the surface). As the PGA during an earthquake decreases with depth (as we have already pointed out), the design peak acceleration at the depth of the foundations cannot be directly compared with the PGA at surface derived from the Probabilistic Seismic Hazard Analysis (PSHA, 2004). In order to be able to compare Krško NPP's seismic design load with the seismic load from the PSHA, due regard must be paid to the uniform hazard spectrum at the level of the foundations, which was determined in the PSHA of 2004. In order to compare Krško NPP's seismic design load with the results of the PSHA, due regard must be paid to the uniform hazard spectrum for the level of the foundations as calculated in the PSHA of 2004. A comparison between the design response spectra and the uniform hazard spectrum and a seismic analysis of the main Krško NPP island carried out in 2013 showed that the original seismic forces considered when the plant was being designed were comparable with the seismic forces for the design response spectrum under RG 1.60 with a PGA of 0.6 g on the open surface, which corresponds to a PGA with a recurrence interval of more than 10,000 years (0.56 g with a recurrence interval of 10,000 years – PSHA 2004).
As explained in the introduction, seismic safety cannot be discussed solely in terms of seismic hazard at the site, as additional safety factors were incorporated at the design stage that have increased the seismic performance of the plant relative to the seismic design load by one or two orders of magnitude. These safety factors and uncertainties were evaluated as part of the seismic analysis of brittleness and the seismic probabilistic safety assessments of the plant conducted in 1996 and 2004. It has been proved that the original SSCs can withstand considerably higher PGAs than those for which they were originally designed. On the basis of seismic brittleness assessments, it is estimated that there is a high probability that the plant can withstand a PGA greater than 0.6 g. The stress tests, which did not take into account the new DEC systems because they had not yet been implemented, showed that the PGA at which core damage probability could not be ruled out was 0.8 g or more.
One should emphasise that Krško NPP's seismic performance as stated in the Slovenian national stress-test report has been independently reviewed by institutions certified by the SNSA, and reviewed and confirmed during the international review of all stress tests carried out for the European Commission by ENSREG.
Krško NPP's seismic performance as stated in the stress test is conservative for two reasons. The first part of the conservatism derives from the fact that there is a difference between the seismic load considered in the plan/analyses and an actual earthquake. A design earthquake is not determined by PGA alone but also by the default elastic spectrum of accelerations, which is smooth and has high spectral accelerations at a wider interval of frequencies. This generally does not occur during a single actual earthquake. This means that spectral accelerations in the event of an earthquake with a PGA of 0.8 g will very probably be lower within a wider interval of frequencies than those considered in the Krško NPP seismic hazard analysis. In an actual earthquake with a PGA of 0.8 g, the seismic load in terms of spectral accelerations for a wider spectrum of frequencies is very likely to be lower than the seismic load that was considered in the analysis of Krško NPP's safety margins. This is because the actual spectrum, adjusted to a PGA of 0.8 g, is a great deal lower than the uniform hazard acceleration spectrum.

An additional source of conservatism derives from the fact that Krško NPP's seismic capacities as reported in the stress tests do not include the favourable impact on seismic and nuclear safety of additional engineered safety features designed and installed during the Krško NPP Safety Upgrade Programme. Some of this new equipment has been installed in facilities on the main Krško NPP island, although most has been installed in new buildings away from the main island. For example, the new bunkered building (BB1) is equipped with a new (third) diesel generator, while BB2 has additional pumps and alternative redundant cooling water tanks. These systems have been designed to withstand very powerful earthquakes. In comparison with the original seismic design loads incorporated when Krško NPP was being designed, the new systems have even greater seismic resilience (e.g. 0.78 g for BB2) and, as such, are capable of replacing the most vulnerable original systems in the event of their failure during an earthquake. If we take the new systems into consideration when analysing Krško NPP's seismic safety, the estimate of seismic capacity is even greater than the estimate presented in the EU stress-test report.
Slovenian law and EU practice require seismic hazard (and other hazards) to be periodically reassessed using the very latest methods. A new seismic hazard analysis is currently being drawn up in line with international standards and guidelines. According to the preliminary results, and taking the newly developed non-ergodic ground-motion model into account, significant differences in seismic hazard from the PSHA from 2004 are not expected.
Regarding the reservation expressed by the IRSN in 2013, it should be noted that this was a reservation concerning the definition of the selected fault as a capable fault. The IRSN presented a separate interpretation that contradicted the interpretations of the other partners in the consortium (the French geological survey [Bureau de Recherches Géologiques et Minières], the Geological Survey of Slovenia and the Slovenian National Building and Civil Engineering Institute) that had carried out the first phase of the project to update the PSHA for the immediate vicinity of Krško NPP in Krško. Those other partners established, on the basis of the preliminary results known up to that point, that the selected fault could not, without additional evidence, be defined as a capable fault that was able to cause permanent ground displacement at the Krško NPP site. The results of the PSHA showed, for permanent ground displacement, that there was no danger of larger permanent deformations, while the likelihood of very minor permanent ground displacements was negligibly small. Krško NPP also conducted a detailed analysis under the independent supervision of two different certified institutions; this showed that the plant's structures and systems could withstand larger permanent ground displacements than those with a recurrence interval of 10 million years (http://ursjv.arhiv.spletisc.gov.si/si/info/posamezne_zadeve/o_potresni_varnosti_nek/index.html).

Question 15: In their conclusion, the author of the comment notes that the reports supplied by Krško NPP for the EIA procedure were deficient in terms of quality and should not be accepted. They believe that high priority should be given to an alternative and realistic energy policy that includes the immediate termination of Krško NPP.

After receiving the comment, the ministry again reviewed the material and established that the EIA Report had been drawn up in accordance with the Slovenian Decree on the method of drafting and on the content of the report on the effects of planned activities affecting the environment, which complies with the EIA Directive.
The EIA Report and all additional documents were drafted by qualified and competent experts, as required under Slovenian legislation on EIAs and the EIA Directive. The qualifications of these experts are clearly stated in the EIA Report, as required under the Decree on the method of drafting and on the content of the report on the effects of planned activities affecting the environment.
A realistic national energy policy is set out in Slovenia's Integrated National Energy and Climate Plan, which is a strategic document that determines the objectives, policies and measures for the period leading up to 2030 (with an outlook to 2040) within the five dimensions of the Energy Union. The Integrated National Energy and Climate Plan was developed on the basis of extensive analyses and modelling carried out by leading institutes, universities and companies in the fields of energy efficiency, renewable energy, greenhouse gas emission reduction, mutual connections, research and innovation.

GERMANY

All the material for the transboundary consultation sent to Germany was in the German language. At the technical videoconference meeting on 22 March 2022, the competent environment ministries of Slovenia and the authorised representatives of the Federal Republic of Germany and the competent Bavarian ministry agreed on the technical aspects of the consultations and the involvement of the German public.
The authorised federal German ministry made all the necessary technical preparations for the public presentation of the material for 30 days, and set up a contact information point for comments. The material was publicly presented online, an email account sufficiently robust to receive a large number of comments was put in place and the public were informed of the Krško NPP lifetime extension project. There were no comments submitted by members of the public.

A transboundary technical consultation involving the parties was held in Krško on 29 June 2022 at which all the environmental and safety aspects of the extension of Krško NPP's operational lifetime were presented, an inspection of the condition of the plant carried out and precise technical explanations provided. There were no outstanding issues after the consultations were concluded (minutes, document no 35409-282/2020-97). In letter no. 35409-282/2020-99 of 1 July 2022, Slovenia sent the Federal Republic of Germany written clarifications of the technical issues discussed at the consultations ("Fragen zum Umweltvertraglichkeitsprufung für das KKW Krško, GRS – V – 4719iO1420-01/2022, Technische Notiz."), as follows:

The transboundary consultations proceeded on the basis of the questions and responses of the expert technical groups from Germany and Slovenia. Responses to technical notes, Questions regarding the environmental impact assessment for Krško NPP no.
Discussion of the safety aspects for long-term operation

Presentation of the safety level
Question 1: On what basis and according to which criteria was the level of safety at Krško NPP ranked in the European comparison?

The ministry responds by saying that, based on the ENSREG methodology prepared jointly by all countries of the European Community, the SNSA instructed Krško NPP to carry out an extraordinary safety review. The report mainly reflects the assessment of the nuclear safety measures in place at the time in the event of external emergencies. On 23 December 2011, the SNSA submitted the National Stress-Test Report to ENSREG and published it on its website. The basis for the review of nuclear power plants was the methodology prescribed for the performance of the EU ENSREG stress tests. The tests included inspections of the robustness of the plants and of the measures in place to prevent and mitigate severe accidents. Checks were made of the design bases, analyses were conducted of the safety margins, and the weak points and the measures to address the coming challenges to power plants were identified:
1. seismic risk and seismic loads;
2. risk from external floods;
3. extreme weather conditions;
4. loss of all AC power and the loss of all AC power for a prolonged period of time;
5. loss of the heat sink (loss of power plant cooling, combination of loss of cooling with loss of all AC power);
6. measures in response to severe accidents.

Where shortcomings in "defence in depth" in relation to the above-mentioned risks were identified, the findings and suggestions for improvement were documented. Krško NPP received no suggestions for improvement.

Question 2: To what extent have the WENRA safety reference levels been taken into account at the plant? Have they already been already taken into account in the Safety Upgrade Programme?

The ministry responds by saying that Krško NPP used the WENRA SRL as one of the basic documents in the SUP. The WENRA Safety Reference Levels for Existing Reactors 2014 was incorporated into the design bases, and the adequacy of the power plant design and the SUP was subsequently checked against the latest edition of the WENRA SRL for Existing Reactors 2020.

Question 3: To what extent have the updated WENRA SRL from 2020 already been taken into account?

The SNSA is in the process of amending regulations to bring the legislation into line with the recent updates to the key IAEA international standards and the WENRA requirements. These amended regulations will incorporate the WENRA 2020 requirements and will be compiled by the end of 2022. Krško NPP's compliance with the WENRA SRL for Existing Reactors 2020 will be checked in the course of the Periodic Safety Review currently under way. According to the preliminary results of an independent
review, Krško NPP does comply with the WENRA SRL for Existing Reactors 2020. If deviations are found, corrective measures will be introduced to eliminate them.

Question 4: To what extent have the requirements for new nuclear power plants already been taken into account in the preparation of the Safety Upgrade Programme?

WENRA requirements and documents are issued separately for existing and new power plants. Krško NPP therefore primarily incorporates the requirements for existing plants (WENRA SRL for Existing Reactors). The WENRA RHWG report "Safety of New NPP Designs" (March 2013) was also implemented to the greatest extent possible.
Krško NPP has in place the following design solutions, which comply with the WENRA requirements for new reactors:

1. pressuriser PORV Bypass MOVs, which are capable of releasing water;
2. an independent alternative AC voltage source (diesel generator 3), protected against external hazards and designed for DEC;
3. a diversified reactor trip system;
4. an independent auxiliary control room that ensures that the parameters can be monitored and alternative DEC engineered safety features managed;
5. passive seals resistant to high temperatures at the reactor pumps (RCP);
6. alternative systems (ASI, ARHR, AAF) for managing loss of feedwater and loss of ultimate heat sink (UHS);
7. baskets with trisodium phosphate that reduce radioactive sources (source term) in the containment;
8. passive autocatalytic recombiners (PARs);
9. a passive containment filtered venting system (PCFVS);
10. an alternative residual heat removal (ARHR) system and passive containment filtered venting system (PCFVS), which are designed for design-extension conditions, enable cooling in the recirculation operating mode, and prevent subsequent failure of the containment owing to excessive pressure.

Question 5: On what basis was the comparison with the safety of new nuclear power plants carried out?

A basic comparison between power plants focuses on a comparison of core damage frequency (CDF) for all events. At Krško NPP, the CDF is slightly less than $1.4E^{-5}$/year and almost meets the criterion for new plants of $1E^{-5}$/year. These values relate to all events (to highlight: internal events, seismic events, internal and external flooding, internal fires, high-energy pipe fractures, aircraft crash, relevant combinations of events, strong winds and other hazards).
In addition, Krško NPP has, as part of the third Periodic Safety Review (PSR3), carried out a review of compliance with the WENRA criteria for new reactors. The review established that Krško NPP was implementing several of the recommendations for compliance with WENRA for new reactors, as stated in the previous reply.

Question 6: To what extent does the safety assessment take the IAEA Safety Guides into account (e.g. SSG-25)?

Slovenian legislation on nuclear and radiation safety is regularly updated to comply with IAEA safety standards. Compliance is checked by IAEA IRRS (Integrated Regulatory Review Service) missions, which independently inspect the legislative and administrative framework against the standards of the agency. The IRRS mission was carried out in 2011, with a follow-up mission taking place in 2014. The last mission was recently completed (in April 2022). While the most recent mission proposed that several regulations be supplemented, no major deviations from the IAEA safety standards were established.
The Krško NPP PSR follows the national requirements and IAEA SSG-25. IAEA SSG-25 defines 14 safety factors and Slovenian legislation a further four: Safety Culture (separate safety factor), Radioactive Waste, Physical Security and Radiation Protection.
Compliance with the applicable IAEA standards in the Krško NPP safety assessments is checked in the course of a PSR; however, compliance checks have also been made by various IAEA missions invited to Krško NPP, such as OSART and SALTO.

Question 7: Was the decision on lifetime extension adopted solely on the basis of the results of the first PSR from 2003? Has the decision been subsequently re-examined on the basis of later findings?

Krško NPP has a valid open-ended operating licence until 2043, subject to the condition that, in accordance with the applicable legislation, it performs a Periodic Safety Review every ten years and that review is approved by the SNSA. Krško NPP is obliged, by the prescribed deadlines, to ensure the comprehensive and systematic verification of nuclear safety by means of a PSR, and to use that review to publish an assessment of future safe operation and produce a plan for implementation of the proposed modifications and improvements at the plant. In light of this, the SNSA uses the results of each PSR as the basis for deciding on the future course of operations at Krško NPP. No shortcomings that would require immediate action were identified in the course of the second PSR, and a plan of improvements to eliminate the identified non-compliances was drawn up. The SNSA issued a decision confirming that Krško NPP had completed the second PSR and that the safety of the installation had been ensured, that the power plant was as safe as originally planned, and that it was capable of operating safely until the next PSR.

Question 8: Can major updates of Krško nuclear power plant be expected on the basis of the results of the current Periodic Safety Review?

The third PSR is currently under way and will be completed in 2023 when the plan of measures is approved by the SNSA. The preliminary results, which are currently being assessed by the SNSA, show that there are no major safety-related deviations or findings that would require immediate action. The deviations that have been found relate mainly to improvements to procedures and programmes and do not directly concern nuclear safety. Under Slovenian legislation, any deviations established during a PSR must be eliminated at the earliest opportunity, with due regard to their significance for nuclear safety. Deviations that could threaten the nuclear safety of the facility should be eliminated without delay; however, there are no such deviations. A successful PSR is a precondition for extending operation of the plant for a further ten years.

Question 9: Aging management
1: Section 2.7.4 of the EIA Report (EIA 22) states that the aging management of Krško NPP has largely been carried out in line with the American model. Section 2.7.15 of the EIA Report states that the Aging Management Programme (AMP) was drawn up as part of the Periodic Safety Review (PSR1) and with the actions that stemmed from the final report for PSR1.

a) To what extent does the implementation of aging management comply with the applicable requirements of the IAEA (SSG48)?

The ministry explains that Krško NPP has checked the compliance of the AMP with the IAEA SSG-48 recommendations. The approaches are essentially very similar, with a few minor differences. Krško NPP identified these deviations and prepared an action plan to remedy the shortcomings. The action plan is being implemented as part of PSR3, which will again independently assess the AMP and define the action plan.

b) To what extent are the findings from international cooperation, particularly within the framework of the IAEA IGALL programme, incorporated into the improvements to the Krško NPP AMP?

In relation to this question, the ministry explains that Krško NPP has produced comparisons of its existing AMPs, prepared in accordance with NUREG-1801 and revised in accordance with Rev. 2, with IGALL. In response to the deviations detected, we supplemented the Krško NPP programmes with the new IGALL findings.

c) What technical equipment does the AMP include? How is the scope of control defined?

Krško NPP conducted an Aging Management Review (AMR) of the SSCs within the AMP, in accordance with 10 CFR 54.4. The AMR of the devices was independently reviewed and approved by the regulatory authority (SNSA). A review of the recommendations of IAEA SSG-48 ("Ageing Management and Development of a Programme for Long Term Operation of Nuclear Power Plants") uncovered several deviations that were then incorporated into the action plan and supplemented in the master equipment component list (MECL). The devices, systems and structures within the AMP are marked in the MECL with the attribute AM: YES.

d) How are the interfaces between aging management and the Periodic Safety Review defined at Krško NPP?

The Ionising Radiation Protection and Nuclear Safety Act (ZVISJV-1A) and its implementing regulations determine the scope of the PSRs. All safety review requirements are defined in the "Practical Guidelines on the Content and Scope of the Periodic Safety Review of a Radiation or Nuclear Facility". The Guidelines are based on the IAEA SSG-25 document "Periodic Safety Review for Nuclear Power Plants", which covers, in addition to all SSG-25 content, the additional content required by the regulatory authority, such as additional safety factors and more in-depth examination.
The AMP is part of the PSR within the framework of Safety Factor 4 (Aging Management). The results of the pre-SALTO mission with action plan will also be reviewed as part of the review of Safety Factor 4.

2: Because of the extension of Krško NPP's operational lifetime from 40 to 60 years, the current state of the technical equipment in use and the effectiveness of the AMP are even more important. According to the EIA Report, the current systematic assessment will not be available until 2023 with the third PSR.
a) What is the current condition of the technical equipment in use at Krško NPP?

The equipment (SSCs) at Krško NPP is in excellent condition. This has been proved by the operating results and the independent reviews conducted by external institutions (WANO, IAEA), independent inspectors of outage activities, and the PSR. The equipment is constantly replaced, in line with the five-year investment plan, which is updated annually, and other operating experiences (internal and external). The operating status of equipment is continuously monitored via the operating performance control programme (AP-913) and the "maintenance rule" (10 CFR 50.69). The status of all systems at the plant is reported in the quarterly System Health Reports.
All anomalies in the equipment are detected via a corrective programme and the necessary preventive or corrective actions analysed and defined. Daily reviews of the corrective programme are also carried out by a dedicated aging monitoring group. Suspicions of accelerated aging are dealt with by the group, which then determines additional preventive actions where required.

b) Is there any Krško NPP technical equipment for which a 60-year operating period presents particular challenges as far as aging management is concerned?

Krško NPP requires that additional attention be paid to the aging of certain components. These components include: the reactor vessel, the entire primary circuit or reactor coolant system (RCS) and the connection points to the primary circuit, instrumentation within the scope of the environmental qualification (EQ), and lifting gear.
Time-Limited aging analyses (TLAA) have been carried out for all these components. Analyses demonstrate that SSCs are capable of performing their design functions for 60 years as well. The analyses were carried out for the first time in 2010 by Westinghouse and independently reviewed by certified institutions. The TLAAs of 2010 already presupposed that the lifetime of Krško NPP would be extended to 60 years. All the analyses were approved by the SNSA.
Krško NPP began updating the TLAAs in 2021. That process is still ongoing, although the preliminary suggestion is that there are no differences to the situation in 2010.

c) What were the results of the pre-SALTO mission in 2021?

The pre-SALTO mission that took place at Krško NPP identified nine good practices, five recommendations and nine suggestions. The review showed that plant staff were professional, open and receptive to suggestions for improvements, and noted that plant management were committed to improving preparedness for long-term operation (LTO). The reviews showed that equipment, systems and structures were in good condition. The most significant good practices and successes noted by the team were in the following areas:
– The plant has a well-structured and comprehensive programme of proactive and reactive activities for the aging management of the safety-related cables.
− The plant has set up an efficient intranet portal that contains links to several subordinate modules and offers access to all relevant management applications, programmes, documents, procedures, data and records.
– The plant’s Steam Generator Aging Management Programme demonstrates a strong commitment to excellence, with several activities under this programme exceeding international safety standards.
The review also outlined opportunities for improvements, which mostly resulted from differences in approach between the American standards and the IAEA recommendations. From the point of view of equipment aging, Krško NPP has an AMP in accordance with 10 CFR 54 for passive components and with 10 CFR 50.65 for active components, with an additional Equipment Reliability Programme. The IAEA prescribes the same aging management for passive as for active components. Some recommendations were linked to documentation of the LTO process, as additional specialist education and training for aging, and knowledge management.
For these types of recommendation, between 10 and 15 recommendations and suggestions are always identified, as the nuclear industry is based on a drive for excellence in all aspects.
Krško NPP has drawn up an action plan, which is currently being implemented. The action plan is also part of PSR3 and will be part of the PSR3 action plan.

d) What methods are used for assessing the performance of the Krško NPP AMP?

The ministry explains that Krško NPP applies performance indicators in accordance IAEA-TECDOC-1141 (“Operational Safety Performance Indicators for Nuclear Power Plants”) and WANO WGP-ATL 96-002 (“Use of Performance Indicators”).
Twenty-one indicators are currently in use for the indirect and direct monitoring of equipment aging at Krško NPP. The indicators are chiefly oriented towards maintenance interventions and the occurrence of adverse plant statuses (e.g. the indicator “Number of aging-related corrective actions, etc.”).
There is also a review under way of the document and NEI 14-12 (“Aging Management Program Effectiveness”), which will include additional indicators.

3: Section 2.7.15 of EIA Report (EIA 22) states that time-limited aging analyses (TLAA) have also been carried out. The main role in this is usually played by the brittleness of the reactor vessel because of neutron flux.

a) What will the maximum temperature of the brittle-ductile transition be for materials in the area close to the core (RPV beltline) after 40 years of operation and what value is estimated for 60 years of operation?

The maximum temperature of the brittle-ductile transition for the material of the reactor vessel, which at Krško NPP is determined using the RG-1.99 methodology (ART – adjusted reference temperature), is 75.5°C for 40-year operation and 78.3°C for 60-year operation.

b) How is the course of the temperature of the brittle-ductile transition controlled for materials in the area close to the core up to the neutron flux reached after 60 years of operation?
In nuclear power plants regulated by the provisions of 10 CFR 50, resistance to brittle fracture is not monitored directly through the temperature of the brittle-ductile transition but ensured by the p-T limiting curve and the Charpy test upper-shelf energy of the reactor vessel material. Pressure-temperature limiting curve
The p-T limiting curve constitutes the temperature and pressure spectrum within which operation is permitted and is fixed in accordance with 10 CFR 50 Appendix G, i.e. on the basis of the temperature of the brittle-ductile transition (ART under RG-1.99) and the maximum neutron fluence (n/cm^2) of fast neutrons for the envisaged 60 years of operation. In this sense, it guarantees operation within the pressure-temperature limiting curve of resistance of the reactor vessel to brittle fracture for a period of 60 years of operation. The pressure-temperature limiting curve is therefore part of Krško NPP's Technical Specifications.

c) What measures have been taken to reduce the maximum neutron flux in the area close to the core?

Since the fifth cycle, Krško NPP has implemented low leakage loading configuration of the core. One should point out that special measures are not needed to reduce neutron fluence as Krško NPP meets the 10 CFR 50 Appendix G criterion for Charpy test upper-shelf energy of the reactor vessel material for 60 years of operation (10 CFR 50 Appendix G criterion: at least 68 J, Krško NPP value 83.3 J) and because the brittleness of the reactor vessel material is monitored through the pressure-temperature limiting curves. With higher neutron flux, these curves are more limiting.

d) Have analyses been performed of accidents specific to Krško NPP for pressurised thermal shock (PTS)? If they have been, what is the highest permitted temperature of the brittle-ductile transition for the Krško NPP reactor pressure vessel?

The ministry responds by saying that the mechanical fracture requirements for protection against PTS are standard for Krško NPP and prescribed by 10 CFR 50.61, which to this end gives the maximum temperature of the brittle-ductile transition after the end of the plant's lifetime. 10 CFR 50.61 further provides that a specific mechanical fracture analysis of PTS is only performed if the prescribed maximum temperature of the brittle-ductile transition is exceeded. According to 10 CFR 50.61, the maximum temperature of the brittle-ductile transition at the end of a plant's lifetime is 270°F (132°C) for basic material and 300°F (149°C) for the circumference welds. For Krško NPP, the temperature of the brittle-ductile transition (ART) for 60-year operation is 78.3°C for the basic material and 25.8°C for the circumference weld. As the ART is lower than the prescribed maximum temperatures of the brittle-ductile transition, Krško NPP does not perform a specific analysis of PTS.

e) What other TLAAs have been performed for 60-year operation and what was the outcome?
The ministry explains that the following TLAAs have been produced:
- Review of Krško NPP Plant-Specific TLAAs Related to Civil Structures

- Review of NPP Krško Environmental Qualification (EQ) Program
- Screening of Potential Time-Limited Aging Analyses in the NPP Krško
- RCL Piping and RCS Components Fatigue
- Auxiliary Class 1/2/3 Piping Fatigue
- Environmental Fatigue Evaluations per NUREG/CR-6260
- Reactor Vessel Beltline Fluence Evaluation
- Reactor Vessel Irradiation Embrittlement
- Impact of Thermal Aging on Stainless Steel Welds and Cast Material
- Update of USAR Chapters 11 and 15
- Class 2/Class 3 Primary Sampling System Lines Fatigue Analysis
- Analysis for Containment Penetrations Fatigue Analysis

All the analyses have shown that Krško NPP is capable of operating for 60 years with sufficient safety margins.

Response in the event of accidents, accident analyses and the radioactive inventory
1. Larger radioactive inventories are, in principle, possible, although with lower probability.
a) To what extent does the DEC-B scenario presented cover the whole of the possible radioactive inventory?

The ministry explains that the representative severe accident in the EIA Report was selected on the basis of the Krško NPP Safety Analysis Report, and of deterministic and probabilistic safety assessments. The reference severe accident was selected as the limiting or envelope scenario that constitutes the biggest challenge for transboundary impact because of the combination of the very conservative scenario of the release of radioactive material within the containment and during release from the containment (source term) and the realistic behaviour of the containment during the implementation of protective measures after 24 hours.
The representative accident constitutes the envelope of radiological releases for every event involving release from the plant caused by internal or external initiators, with a release category frequency of $1E^{-6}$/year or more. The other release categories addressed in the Krško NPP's probabilistic safety assessments, as described below, have a very low probability of fall, or envisage a smaller radioactive inventory (source term) in the containment and, consequently, a lower release of radionuclides than envisaged from total core meltdown in the selected representative accident used in the EIA. This means that the EIA addressed the highest possible radioactive inventory (source term).

b) What are the most significant consequences of accidents at various distances and in various weather conditions in relation to the release categories presented in the EIA?

The representative severe accident scenario used to assess the impacts on the environment for calculating the radiological impact on the environment has been drawn up independently of the Krško NPP PSA calculation by independent external certified organisations, although they do take the Krško NPP PSA calculation into account. The initiator of the representative scenario is the loss of all AC power (station blackout, SBO) with leakage from the reactor coolant system (RCS) and without mitigation in the first 24 hours. Account is taken of design-basis leakage from the containment into the environment and release through the PCFVS after passive activation. Mitigation of the accident is assumed after 24 hours with the use of qualified DEC engineered safety features.
Krško NPP has implemented a Safety Upgrade Programme, which meets the requirements of WENRA SRL (2014 and 2020) and IAEA – SSR 2/1, Rev. 1. This SUP has practically eliminated all large releases, the installation of PCFVS and PAR has provided additional protection of the containment pressure barrier, and the installation of DEC-A systems (ASI – alternative safety injection, AAF – alternative auxiliary feedwater, ARHRS – alternative residual heat removal system) has reduced the sequences that bypass the containment barriers.
The radiological consequences of RC6, RC7A and RC7b, RC8A and RC8B were not considered because of their very low frequency of occurrence (in the case of RC8A, which reduces the effect of

release under the water surface, as well as on the surface of the pipe prior to release into the environment).
RC6 represents the early failure of the containment and has a frequency of 4.89 E^{-9}/year. RC7A represents the failure of the isolation of the containment without molten core concrete interaction (MCCI) and has a frequency of 7.02E^{-10}/year. RC7B represents failure of the containment with MCCI and has a frequency of 8.60E^{-10}/year. RC8A represents the reduced bypass of the containment and has a frequency of 1.0E^{-7}/year. RC8B represents the unreduced bypass of the containment and has a frequency of 2.93E^{-8}/year.
In addition to the above, and in accordance with GL NRC No 88-20, Appendix 2, sequences that cause a bypass of the containment with a frequency of 1E^{-7}/year, or account for fewer than 5% of all releases, are not subject to the calculation of radiological consequences. The calculation therefore does not take radiological impacts on the environment into account.
A representative accident is used that represents the envelope of radiological releases for all other release categories:

- RC2 (without damage to the containment), with a frequency of 3.4E^{-6}/year, concerns design leakage from the containment. The radiological source within the containment is equal to or lower than the representative accident and the releases from the containment are consequently smaller.
- RC4 (penetration of the concrete foundation), with a frequency of 6.79E^{-7}/year, does not involve direct release into the atmosphere.
- RCV3A, RCV3B and RCV5A, with frequencies of 1.03E^{-7}, 1.72E^{-6}, and 2.52E^{-6}/year, respectively, are filtered releases from the containment with radioactive releases from the containment that are lower than or equal to the representative accident.

Taking all of the above into account, the representative accident constitutes the envelope of radiological releases for every event involving release from the plant caused by internal or external initiators, with a release category frequency of 1E^{-6}/year or more. The frequencies of the release categories have been calculated in accordance with NUREG-1935 and IAEA EPR-NPP, as required for the planning of measures in the environment. In accordance with the above, the accident analysed in the EIA gives the most significant consequences in the environment for the analysed distances and the representative meteorological conditions. The most significant consequences of accidents at various distances and in various weather conditions can be expected in the event of the accident analysed in the EIA.

2. Regarding the concept of the “wet cavity” SAMG measure:
a) Have the recommendations of the RAMP (Review of Accident Management Programmes) mission been implemented?

The ministry responds by saying that all recommendations from the RAMP mission of 2001 have been implemented. Following additional analyses, a link was made between the containment and the reactor cavity (“wet cavity” design) to enable the melt to be flooded, thereby preventing molten core concrete interaction (MCCI).
In connection with the RAMP recommendation “Non-Uniform Distribution of Hydrogen within the Containment Space”, it was concluded that the mixing of the atmosphere of the containment during a severe accident was very good and did not lead to stratification or the unequal distribution of hydrogen. Passive autocatalytic recombiners (PARs), which significantly reduce the quantity of hydrogen and CO in the containment during a severe accident, were also installed during the Safety Upgrade Programme.

b) Under what circumstances is the ex-vessel cooling of the RDB envisaged, in the current concept, as a response to severe accidents?

The ministry explains that immediately as soon as the Severe Accident Management Guidelines (SAMG, SAG-1 MCR SAG Initial Response) become relevant on account of damage to the core, the containment is flooded, thereby ensuring ex-vessel cooling.

c) Have construction measures been taken regarding the external insulation of the RDB so as to ensure

ex-vessel cooling?
On the basis of an evaluation and detailed review of insulation, the conclusion was reached that insulation did not prevent ex-vessel cooling. In accordance with the above, structural measures regarding external insulation of the reactor vessel were not carried out.

d) On what basis can a steam explosion be excluded with certainty?

Krško NPP has a "large dry containment", i.e. a large empty space, which also makes a steam explosion very unlikely (probability estimated at $1E^{-9}$/year), and any accompanying shock wave (leakage of molten core into the water below the reactor vessel) would not be able to jeopardise the integrity of the containment. These conclusions are derived from generic analyses conducted in the USA for this type of containment and from analyses specific to Krško NPP.

3. Decontamination factor for elementary iodine
a) What is the decontamination factor (DF) for elementary iodine?
b) What value was used to calculate the radioactive inventory (particularly for the representative DEC-B scenario)?

The ministry explains that the requirement for PCFV filter design is a DF for elementary iodine >100. The decontamination factor of the iodine filter for the PCFVS for elementary iodine is 18,500 (filter manufacturer's test). The tests also shows that 95% of the elementary iodine is retained in the aerosol filters so that the actual DF is considerably higher (total DF of 370,000). A total filter DF of 100,000 was used to calculate the radioactive inventory (source term). Consideration must be given to the fact that the AST radioactive inventory (source term) estimates the chemical composition of iodine as 95% aerosol, 4.85% elementary iodine and 0.15% organic iodine. To determine the influence of the chemical form of iodine on the dose value, the RODOS calculation was performed with 100% elementary iodine and the chemical composition commonly used in modern (post-Fukushima) emergency response planning (30% elementary iodine, 25% aerosol and 45% organic iodine), for the same total activity of released iodine. In the first case the deposition is maximised, in the second the inhalation dose is for the thyroid. The differences are within the bounds of uncertainty of meteorological parameters.

External impact, earthquake
1. The EIA does not show what actual safety margins the engineered safety features have that are necessary for managing DBAs in relation to earthquakes, as they were originally designed for 0.3 g.
a) How high are the safety margins in relation to earthquakes in the individual engineered safety features?

The acceleration referred to relates to Krško NPP's seismic design load, which was set with a RG 1.60 design acceleration spectrum with a peak acceleration of 0.3 g at the level of the foundations of the main structure of the plant. During an earthquake, PGA decreases with depth. In order to be able to compare Krško NPP's seismic design load with the seismic load from the Probabilistic Seismic Hazard Analysis, due regard must be paid to the uniform hazard spectrum at the level of the foundations, which was determined in the PSHA of 2004. A comparison between the Krško NPP design spectrum and the uniform hazard spectrum for the level of the foundations shows that the spectral acceleration for a frequency of 3.33 Hz (which is in the range of the significant own frequencies of Krško NPP facilities) from the UHS (PSHA, 2004) is approximately 12% lower than the corresponding value of the design spectral acceleration for 5% attenuation. Moreover, the seismic analyses of 2013 estimated that the floor spectral accelerations taken into account when Krško NPP was being designed were approximately comparable with the floor spectral accelerations determined on the basis of the RG1.60 spectrum of accelerations and a PGA of 0.6 g on the open surface, which roughly corresponds to a PGA with a recurrence interval of 10,000 years (PSHA, 2004). The favourable impact of the interaction between the Krško NPP structure and the ground (which scatters a significant amount of the energy) was also taken into account in this transformation.

Seismic vulnerability analyses have been performed for all existing Krško NPP SSCs using the EPRI methodology. These analyses show that, because of the safety factors that had to be incorporated at the design stage, Krško NPP's systems can withstand a seismic load at a PGA value of approximately 0.6 g with a high level of conservativism. The seismic capacities expressed in terms of HCLPF PGA, which were determined in accordance with the WENRA guidelines, exceed 0.6 g. The stress tests carried out in 2011 showed that, on account of the high seismic capacities of the Krško NPP systems, Krško NPP could shut down safely and maintain long-term cooling operations in the event of an earthquake with a PGA greater than 0.6 g at surface. The ENSREG stress-test report of 2011 estimated that damage to the core was unlikely with earthquakes with a PGA at surface of less than 0.8 g. However, this estimate did not take into account the favourable impact of the new safety equipment installed at the plant in the last ten years in response to the Krško NPP Safety Upgrade Programme.

b) According to the statements made in the document (WEN 21a), Slovenia has incorporated the WENRA 2014 reference level into national regulations. Does the current PSR specifically address the design of engineered safety features in accordance with the WENRA safety level?

The ministry explains that design of the engineered safety features is being examined in accordance with the WENRA 2014 guidelines in the Periodic Safety Review (PSR3) currently under way. In addition to the response to the previous question (Section 3.4.1, Question 1a), it is important to note that the new systems have also been designed to withstand very powerful earthquakes. The design PGA for new systems on the main island was 0.6 g, which corresponds to a PGA with a recurrence interval of 10,000 years. A highly conservative estimate was made for BB1, which was designed for a 50% higher seismic load than the original seismic criteria for Krško NPP, i.e. it can withstand a PGA of 0.8 g at surface (this figure even rises to 0.78 g for BB2 and the dry storage). In the construction of the

new BB1 and BB2 bunkered buildings, as well as the spent fuel dry storage, the safety acceptance criterion in the analysis of seismic vulnerability was also determined using the HCLPF PGA. In comparison with the original seismic design loads incorporated into the Krško NPP design process, the new systems have even greater seismic resilience and, as such, are able to replace the most vulnerable original systems in the event of their failure during an earthquake. If the seismic safety assessments for Krško NPP were to take the new systems into account, the assessment of seismic capacity would be even higher than was shown in the stress-test report.

2. With regard to transboundary impacts, the operation of the filtered venting system in the containment is particularly important. How has this earthquake-protection system been designed? Has it been designed for a ground acceleration of 0.56 g?

The ministry explains that all new engineered safety features on the main Krško NPP island (including the new filtered venting system in the containment) have been designed with due regard to the design floor response spectra calculated by taking into account the design response spectrum in accordance with RG 1.60 and a PGA of 0.6 g at surface.

3. The EIA does not show the extent to which the risk of liquefaction of the ground in the event of an earthquake was examined (particularly with ground acceleration ≥ 0.56 g).
a) Have investigations been carried out in relation to the risk of liquefaction of the ground at the site?

The ministry explains that analyses have been conducted on three occasions: first as part of the design process in the 1970s and second as part of the seismic PSA analysis, as a separate part of the Probabilistic Seismic Hazard Analysis (PSHA) for the Krško NPP site. (that analysis of resistance of the ground to liquefaction at the Krško NPP site concluded, with a high degree of reliability, that liquefaction would not occur in earthquakes with a PGA of 0.8 g and that local instances of liquefaction could be expected with the damming of the Sava with a PGA greater than 1.0 g). The third analysis of liquefaction was carried out when Brežice hydropower plant was being constructed (2014–2016). That analysis also confirmed that local instances of liquefaction could be expected only with earthquakes with a PGA greater than 1.0 g.

b) At what ground acceleration is it possible to expect (at least partial) liquefaction of the ground at the site?

The foundation ground of the Krško NPP complex comprises compact 100,000-year-old Quaternary stratigraphies of sandy-gravelly layers in the upper 9 m, and very compact reconsolidated Tertiary, partly clayey layers of fine sandstone between 2 and 70 million years old at depths of below 9 m. The groundwater is at an average depth of 5 m. Owing to the considerable compactness of the layers and partial saturation, the potential for the occurrence of liquefaction during a powerful earthquake is low. It has been estimated, with a high degree of confidence, that liquefaction is not likely with PGAs of up to 0.8 g at surface. The possibility of local liquefaction is not excluded with higher PGAs (over 1.0 g).

c) What impacts on safety can be expected in the event of an earthquake with an average recurrence interval of ≥ 10,000 years (or with a ground acceleration at the location of ≥ 0.56) from the resulting ground liquefaction?

On the basis of Krško NPP's comments, the ministry explains that partial liquefaction at the site of dam facilities on the Sava and the essential service water pumping station could occur with PGAs greater than 1.0 g at surface. Local liquefaction can affect the below-ground components and systems, while the overall stability of Krško NPP facilities would not be jeopardised by partial liquefaction at the site of dam facilities (because of the deep foundations of the Krško NPP facilities). BB2, with additional water sources and pumps, was built as part of the Safety Upgrade Programme. The building is almost entirely below ground (deep foundations). As stated, the partial collapse of the flood-protection embankments on the Sava during a powerful earthquake cannot be ruled out. Krško NPP therefore has additional flood protection (part of the SUP) against the overflowing of the Sava with flow rates with a recurrence interval of 10E6/year (combination of extreme earthquake and extreme floods).

In letter no. 35409-282/2020-2550-70 of 9 May 2022, the Bavarian State Ministry of the Environment and Consumer Protection (Bayerisches Staatsministerium für Umwelt und Verbraucherschutz), which is the representative in the procedure for the Federal Republic of Germany, confirmed that there were no further outstanding issues regarding the transboundary procedure.

HUNGARY

Hungary received notification in May 2021, along with documentation translated into Hungarian and a request for public participation and the participation of ministries and organisations, and registered for the environmental EIA procedure because significant impacts could not be ruled out. Transboundary consultation with Hungary took place in writing with the Ministry of Agriculture, Environmental Protection Directorate, Budapest, Apaczai Csere Janos u.9, via the contact person for the Espoo Convention, who in letter no. 35409-282/2020-2550-65 (ref. no. KmF/38-4/2022) notified Slovenia that in order to ensure compliance with the eighth paragraph of Article 3 of the Espoo Convention, invited public participation on the official website of the Hungarian Ministry of Agriculture between 30 June and 22 July 2021 in the early phase and that the project to extend Krško NPP's operational lifetime (2023–2043) had not attracted any comments from the public.

The competent Hungarian agriculture ministry publicly unveiled the EIA Report between 21 March and 21 April 2022 and received written comments from two non-governmental organisations, Energiaklub Szakpolitikai Intezet and Modszertani Kozpont, which it forwarded in letter no. KmF/38-4/2022 (document no. 35409-282/2020-2550-65).

At the same time the documentation was also sent to interested authorities, who suggested more precise technical explanations in relation to the following issues: seismic safety; floods and the impact of climate change on Sava water levels; the results of the impacts of the calculations of releases under the scenario of rare accidents; radioactive waste management and the capacity of repositories and the disposal share of the Croatian co-owners; the impact of increased quantities of waste resulting from lifetime extension on the planned capacity of the dry storage; an explanation of which measures to reduce impacts are the result of stress tests and which the result of Periodic Safety Reviews; a precise presentation of radiological impact; concentrations on the borders in the event of the worst scenario; the methodology and basis for calculations for ensuring compliance with international standards and practices; monitoring; special technical and organisational measures to prevent, avoid and reduce impacts from emergencies with the aim of reducing environmental damage and for controlled releases in the event of a major accident.

The ministry proposed technical consultations (which Hungary suggested should take place in writing as a result of the Covid-19 pandemic). The two parties to the Espoo Convention agreed and decided that the consultations would take place under point 5 of Article 2 of the Espoo Convention in writing.
Slovenia supplied responses and comments to Hungary's preliminary position on the extension of the operational lifetime of the existing Krško nuclear power plant (from 2023 to 2043):

Question 1: Is information available on why the scenarios of late failure of the containment (failure of the containment at least 24 hours after the initiating event) are not included in the PSA Level 2?

The ministry explains that Krško NPP produced calculations for a longer period of time (over 24 hours) as well as for seven days. Krško NPP also produced analyses of the deliberate postponement of mitigation measures for 24 hours as sensitivity cases. As part of the Safety Upgrade Programme, Krško NPP installed a containment filtered venting system (CFVS) and passive autocatalytic recombiners (PAR) whose function is to prevent the late build-up of pressure/hydrogen in the containment.
Recalculations using MAAP confirmed that the likelihood of failure of the containment after 24 hours was negligible. After this time, the CFVS mitigates the overpressure of the containment and the PARs mitigate the explosion of hydrogen/CO in the containment.

Question 2: Section 2.13 of the EIA Report contains the following statement: "Core damage is the uncovering and heating of the reactor core to the point where increased oxidisation and severe damage to the fuel elements across a large section of the core can be expected."
If core damage is defined in this way, this could mean that mechanical damage to fuel is excluded (e.g. a heavy load falling into the core) or geometrical changes and damage to the envelope (e.g. owing the exceeding of the average radial criteria of enthalpy and the causing of damage to the envelope and the spraying of fuel into the coolant). According to international practice, this is normally regarded as damage to the core. This interpretation of the text is supported by the following statement in the EIA Report: "For sufficient quantities of these substances to escape from the ceramic tablets, the fuel must overheat, thereby causing most of the gaseous and evaporative radioactive substances to escape." This is again incorrect for core damage, which arises as a result of mechanical damage to the core or if there is rapid crushing of fuel pellets in certain reactivity-initiated accidents.
Could you list the criteria for core damage (e.g. highest temperature of the liner, average radial enthalpy, degree of oxidisation, etc.) and say whether mechanical damage (e.g. a heavy load falling into the RPV) is not taken into account, or can you describe the basis for it exclusion?

On the basis of Krško NPP's comments regarding the possibility of core damage, the ministry points out the following:
Uncovering and heating of the reactor core to the point where long-term oxidation of the liner and serious damage to the fuel is expected. Core damage occurs if:
• the highest temperature of the fuel/liner reaches 923 K but does not exceed 1,348 K, and is above 923 K for more than 30 minutes; the fuel is deemed to be considerably oxidised;
• the highest temperature of the fuel/liner exceeds 1,348 K and the core is deemed to be heavily

damaged.
The carriage of heavy loads over the RPV and spent fuel is prohibited.
Design-basis accidents in the handling of fuel in the containment have been assumed despite the large number of regulatory controls and physical restrictions on fuel handling. An accident involving the handling of fuel within the containment is defined as the fall of a spent fuel assembly into the core during refuelling. An analysis has shown that, based on conservative assumptions, the doses received at the boundary of the site are within the limits for an accident set out in 10 CFR 100 and Slovenian law.
The fuel-handling crane, which is used to handle spent fuel casks, is single-failure-proof. According to NUREG-0554 and NUREG-0612 it is acceptable for a fuel-handling crane to be suitable for freight-handling procedures. In this case, analyses are not necessary for an accident involving a fall from a spent fuel cask because of the very small likelihood of such an event occurring.

Question 3: Section 2.13 of the EIA Report contains the following statement: "Sufficient quantities of radioactive material to cause a nuclear accident are located only in the nuclear fuel in a reactor that has been operating for at least a few months, and in the spent fuel in the spent fuel pool." In many countries, safety assessments that are at least at the level of a safety review consider other larger sources of radioactivity (e.g. the refuelling pool or transport containers). Can you provide grounds for the claim that no other larger source of radioactivity could cause early or large releases and/or that such events can be excluded from the design envelope?

After studying Krško NPP's statements, the ministry responds by saying that the spent fuel transport routes are addressed as part of safety assessments of the spent fuel pool. Krško NPP does not (yet) have a working dry storage or other facility in which spent fuel could be stored. However, that facility is in the final stage of construction, with technical acceptance taking place on 10 January 2023.
Design-basis accidents involving the handling of fuel in the containment and spent fuel storage buildings were assumed despite the large number of regulatory controls and physical restrictions in place for the fuel-handling operations. All fuel-supply operations take place in accordance with the prescribed procedures and under the direct supervision of a controller. Two fuel-handling accidents have been considered: a refuelling accident outside the containment and a refuelling accident inside the containment. Both scenarios could cause damage to fuel elements, followed by the release of gaseous fission products into the plant or outside into the environment. A fuel-handling accident outside the containment is defined as the fall of a fuel assembly onto the floor of the spent fuel pool. An accident involving the handling of fuel within the containment is defined as the fall of a spent fuel assembly into the core during refuelling. An analysis has shown that, based on conservative assumptions, the doses received at the boundary of the site are within the limits for an accident set out in 10 CFR 100 and Slovenian law.
As stated in the response to question 2, the crane used to load spent fuel casks is single-failure-proof. According to NUREG-0554 and NUREG-0612 it is acceptable for a fuel-handling crane to be suitable for freight-handling procedures. In this case, analyses are not necessary for an accident involving a fall from a spent fuel cask because of the very small likelihood of such an event occurring.

Question 4: Section 2.7.2.1 of the report mentions three external events addressed in the PSA: internal fires, internal flooding and high-energy line breaks. The relevant WENRA requirements/recommendations mention eight events that must be considered in an internal hazard analysis (WENRA RL SV 2.2). Does the PSA consider other types of internal event, such as falls of heavy loads, or only the events mentioned? If the answer is yes, could you provide a comparison of the CDF/LRF results between various internal events; if no, could you justify why other events such as the fall of a heavy load are excluded from the analysis?

After studying Krško NPP's statements, the ministry responds by saying that in addition to internal fire, internal flooding and high-energy line breaks, Section 2.7.2.1, Figure 5, of the EIA Report addresses the category of internal initiating events, which includes all other assessed internal initiating events. All internal hazards important to safety have been identified in accordance with WENRA RL Issue SV. The list of internal hazards addressed includes all events referred to in SV2.1: fires, explosions, missiles, pipe breaks (with consequent hazardous conditions), flooding, collapse of structures and falling objects, electrical disturbances and electromagnetic interferences, and the release of hazardous substances. Falls of heavy loads were considered in Krško NPP's PSAs. The analysed results of the events are given in the table below. Explosion, turbine missiles, AFW turbine projectiles, the fall of a heavy load and electromagnetic interference are evaluated and assessed under the screening value (<1E^{-07}/year). The screening methodology used follows ASME/ANS RA-Sb-2013 (Addenda to the ASME/ANS RA-S-2008 Standard for Level 1/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications, ASME/ANS RASb-2013).

Internal hazard	CDF (/year)	LERF (/year)
Internal fire	3.53E^{-07}	5.11E^{-10}
Internal flooding	9.03E^{-09}	8.04E^{-12}
Pipe break HELB	2.82E^{-08}	3.34E^{-11}

Question 5: Section 2.7.2.1 only shows the results of the seismic hazard analysis among all external hazards, while Section 2.7.9 also mentions other important hazards incorporated into the assessment. Could you provide more information on external hazards that are not of seismic origin, e.g. the features of the modelling of PSA for an aircraft crash, given the proximity of and upgrades to Cerklje ob Krki airport (e.g. the wWs assessment assumes that the majority of aircraft crashes occur during take-off/initial climb or when landing/preparing to land)? Could you also provide a comparison for CDF/LRF for non-seismic external hazards and external hazards triggered by earthquakes?

The ministry explains that the following group of other external initiating events have been considered: aircraft crashes, external flooding, strong winds, external fires, industrial or military accidents, gas pipelines, chemical release, road accidents, turbine missiles, AFW turbine missiles, ice storms and extreme drought. Where necessary, events triggered by earthquakes and combinations of events have also been considered. All external events have been considered, in accordance with the WENRA SRL. The overall analysis of the risk of an aircraft crash was performed using the approach defined in the DOE 3014-2006 standard (NUREG/CR-5042, "Evaluation of External Hazards to Nuclear Power Plants in the United States") and the ANSI/ANS standard for the PRA for external events. For Krško NPP the main risk factors for core damage resulting from an aircraft accident are: accidents connected with the nearby Cerklje airport (including expansion of the airport), general aviation aspects, military aircraft and commercial aircraft. In the DOE 3014-96 standard, aircraft operations are divided into three categories: take-off, landing and flight. Owing to its proximity, the risk to Krško NPP from Cerklje airport comes from take-off and landing. A comparison for CDF for non-seismic external hazards and external threats triggered by earthquakes is given in Figure 5 in Section 2.7.2.1 of the EIA Report. The contribution of other external hazards to LERF is even smaller (only 1.9% to the LERF).

Question 6: Although at several points the document mentions the effects of climate change (and this should be an important part of the justification for lifetime extension), no explicit mention is made of whether the design bases have been updated/modified in response. Have the basic design values for external hazards, such as extreme heat, extreme cold, extreme drought, extreme wind, floods, etc. been reviewed and updated (either before the report or during the PSR) with due regard to the effects of the climate changes presented in Section 4.1.2.3 and, if so, could you provide information on how those values have been changed?

On the basis of Krško NPP's explanations, the ministry responds by saying that the DEC (design-extension conditions) systems and structures are designed for minimum/maximum external temperatures of -35.1°C/46°C (the existing external design temperatures for Krško NPP are -28°C/40°C). DEC structures, systems and components (SSCs) are designed for extreme winds with a maximum speed of 240 km/h, which are highly unlikely to occur in the area, and for tornadoes and tornado missiles in accordance with Regulatory Guide RG-1.76 (Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants).

<u>Question 7</u>: Regarding the extension of the operational lifetime of Krško nuclear power plant in Slovenia, the Institute for Policy and the Energiaklub methodology centre (Az Energiaklub Szakpolitikai Intézet és Módszertani Központ véleménye a szlovéniai Krško atomerőmű üzemidő hosszabbításával kapcsolatban) welcomes the fact that Slovenia is carrying out an EIA for the planned extension of Krško NPP's operational lifetime, and submits its comments on the EIA documents and asks that they be addressed.

The ministry finds that notification under the Espoo Convention was sent to the contact point at the Hungarian Ministry of Agriculture, Environmental Protection Directorate for the purpose of ensuring adequate and effective consultations. As stated in the preliminary opinion of Hungary regarding the extension of the operational lifetime of the existing Krško nuclear power plant (from 2023 to 2043), Slovenian project ref. no. KmF/38-4/2022, the Hungarian side proposed that discussions under point 5 of Article 2 of the Espoo Convention be commenced in writing as a result of the Covid-19 quarantine restrictions.

<u>Question 8</u>: Alternatives
The environmental impact study has omitted an important piece of information: whether the extension of operational lifetime is even necessary for satisfying Slovenia's and Croatia's energy needs. A recent study by Vienna University of Technology showed that more than 50% of Slovenia's energy needs could be covered by solar and on-shore wind energy by 2030, and that the electricity needs of Slovenia and Croatia could be fully met by renewable energy sources by 2050. The Espoo Convention and the EIA Directive both require an assessment to be made of alternatives to a proposed activity. We therefore expect the EIA Report to present energy scenarios that do not rely on the extension of the operational lifetime of a 40-year-old nuclear power plant. In response to the climate crisis, alternative scenarios must also include energy-efficiency and energy-saving measures, while electricity generation must be based on renewable energy sources, whose costs are continually falling.

On the basis of Krško NPP's comments, the ministry notes that Slovenia's 2021 Integrated National Energy and Climate Plan (NECP) and Croatia's 2020 Integrated National Energy and Climate Plan, which were drawn up and presented to the European Commission in accordance with Regulation (EU) 2018/1999 of 11 December 2018 on the Governance of the Energy Union and Climate Action, constitute the basis for the project to extend Krško NPP's operational lifetime. The Integrated National Energy and Climate Plans drawn up by both countries set out the objectives, policies and measures for five dimensions of the Energy Union up to 2030 (with an outlook to 2040), and cover, among other things: decarbonisation (greenhouse gas emissions) and renewable energy sources, energy efficiency and energy security. All scenarios of future energy use and supply defined in the Integrated National Energy and Climate Plans are based on continued use of nuclear energy. The analyses that formed the basis for the National Energy and Climate Plans have shown that increasing the use of renewable and low-carbon-emission sources and increasing energy efficiency are not in themselves sufficient to enable the targets to be met if we take estimated electricity consumption and the increased requirements to reducing greenhouse gas emissions into account.
A study titled "Energy, systemic, economic and ecological aspects of the extension of the operational lifetime of Krško NPP", which was drawn up by Elektroinštitut Milan Vidmar and the Faculty of Electrical Engineering at the University of Zagreb, showed that Krško NPP would be irreplaceable in the short-term period. If Krško NPP's operational lifetime is not extended, both countries will be reliant on electricity imports, where and if available. EU Member States' national energy and climate plans show a net energy deficit, meaning that electricity imports will not always be available when needed and that reducing consumption will be the only alternative in crisis situations. This is not in line with the first dimension of the Energy Union: "Security, solidarity and trust - diversifying Europe's sources of energy and ensuring energy security through solidarity and cooperation between EU countries". Operating Krško NPP until 2043 is a first step towards decarbonisation and long-term energy independence. It will not be possible for either country to maintain short-term energy security without Krško NPP. The

situation is similar for future energy use, as electricity is considered the predominant form of energy in the economy (industry, transport, services) and for most of the population's energy consumption. Current developments and their forecasts do not indicate a sufficient technological breakthrough capable of replacing Krško NPP's current generation capacity with renewable energy sources while meeting the current and future required criteria of reliability, safety, environmental sustainability and economic viability. The requirement to preserve spatial features and natural and other assets makes it difficult to introduce new renewable energy sources capable of replacing Krško NPP in the next 20 years. Based on the scenarios and sensitivity analyses of energy balances and electricity demand, it is clear that extending Krško NPP's operational lifetime is the most technically, environmentally and economically advantageous solution. Events in recent months, which have seen a steep rise in fuel and electricity prices, are further confirmation of the urgency of maintaining production at Krško NPP, as it guarantees affordable and sufficient supply of the electricity that industry and commerce need. If Krško NPP's operational lifetime is not extended, the stability and reliability of the electricity systems of Slovenia and Croatia will be at risk, which could slow its progress towards climate neutrality. The conclusions of a study produced by Vienna University of Technology, which sets out the options for the future use of renewables for energy purposes, highlight the natural conditions, such as solar radiation and the presence of wind, in Slovenia and Croatia. Unfortunately, they do not take into account any other equally important factors. The new EU Strategy for Biodiversity 2030 requires Member States to redouble their efforts to preserve biodiversity and to protect 30% of their land and sea areas (10% under strict protection conditions) by 2030. The Convention on Biodiversity (CBD), which is the global framework for biodiversity, will have similar coverage requirements after 2020. This means that the network in the EU will have to be expanded over the next decade, by approximately 4% on land and by 19% on sea. Slovenia has a large number of protected and Natura 2000 areas compared to other European countries, which places restrictions on the use of renewable energy sources.
Background documents have been produced for the use of wind energy in Slovenia. They conclude that: Slovenia has fairly limited wind power potentials. Average wind speeds are relatively low, while the small number of areas suitable for wind power largely coincide with extensive and multi-layered areas of protection, protected, sensitive and endangered areas; these are seen as exclusionary or limiting criteria for the siting of wind farms. When the minimum distance between a wind turbine and a settlement is taken into account, the number of potentially suitable locations falls still further because of Slovenia's highly dispersed settlement pattern.

The alternative to lifetime extension is presented in Section 3 of the EIA Report. The Espoo Convention defines possible alternatives as one of the areas of transboundary consultation ("no action alternative", technical alternatives) for a proposed activity, while the EIA Directive requires an examination of reasonable alternatives. The possible (i.e. reasonable) alternatives must be capable of satisfactorily achieving the objectives of the proposed activity, and also be feasible in terms of technical, economic and other important criteria. It must be realistic to realise the alternatives at the time the decision on the activity is taken. Constructing a power plant or plants (including those that use renewables in combination with other sources) to replace production at Krško NPP is currently not a realistic proposition. In addition, the UNECE Good Practice Recommendations on the Application of the Convention to Nuclear Energy-Related Activities, the Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention) explains that alternative means of energy production or balancing demand and supply are national issues of the party of origin and are therefore more properly addressed at the political and strategic level, as they are in the Integrated National Energy and Climate Plan.

<u>Question 9</u>: Risk of severe accidents
One very important question in the transboundary context is: Could an accident happen at the old nuclear power plant that would have significant impacts on the surrounding areas and on other countries as well?

The ministry responds to this question by saying that Section 6.4 of the EIA Report outlines the transboundary impacts during normal operation and, owing to the inclusion of the safety of the population, in the event of an emergency/accident at Krško NPP as well. This section presents the results of dose calculations at certain distances for design-basis (DB) and beyond-design-basis (BDB) accidents at Krško NPP. The assumed reference BDB event has used a very conservative (unlikely) scenario and provides an envelope for any impact of an accident on the environment.

Question 10: Seismic risk
Krško lies in an active seismic zone. Krško NPP was originally designed to withstand a PGA of 0.3 g. This was increased to 0.56 g on account of several Probabilistic Seismic Hazard Analyses (PSHA) conducted up to 2014. New structures, systems and components (SSCs) have been designed to withstand 0.6 g or even 0.78 g. No proof has been provided that old SSCs can also withstand higher PGAs. New studies show that the seismic hazard was underestimated in the PSHAs of 2004 and 2014. Historical earthquakes could exceed 0.56 g. We are demanding the use of a new PSHA drawn up using the latest methods (new methods for determining seismic hazard have been introduced in the last few years). This must be done before a decision on lifetime extension is made.

After studying Krško NPP's statements and the opinions produced by the Faculty of Civil Engineering and Geodesy (FGG), the ministry notes that while Krško NPP does lie in an active seismic zone, it is earthquake-resistant, as the last 40 years of operation have shown. The seismic design load of Krško NPP comprises the spectrum of accelerations in accordance with the American RG 1.60 guidance, scaled to a PGA of 0.3 g at the depth of the foundations (approx. 20 m below the surface). As the PGA during an earthquake decreases with depth, as we have already pointed out, the design peak acceleration at the depth of the foundations cannot be directly compared with the PGA at surface derived from the PSHA. In order to be able to compare Krško NPP's seismic design load with the seismic load from the PSHA, due regard must be paid to the uniform hazard spectrum at the level of the foundations, which was determined in the PSHA of 2004. A comparison between the Krško NPP design spectrum and the uniform hazard spectrum for the level of the foundations shows that the spectral acceleration for a frequency of 3.33 Hz from the uniform hazard spectrum (PSHA, 2004) is approximately 12% lower than the corresponding value of the original design spectral acceleration for 5% attenuation. Moreover, the seismic analyses of the main Krško NPP island (2013) estimated that the original seismic forces taken into account when Krško NPP was being designed were approximately comparable with the seismic forces on the facility resulting from the RG1.60 seismic load and taking into account a PGA of 0.6 g on the open surface, which roughly corresponds to a PGA with a recurrence interval of 10,000 years (0.56 g for a recurrence interval of 10,000 years – PSHA, 2004). The calculations showed that the floor spectral accelerations resulting from an earthquake with a PGA of 0.6 g at surface were less than the acceleration values for equipment with their own frequencies of between 4 and 16 Hz, which covers a wide range of engineered safety features and equipment at Krško NPP.
Seismic safety cannot be discussed solely on the basis of the seismic hazard at the site. It should be noted that additional safety factors were taken into account during the planning phase. These safety factors and uncertainties have been evaluated as part of the seismic analysis of brittleness and the seismic probabilistic safety assessment of the plant. The analysis of seismic brittleness, which was carried out in 2004 and subsequently, proved that the original SSCs could withstand much higher PGAs than those for which they were originally designed. On the basis of seismic brittleness assessments, it is estimated that there is a high probability that the plant can withstand a PGA greater than 0.6 g. The stress tests, which did not take into account the new DEC systems because they had not yet been installed, showed that the PGA at which core damage becomes probable is 0.8 g or more.
It should be stressed at this juncture that Krško NPP's seismic capacities are taken from the Slovenian national stress-test report, which was independently reviewed by institutions authorised by the SNSA and then examined and approved within the framework of the international review of all stress tests conducted for the European Commission by ENSREG.
The above-mentioned seismic capacities mentioned in the report and drawn up as part of the EU stress tests do not take account of the favourable impact of the additional seismic and nuclear engineered safety features that have been planned and installed at Krško NPP as part of the Safety Upgrade

Programme. Some of this new equipment has been installed in facilities on the main Krško NPP island, although most has been installed in new buildings away from the main island. A new (third) diesel generator has been installed in the new Bunkered Building 1 (BB1) to provide independent supply to the engineered safety features, while additional pumps and alternative redundant cooling water tanks have been installed in Bunkered Building 2 (BB2). As stated above, these systems have been designed to withstand very powerful earthquakes. In comparison with the original seismic design loads incorporated into the Krško NPP design process, the new systems have even greater seismic resilience and, as such, are able to replace the most vulnerable original systems in the event of their failure during an earthquake. If the seismic safety assessments for Krško NPP were to take the new systems into account, the assessment of seismic capacity would be even higher than was shown in the stress-test report.

No earthquake with a PGA close to 0.56 g, which is mentioned in the above statements, has occurred in the wider Krško area since the plant began operating. The most powerful earthquake in the immediate vicinity of Krško NPP took place in 1917 in the town of Brežice. According to data from the time, the magnitude of the earthquake was estimated to be 5.7 and the depth of earthquake epicentre was 13 km.

The intensity of the earthquake was estimated to be 8 on the European Macroseismic Scale (EMS, source: http://www.arso.gov.si/potresi/potresna%20aktivnost/potres1917.html). The earthquake of 1917 was a typical earthquake of the type expected in the wider Krško NPP area. Earthquakes with an EMS intensity level of 8 can cause considerable or severe damage to classically constructed buildings, but do not present an extreme seismic hazard to massive reinforced-concrete buildings and robust systems such as nuclear power plants.

Slovenian law and EU practice require seismic hazard (and other hazards) to be periodically reassessed using the very latest methods. A new seismic hazard analysis is currently also being drafted for the potential second unit at the Krško site. According to the preliminary results, and taking the newly developed non-ergodic ground-motion model into account, significant differences in seismic hazard from the PSHA from 2004 are not expected.

<u>Question 11</u>: Risk of severe accidents

Extreme weather events are among the consequences of climate change. It is not clear whether Krško nuclear power plant is sufficiently robust to resist the increasingly extreme weather events or combinations of effects, such as earthquakes that cause floods. We request that the WENRA regulations from 2020 be applied to the determination of the planning bases for safety measures to protect against these hazards.

After studying Krško NPP's comments and the SNSA's opinion, the ministry responds by saying that special adaptation measures and safety upgrades have been carried out to improve the plant's resilience and safety in the face of future climate challenges and extreme weather events. These measures and upgrades have given due consideration to all known extreme weather phenomena. As climate change can have an impact on safety, the potential impacts of climate change and new findings regarding the likely trends in external events are also addressed in the Periodic Safety Reviews, which contain a reassessment of protection against external hazards and an analysis of the impact of extreme weather events on safety.

As described in Section 2.7.9 of the EIA Report, Krško NPP has compiled a technical report titled "Identifying external hazards", which provides an overview of external hazards in accordance with the requirements and guidelines of WENRA Issue T: Natural Hazards, Guidance Document and EPRI– Identification of External Hazards for Analysis. Krško NPP has developed a systematic approach to the regular updating of information on all significant specific threats to the plant, including by applying procedures to uncover possible new threats and regularly updating information on known threats. The external hazards report defines 104 external events. Krško NPP has also considered all combinations of hazards in accordance with the explanations set out in WENRA RHWG, Issue T: Natural Hazards Head Document, Guidance for the WENRA Safety Reference Levels for Natural Hazards introduced as lesson learned from TEPCO Fukushima Daiichi accident. The combinations of external events assessed

included earthquake and fire, earthquake and external flooding, earthquake and extreme drought, and extreme combinations of long-lasting external events. A review of external hazards showed that all such hazards had been given due consideration in the plant's analyses and procedures, and that Krško NPP was robust, able to cope with extreme weather events and also able to withstand combinations of external hazards. The results of the assessment have been reviewed and approved by the SNSA. The EU stress tests have also shown that Krško NPP has a robust design that withstands extreme weather events and external hazards, and that it is well-prepared for such events. The extensive overview of external hazards that could affect Krško NPP and produced as part of the EU stress tests included: floods, strong winds, intensive 24-hour rainfall, extreme cold, extreme heat, hailstorms, frost, heavy snowfall and cyclonic storms. Extreme weather events and combinations of risks were the (planning) basis underpinning the Safety Upgrade Programme described and presented in the EIA Report, which introduced additional DEC engineered safety features to further improve protection of the plant.
The WENRA Safety Reference Levels, which have been incorporated into Slovenian law, are binding, i.e. WENRA Safety Reference Levels for Existing Reactors, September 2014. The WENRA SRL for Existing Reactors 2020 are being examined in the course of the third Periodic Safety Review, which is currently under way. According to the preliminary results of the independent review, Krško NPP complies with the WENRA SRL for Existing Reactors 2020.

Question 12: The aging of an old nuclear power plant is a serious problem. Both the first Topical Peer Review on Aging Management in 2017/2018 and the IAEA pre-SALTO mission showed up deficiencies in aging management. The original design has become outdated, which is a problem not even the extensive post-Fukushima Safety Upgrade Programmes have been able to eliminate.

The ministry responds by saying that Krško NPP has a comprehensive Aging Management Programme (AMP) in place for monitoring the aging of all passive structures and components (reactor vessel, concrete, underground pipes, steel structures, electrical cables, etc.). The aging of active components is monitored by means of an effective preventive maintenance programme. The aging of active components is controlled through the monitoring of maintenance efficiency in accordance with the requirements set out in Maintenance Rule 10 CFR 50.65, Reliability Centred Maintenance INPO API 913, and Environmental Qualification Programmes 10 CFR 50.49, as well as with US regulations and standards. Activities relating to the replacement of equipment are included in the long-term plan of investments and maintenance activities. Inspections, controls and other aging-related activities are currently carried out via a system of work orders and preventive maintenance. The following existing programmes at the plant are essential for the management of the aging of active components: maintenance programmes, equipment qualification programmes, programmes of checks during operation, control programmes and aquatic chemistry programmes.
The AMP comprises various Krško NPP programmes, procedures and activities that ensure that all the allotted functions of SSCs managed under the AMP are identified and adequately checked for the effects of aging. The findings are used to determine measures that enable the SSCs to perform their allotted functions until the end of Krško NPP's operational lifetime and also in the event that its operational lifetime is extended. The Krško NPP AMP has been designed in compliance with the NUREG-1801 – Generic Aging Lessons Learned (GALL) Report. It ensures comprehensive supervision of the aging of the plant, including mechanical, electrical and structural SSCs (in relation to which it systematically identifies aging mechanisms and their effects on SSCs important to safety), identification of the possible consequences of aging and the determination of measures to maintain the performance and reliability of SSCs.
Krško NPP received the following assessments in the ENSREG First Topical Peer Review on Aging Management: one good practice, four good performances and four areas for improvement. As the ENSREG First Topical Peer Review Updated National Action Plan on the Krško NPP Ageing Management Programme (May 2021) makes clear, all the problems identified have been resolved or are being addressed in accordance with the action plan and the regulatory requirements.
The Krško NPP AMP was reviewed and evaluated by the IAEA pre-SALTO (Safety Aspects of Long Term Operation) mission. The pre-SALTO mission carried out a thorough review of AMPs and their

implementation on the basis of IAEA standards and international best practice. The pre-SALTO mission found that the plant was in good condition, although there were some areas that required improvement to reach the level of the IAEA safety standards and international best practice. The mission resulted in 9 good performances and 14 issues resulting in a suggestion or recommendation for improvement. An action plan was set up to resolve the problems identified and is currently being implemented. The AMP is also being comprehensively and systematically assessed within the context of the third Periodic Safety Review (PSR3), which is currently under way. The Krško NPP AMP is an ongoing programme with an in-built capacity for improvements based on in-house and external operating experience and the results of worldwide research and development.

Question 13: As difficulties with materials and design increase, so does the risk of terrorist attacks. Power plants designed more than 50 years ago are not in a fit state to withstand the effects of the current threat.

The ministry responds by saying that Krško NPP has redundant engineered safety features that are physically separate from each other. As part of the Safety Upgrade Programme, Krško NPP installed additional engineered safety features in two bunkered buildings that are physically separate and adequately distanced from the plant's main island, where the reactor is located in a double-shell containment. This ensures that the plant's operation can be safely halted in the event of a large commercial airliner crashing into it. Krško NPP is also protected against other types of terrorist attack or commando raid. However, owing to the sensitive nature of physical protection and security at Krško NPP, information on protection against the downing of an aircraft, terrorist attacks and commando raids is classified.

Question 14: The EIA Report calculated the design-extension condition using the assumption that the containment would remain unaffected. However, this accident is not the worst accident that could happen. While a severe accident that leads to failure of the containment is highly unlikely, the risk of an accident of that kind cannot be overlooked.
The results of the flexRISK research project showed that an accident at Krško involving containment bypass could release up to 69 petabecquerels (PBq) of Caesium-137 and 539 PBq of Iodine-131. The following figure from the flexRISK6 shows the weather-related risk to Europe of being contaminated with Cs-137 at levels exceeding 37 petabecquerels per m^2 in the event of a severe accident of this kind.
In the event of a severe accident at Krško, highly radioactive contamination could affect every country in Europe in adverse weather conditions. The EIA Report should also include calculations for an accident with the highest radioactive inventory (highest source term), the risk of which is not zero, and dispersion calculations for the whole of Europe.

The ministry responds by saying that the representative accident in the EIA Report was selected on the basis of the Krško NPP Safety Analysis Report, the PSA and internationally recognised nuclear safety standards, in line with industrial and regulatory practice. The identification criteria applied to determine the most important severe accident sequences comply with the US NRC instructions. The accident scenario was determined on the basis of the likelihood that it would lead to significant adverse transboundary impacts. The scenarios and results presented in the EIA Report have been reviewed by the SNSA.
The EIA Report analysed radiological releases from a reactor core accident in the case of a design-basis accident and a representative severe accident (DEC-B or BDBA) (EIA Report, Section 6.4). According to the plant's Safety Analysis Report, from the point of view of radiological release the limiting fault accident is a large-break LOCA. No other design-basis accident causes a major release of radioactivity into the environment. This also includes the accident class involving containment bypass, as represented by steam generator tube rupture (SGTR). The activity of the primary coolant in line with the technical specifications and the measures undertaken at the plant in accordance with abnormal operating procedures (AOP) and emergency operating procedures (EOP) reduces the radiological consequences of this event.

A radiological release in the case of any possible severe accident (DEC-B or BDBA) was analysed using station blackout (SBO) with no action taken in the first 24 hours (the assumption is that operators will not take any action in the first 24 hours), with release through the passive containment filtered venting system (PCFVS) as the reference case. This sequence was chosen because of the expected complete meltdown of the core and the most rapid and most conservative release of radioactivity within the containment. The PCFVS was installed to protect the integrity of the containment in the event of an increase in pressure during a severe accident, and to filter the atmosphere of the containment in the event of any release. This protects the environment and the surrounding population from radioactive aerosols in the air and from gaseous radioactive iodine and its organic compounds. The system is passive and fully designed in accordance with DEC requirements (including seismic). The release of radioactivity after a severe accident can be attributed to it. Moreover, the analysis considers the release of radioactivity from containment leakage before and after the PCFVS is activated. To summarise, the most conservative complete core damage is assumed, together with a conservative leakage from the containment and the use of containment protection with a passive, conservatively designed system of filtered venting channels. The difference between our radioactive inventory (source term) and that used in flexRISK is the result of the explicit calculation of the capacity of the containment in our case and the release of almost all the available radioactive material in their case. Our position is that the source of the accident has been prepared in accordance with the requirements of the EIA Report.
In the EIA Report (Section 6.4), the dispersion calculations for the selected accidents were carried out for distances of up to 200 km from Krško NPP. The calculated doses for releases into the atmosphere in the accidents studied have shown that a DBA and DEC-B are not expected to have major impacts beyond of a radius of 10 km from the plant. The effects are considerably less at distances of up to 200 km, as the calculations clearly show. As the effects are further reduced at distances over 200 km, greater distances were not specifically addressed.
The authors of the final flexRISK report (Flexible Tools for Assessment of Nuclear Risk in Europe Final Report (2013)) discussed the shortcomings of their work and pointed out the limitations and uncertainties of the data used in the project. The project made use of available generic data, such as generic accident scenarios and radioactive inventories (source term), as well as available probabilistic safety assessments (PSA) that are not directly comparable. The authors themselves state that a comprehensive PSA would be required for each nuclear power plant, along with the use of appropriate computer codes and models. Krško NPP has carried out a series of upgrades in the areas of seismic hazard, flood protection, mitigation of the effects of fire, and the provision of additional sources of supply in the event of emergency situations or failure of the external power supply, etc. (EIA Report, Section 2.8). The Krško NPP SUP has led to a reduction in risk in the last few years. All safety upgrades are reflected in the Krško NPP safety analyses and in the PSA model, which shows a significant reduction in the core damage frequency (EIA Report, Section 2.8). We cannot take the flexRISK assessments, which are based on generic data and do not take into account possible safety improvements carried out at Krško NPP, as representative.

Question 15: Spent fuel and radioactive waste
The safe disposal of radioactive waste and spent fuel is a problem that has not been resolved anywhere in the world, particularly as regards final disposal technologies, which are typically unsuccessful – see Asse (Germany) or WIPP (USA). Expecting safety to continue almost forever is, given today's knowledge and technical capacities, an illusion. It has not been proved that the additional nuclear waste resulting from lifetime extension can be disposed of safely. In the case of Krško NPP, there is no temporary spent fuel storage facility at all: the dry storage is still being built and spent fuel is being stored in storage pools until that time. There is currently no concrete plan for the final storage location. Slovenia and Croatia, who are the owners of Krško NPP and are jointly responsible for nuclear waste management, are pinning their hopes on a multinational repository. The national repository, which is supposed to be built in Slovenia or Croatia, will begin operating in 2063 at the earliest, although the other date mentioned in the EIA study (2093, towards the end of the century) is more realistic. Furthermore, they intend to use the Swedish KBS-3 method of final disposal of spent heating elements, without taking into account the fact that the latest research findings show that copper can corrode even

in oxygen-free environments. In addition to other corrosion mechanisms and the existence of mechanisms that could cause stress to copper containers, it is not possible to ensure the integrity of those containers over the long term. For the final disposal of HLW resulting from operation and the possible extension of Krško NPP's operational lifetime, the Slovenian authorities are advocating an untested technology that has been subject to criticism.

The ministry responds by saying that an EIA was produced for the spent fuel dry storage, which included a transboundary assessment and the acquisition of a building permit, and that construction of the facility is in full swing. The first campaign of transfer of spent fuel to dry storage will take place in the first half of 2023. The disposal of spent fuel will take place in accordance with the Programme for the Disposal of Radioactive Waste and Spent Fuel, which was prepared in accordance with the provisions of the Treaty between the Government of the Republic of Slovenia and the Government of the Republic of Croatia on the Regulation of Status and Other Legal Relations Regarding Investment in and the Exploitation and Decommissioning of Krško Nuclear Power Plant (Intergovernmental Treaty). Periodic reviews of the disposal programme are carried out at least every five years in order to update the disposal reference concept in line with new technical solutions and information. Spent fuel from Krško NPP will be deposited in a spent fuel repository at an as-yet-undetermined location in Slovenia or Croatia (or, if possible, in a regional or multinational repository). In order to develop a final solution and a reference disposal scenario, both sides are starting to develop a geological disposal concept and collect data on specific geological formations. Their revisions to the disposal programme reflect the international progress being made with various disposal concepts and the ongoing development of regional and multinational geological repositories. Regarding the Swedish KBS-3 disposal technology, research into and the development of different deep geological disposal concepts will be monitored and the options assessed in the light of scientific progress before any final decision on the disposal concept is taken. A licensed, state-of-the-art solution will be chosen, as was the case with the spent fuel dry storage, for which the tried-and-tested HOLTEC technology was selected. Because of the existing spent fuel and radioactive waste, the quantity of spent fuel resulting from the extension of Krško NPP's operational lifetime does not qualitatively change the situation that needs to be addressed.

Question 16: One significant shortcoming of this EIA procedure is the lack of alternative solutions to the extension of the operational lifetime of an old nuclear power plant, which presents a risk to large parts of Europe. We therefore ask you to study the shortcomings and meet the legislative obligations.

The ministry responds by saying that the alternative is presented in Section 3 of the EIA Report. The EIA Report has been prepared in accordance with the Slovenian Decree on the method of drafting and on the content of the report on the effects of planned activities affecting the environment, which complies with the Directive 2011/92/EU. The alternative to lifetime extension is presented in Section 3 of the EIA Report.

The ministry also sent the responses in writing to Hungary (letter no. 35409-282/2020-2550-119 of 25 November 2022), which did not respond with additional questions or opinions.
The ministry notes that no proposals for additional mitigation measures were made in the course of this consultation process.

ITALY

The ministry sent notice of the "Extension of Krško NPP's Operational Lifetime (2023–2043)" project to the Italian Ministry for Environment, Land and Sea Protection (Ministero dell'Ambiente e della Tutela del Territorio e del Mare). In note MATTM.68706 of 25 June 2021 and pursuant to Article 3 of the Espoo Convention, it informed Slovenia that it wished to take part in the transboundary procedure.
It was therefore sent, in letter no. 35409-282/2020-2550-42 of 22 February 2022, and in accordance with Article 4 of the Espoo Convention and Article 5 of the EIA Directive, documentation for the EIA in Slovenian and English with a request for a public consultation and the preparation of an opinion, and an

invitation to a technical consultation. An Italian translation of the non-technical summary was sent to the Italian ministry in letter no. 35409-282/2020-2550-53 on 1 April 2022.

The two competent ministries agreed on the technical aspects of the transboundary consultation. The Ministry of Ecological Transition (Ministero della Transizione Ecologica) secured public participation by publishing the material online on the Environmental Assessment portal (Strategic EIA and EIA): https://va.mite.gov.it/it-IT/Oggetti/Documentazione/8450/12466.
The material was published on the Italian ministry's website for 30 days. Opinions were gathered from the public and from ministries and organisations, including the regions.

Technical consultations took place between the expert teams of Slovenia and Italy on 11 April 2022, as the minutes (reference no. 35409-282/2020-2550-60) show.
The consultations covered the following topics: safety, risk of accidents, models, zonation, subsidence of wet soil resulting from the separation of water and soil in the event of a seismic event, modelling, monitoring, meteorological models, accident modelling and monitoring. An inspection of the power plant also took place. One important area of focus in the consultation was nuclear safety, with an emphasis on accident modelling and the use of modelling to identify transboundary impacts. Technical explanations were also provided regarding the improvements carried out and the field inspection that took place at Krško NPP. Replies and clarifications were provided for all questions at the technical consultations, as the minutes of 11 April 2022 (reference no. 35409-282/2020-2550-60) show.

However, the ministry was advised that the technical opinion of the environmental assessment committee (no. 270, 20 May 2022) had identified a number of shortcomings and findings relating to:

1. the explicit reference to early and large radioactive releases and the systematic presentation of the level of compliance achieved;
2. the shortcomings in the "Calculation of doses at certain distances for design-basis (DB) and beyond-design-basis (BDB) accidents at NPP Krško" document;
3. the explanation of own assessments in the calculation of the source term used to model the EIA document, particularly for the release of the radionuclide I-131, which has a different value than that used in the Italian National Radiological and Nuclear Accident Management Plan (Article 182(2) Regulation 101/2020);
4. the assessment of the cumulative impacts of the construction of a new nuclear power plant with the extension of the operational lifetime for a further 20 years (2023–2043);
5. the explanation of the safety measures relating to terrorist attacks and acts of sabotage;
6. the updated independent study that stresses the compliance of the existing infrastructure with new seismic knowledge that has been produced in recent years on PGA and is to be used for simulations and for checking the safety of plants and structures, with due regard to the possible liquefaction of the soil;
7. the updated assessment of the geological structural situation in the area and the complex seismic problems deriving from the development of the plant, as set out in the OGS report enclosed with the opinion submitted by the Friuli-Venezia Giulia region and with reference to the scientific work of L. Sirovich, Coste et al. received as a comment on the document from the public, the latter two received in response to the document titled "Geophysical research in the area of Krško nuclear power plant" – Final report and annex to the General Directorate IA Tacis Procurement Unit (contract no. 98-0286,00, Brussels, Belgium).

Regarding the first point regarding safety, the ministry provides explanations in Section E: Impact on the risk of environmental and other accidents, pp. 279–280 [pp. 298-300], F: Impact on the population and human health (p. 281 [pp. 300-301]), Impact on seismic safety pp. 281–282 [pp. 301-303] and Ionising radiation on pp. 284–287 [pp. 304-317] of this decision.

Regarding the second point, the ministry explains that the "Calculation of doses at certain distances for design-basis (DB) and beyond-design-basis (BDB) accidents at Krško nuclear power plant" study (FER-

MEIS, 2021) has been drawn up and has served as the expert basis for the EIA.

Regarding the third point, the ministry explains that the EIA and the modelling are requirements of Slovenian law, and points out that the difference in the legally determined value in the National Radiological and Nuclear Accident Management Plan (Article 182(2) Regulation 101/2020) would not change the results of the modelling, where it is proved what the values are in Italy even if the least probable accident scenario and all meteorological situations are applied and the values would be 129 km from Krško NPP. The "Calculation of doses at certain distances for design-basis (DB) and beyond-design-basis (BDB) accidents at Krško nuclear power plant" study (FER-MEIS, 2021) dealt with the design-basis large-break loss of coolant accident (LB LOCA) and the design-extension conditions (DEC-B). The results of the study show that the 30-day effective dose at a distance of 10 km from the power plant is 1.16 mSv, which is more than two times lower than the annual natural background dose in Slovenia (approx. 2.5 mSv). The thyroid dose (13.5 mSv) at a distance of 3 km from Krško NPP is below the limit prescribed by law for iodine prophylaxis, which is 50 mSv for seven days (Decree on limit doses, reference levels and radioactive contamination, Official Gazette of RS, No. 18/18).

Regarding the fourth point, the ministry responds by saying that the assessment of the cumulative effects of the construction of a new nuclear power plant with a lifetime extension of 20 years (2023–2043) is not the subject of the EIA for the extension of Krško NPP's operational lifetime, nor can the cumulative effects be included because the location is not yet known, the idea has not been the subject of any procedures and no EIA, strategic or otherwise, has been carried out. If any new nuclear power plant is the subject of a procedure within the period of extended operational lifetime (2023–2043), the EIA Report will, in accordance with Slovenian law, have to take the existing plant into account and calculate the cumulative effects.

Regarding whether due regard has been paid to terrorist attacks, the ministry points out that they have been addressed in the EIA and are explained under point 14.8.3 of this decision (pp. 39–40 [p. 43]).

The ministry takes account of the comment regarding the updated independent study that stresses the compliance of the existing infrastructure with new seismic knowledge that has been produced in recent years on PGA and is to be used for simulations and for checking the safety of plants and structures, with due regard to the possible liquefaction of the soil, by determining that the 2023 PSR should take the new seismic study into account, as laid down in point II/1.18 of the operative part of this environmental protection consent.

AUSTRIA

In the transboundary EIA procedure the Austrian Federal Ministry for Climate Action submitted comments and questions from the public, which the ministry then forwarded to Krško NPP for its response. The Krško NPP supplied responses to all of Austria's questions in letter no. 35409-282/2020-2550-72. The ministry's comments on the questions are set out below.

<u>Question 1</u>: <u>Opinion submitted by Ulrika Degiampietro (Stellungnahme zur geplanten Betriebsverlängerung des slowenischen AKW Krško)</u>
Owing to its age (it began to be constructed in 1974 and came into operation in 1982), the current technical status of the reactor should be examined by independent international experts. This should be done not only with computer models but also on the basis of relevant experiences and data from the decommissioning of comparable reactors.

An Aging Management Programme has been established and updated, and time-limited aging analyses (TLAA) produced and updated on the basis of NUREG-1801. The compliance of the AMPs and the TLAAs with IAEA (IGALL) requirements has been examined and confirmed. AMPs are regularly updated at Krško NPP by taking into account new regulatory requirements, foreign and domestic experiences and new R&D findings. Krško NPP has so far implemented 42 AMPs programmes using the GALL approach. IAEA (IGALL) compliance has been examined and confirmed for every programme.

The reactor vessel irradiation control programme controls the effects of aging resulting from a loss of fracture toughness from irradiation and the brittleness of the low-alloy steel material of the reactor pressure vessel. The monitoring methods are in accordance with 10 CFR 50, Appendix H. This programme refers to the requirements for evaluating neutron irradiation, the removal of control capsules, the mechanical testing/evaluation of the sample, and the production of a diagram of the temperature/pressure limits of acceptability for the operation of the reactor vessel. The requirements mentioned in this programme ensure that the reactor vessel's materials meet the requirements regarding the fracture toughness energy of the material under 10 CFR 50, Appendix G, and meet the pressurised thermal shock (PTS) requirements of 10 CFR 50.61. For the period of the lifetime extension, the programme also includes an alternative method of monitoring neutron irradiation (NUREG-1801), which is performed using an ex-vessel neutron dosimetry (EVND) system. Samples are examined, tested and analysed by accredited external laboratories.

Krško NPP also has an in-service inspection programme in place for the non-destructive testing of the reactor vessel and reactor vessel closure head in accordance with ASME XI. For the non-destructive evaluation (NDE) of the basic material of the reactor pressure vessel at the level of the core, Krško NPP is part of the PWROG (Pressurized Water Reactor Owners Group) working group, and implements the latest industrial R&D findings on a continuous basis.

According to all the expert inspections performed so far, Krško NPP is able to demonstrate that the state of the reactor vessel is sufficiently adequate (the pressure boundary safety function is operational) to ensure that the plant is able to operate over the long term.

Tests to check the point at which safety pipelines penetrate concrete structures were included in a specific aging management programme within the framework of the action plan to fulfil the recommendations issued on the basis of the national TPR (ENSREG) report. The Krško NPP containment provides a pressure (safety) boundary using steel containment. Management of the aging of penetrations and welds in the steel containment is addressed in a separate programme that complies with NUREG-1801, XI-M19.

By carrying out regular periodic inspections of structures, systems and components (SSCs), Krško NPP ensures that they are capable of withstanding any design-basis accident even during the period of extended operation (i.e. after more than 40 years of operation). Krško NPP also ensures that aging management processes and preventive measures do not lead to any loss of the original safety margins. This is also confirmed by the inspections conducted by the SNSA, by international inspection missions (TPR, OSART, WANO, IAEA) and by the independent expert institutions involved in all regular outages of the power plant. TLAAs are also performed for SSCs that are subject to time-limited operating conditions; these are independently confirmed by external inspectors so as to ensure that the design bases and requirements for the analysed SSCs are maintained.

Question 2: The data presented on seismic hazard is very out of date. Scientifically up-to-date international studies should be carried out and the results incorporated into the EIA Report.

The ministry responds that the EIA Report (Section 4.1.11, Seismic hazard, p. 176) states that the preliminary results of paleoseismological investigations since 2004 and the updated PSHA (which is under way) have not confirmed the existence of new faults or geological structures in the last ten years that could, in the event of an earthquake, permanently deform the surface of the location ("capable faults"). While the EIA Report was drawn up on the basis of all known data and with the help of the best available knowledge, GEN has nevertheless commissioned a study of the seismic hazard presented by ground displacement, albeit for the requirements of another project. The study, which considered 11 seismic source lines, was completed in 2013. It showed that there was no danger of major permanent ground displacement, while the danger of very minor permanent ground displacement was insignificant (recurrence interval of more than one million years).

Field research also continued after 2004 and has been at its most intensive in the last decade. A project to update the PSHA for the immediate vicinity of Krško NPP is currently under way. As part of this project, a new non-ergodic ground-motion model was developed for the location of the second nuclear power plant block at Krško in 2021. The new non-ergodic ground-motion model takes into account the local characteristics of earthquakes on the basis of the ground-motion measurements that have been provided by ARSO for more than 20 years. This has a positive impact on the results of the PSHA. It has been shown, for the immediate vicinity of Krško NPP, that the PGA and spectral acceleration at higher frequencies and for long recurrence intervals decrease relative to the values determined using the conventional ground-motion model.

A project is currently under way to update the Probabilistic Seismic Hazard Analysis in the wider surroundings of Krško NPP. The project, which began with field research just over ten years ago, is financed by GEN. The preliminary study covers 12 seismic source lines within a 200 km radius of the plant. In addition to seismic source lines, it also considers seismic sources that could arise in specific areas. A new non-ergodic ground-motion model has also been developed for the location.

Krško NPP was designed to withstand earthquakes. The seismic design load of Krško NPP comprises the spectrum of accelerations in accordance with the American RG 1.60 guidance, scaled to a PGA of 0.3 g at the depth of the foundations (approx. 20 m below the surface). As the PGA during an earthquake decreases with depth, as we have already pointed out, the design peak acceleration at the depth of the foundations cannot be directly compared with the PGA at surface derived from the PSHA. In order to be able to compare Krško NPP’s seismic design load with the seismic load from the PSHA, due regard must be paid to the uniform hazard spectrum at the level of the foundations, which was determined in the PSHA of 2004. A comparison between the Krško NPP design spectrum and the uniform hazard spectrum for the level of the foundations shows that the spectral acceleration for a frequency of 3.33 Hz from the uniform hazard spectrum (PSHA, 2004) is approximately 12% lower than the corresponding value of the design spectral acceleration for 5% attenuation. Moreover, the seismic analyses of 2013 estimated that the original seismic forces taken into account when Krško NPP was being designed were approximately comparable with the seismic forces on the facility resulting from the RG1.60 seismic load of RG1.60 and taking into account a PGA of 0.6 g on the open surface, which roughly corresponds to a PGA with a recurrence interval of 10,000 years (PSHA, 2004). The favourable impact of the interaction between the Krško NPP structure and the ground (which scatters a significant amount of the energy) was also taken into account in this transformation. The calculations from 2013 also showed that the floor spectral accelerations resulting from an earthquake with a PGA of 0.6 g at surface were approximately equal to or less than the original acceleration values for equipment with their own frequencies of between 4 and 16 Hz, which covers a wide range of engineered safety features and equipment at Krško NPP.

The stress tests carried out in 2011 showed that, on account of the safety factors taken into consideration during the project design process, Krško NPP could shut down safely and maintain long-term cooling operations in the event of an earthquake with a PGA greater than 0.6 g at surface. The ENSREG stress-test report of 2011 estimated that damage to the core was unlikely with earthquakes with a PGA of less than 0.8 g at surface. However, this estimate did not take into account the favourable impact of the new safety equipment installed at the plant in the last ten years in response to the Krško NPP Safety Upgrade Programme (see also the responses to one of the questions above). BB2 (Bunkered Building 2, a reinforced safety structure) is designed to accommodate an alternative safety injection (ASI) system, an alternative auxiliary feedwater (AAF) system and safety power supply to the building. The AUHS is ensured by the construction of BB2 and the installation of the ASI and AAF systems. The BB2 facilities and systems from the Safety Upgrade Programme, which were built away from the foundations of the main Krško NPP island, were designed for a peak ground acceleration of 0.78 g at the level of the foundations. During the construction of the new facility, the safety acceptance criterion with regard to the analysis of seismic vulnerability was also determined using HCLPF PGA. As has been pointed out on several occasions, additional safety factors are used when designing nuclear facilities so that the likelihood of component failure (including in BB2) is approx. one or two orders of magnitude lower than the likelihood of the occurrence of the design ground acceleration. It should also be pointed out that the design PGA for BB2 and its systems exceeds the value corresponding to a recurrence interval of 10,000 years set out in the PSHA from 2004. According to the preliminary results of the updated PSHA study, which is currently being prepared, the new value of a recurrence interval of 10,000 years is also lower than the design acceleration taken into consideration for BB2.

The impacts of various earthquakes and the adverse events associated with them are taken into account when the core damage frequency (CDF) is being determined; for Krško NPP it is estimated at a value that is acceptable under Slovenian law. This confirms that Krško NPP's seismic safety is adequate.

Question 3: The assumptions in the report regarding the consequences of a super break or meltdown are too optimistic. The decision on whether to extend operation of the plant should be based on real data from real accidents (e.g. Fukushima).

The ministry responds by saying that the representative accident in the EIA Report was selected on the basis of the Krško NPP Safety Analysis Report, deterministic and probabilistic safety assessments, and internationally recognised nuclear safety standards, in line with industrial and regulatory practice. The reference severe accident (DEC-B) was selected as the limiting or envelope scenario presenting the biggest challenge to transboundary impact resulting from a very conservative (almost improbable) scenario involving the loss of all AC power supply, the loss of safety/auxiliary systems, the loss of operating crew for 24 hours (no action is taken by operating crew in the first 24 hours), and radioactive releases through the systems and the passive containment filtered venting system (PCFVS), with additional design-basis leakage from the increase in pressure. An explanation of the selection of the representative accident is given in Section 6.4 of the EIA Report.

This accident scenario was chosen because of the expected complete meltdown of the core and the most rapid and most conservative release of radioactivity in the containment. This means that the EIA addressed the highest possible radioactive inventory (source term). The purpose of the PCFVS is to protect the integrity of the containment in the event of an increase in pressure caused by a severe accident, to filter the atmosphere of the containment in the event of any release, and to protect the environment and the population against radioactive aerosols in the atmosphere and from gaseous radioactive iodine and its organic substances. The system is passive and has been entirely designed in accordance with the requirements of the design-extension conditions (including earthquake-related conditions). Moreover, the analysis considers the release of radioactivity from containment leakage before and after the PCFVS is activated. Therefore, in summary, the most conservative assumption was used: that of complete damage to the core together with the conservative containment leakage and the use of a passive, conservatively designed filter system for protecting the containment.

Following the Fukushima accident, Krško NPP carried out a series of analyses of design-extension conditions. The analyses addressed the combinations of accidents, based on which an additional upgrade of the nuclear power plant was required (DEC). The safety upgrades were carried out as part of the national post-Fukushima action plan following the EU stress tests, and took place as part of the Safety Upgrade Programme described in

3/13 of Section 2.7.12 of the EIA Report. The new additional systems installed as part of the SUP ensure that Krško NPP will manage beyond-design-basis accidents using the extended range of equipment and upgrades. Safety upgrades were carried out in the areas of seismic hazard, flood protection, mitigation of the effects of fire, and the provision of additional sources of supply in the case of emergency situations or the loss of power supply, etc. (EIA Report, Section 2.8). The Krško NPP SUP has led to a reduction in risk in the last few years. All safety upgrades are reflected in the Krško NPP safety analyses and in the PSA model, which shows a significant reduction in the core damage frequency (EIA Report, Section 2.8).

It is not possible to compare accidents in entirely different types of nuclear plant, nor can a comparison be made without taking the cause of the accident into account. The Fukushima accident arose as a result of a failure to take account of the risk presented by external hazards.

The safety upgrade process at Krško NPP involved a systematic approach to improving the safety of the plant on the basis of WENRA and other recommendations. The safety upgrade process incorporated deterministic and probabilistic analyses and international recommendations for improving nuclear safety. All external risks were reviewed in accordance with a variety of international standards, and the plant was found to have no systematic deficiencies.

In light of the above, the analysis of the reference severe accident in the EIA Report suitably addresses the worst possible scenario, with due regard paid to the real (and current) assumptions regarding the radioactive inventory (source term).

Question 4: The report minimises the impact of radioactive releases from Krško NPP on human health. We know from the epidemiological study of childhood cancer in the vicinity of nuclear power plants (the KiKK study) that high emissions of radioactive tritium and radioactive carbon during normal plant operation leads to an increase of 60% in cancer incidence and 100% in leukaemia incidence.

After studying Krško NPP’s comments, the ministry responds as follows to the “KiKK” (BfS) leukaemia study:

Incidence of leukaemia in children

Leukaemia is the most common form of cancer in childhood. It accounts for between 25% and 30% of all newly detected cancers among the under-15s worldwide. The mechanisms that cause leukaemia among children are still poorly understood. Figures from European cancer registers indicate that the incidence rate of leukaemia among children grew on average by 0.7% a year between 1970 and 1999. In the last 20 years, this has risen to 1% a year, mainly in wealthier countries.

Slovenia has a long history of gathering of data on cancer cases. The Cancer Registry of Slovenia (SLORA/CRS) has been maintained at the Ljubljana Institute of Oncology since 1950, making it one of the oldest population registries for cancer in Europe. For more than 60 years it has gathered and annually published data on the incidence, prevalence and survival rate of cancer patients. Its website provides data from 1961 on.

The CRS records data on the incidence of all types of cancer by sex, age and region. Krško nuclear power plant is located in the Spodnjeposavska (Lower Posavska) region. According to figures from the Cancer Registry for 1980–2018, the Spodnjeposavska region (marked in turquoise in the graph) does not stand out in terms of the number of new cases of leukaemia among children and adolescents (0–19 years) in comparison with other Slovenian regions.

Source: http://www.slora.si/stevilo-novih-bolnikov

Figures from the World Health Organization on the average incidence of leukaemia among children aged under 14 in the countries of the European region in 2000 (shown in the figure below) does not show a link between nuclear power plants and the incidence of childhood leukaemia in these countries. As we know, Italy has no nuclear power plants, but still had the highest age-standardised incidence rate (ASIR) of leukaemia among the under-14s (number of patients per million inhabitants) among the selected European countries in 2000.

Source: https://www.euro.who.int/__data/assets/pdf_file/0005/97016/4.1.-Incidence-of-childhoodleukaemia-EDITED_layouted.pdf

Because of the small number of cases (between 5 and 18 new cases per year according to data from the National Institute of Public Health, published on 22 October 2020 at www. kazalci.arso.gov.si.), we are unable to identify a characteristic trend in incidences of childhood leukaemia in Slovenia in the 1998–2017 period.

In 2006 the Municipality of Brežice and the Agency for Radwaste Management (ARAO) commissioned a report from Ljubljana Institute of Oncology (www.onko-i.si) (“Incidence of cancer in the Municipality of Brežice in comparison with the rest of Slovenia”, which was a geographical analysis of the incidence of cancer in the Municipality of Brežice based on data from the CRS).

Data was collected for a standardised incidence ratio in the 12 statistical regions of Slovenia in three consecutive periods: period one 1970-1983, period two 1984–1993, and period three 1994–2003 (both sexes together).

The report states that the factors so far known as causing leukaemia are ionising radiation and certain substances at the workplace, while studies are being made of the impact of some viral infections.

The data excludes chronic lymphocytic leukaemia, which typically does not affect children, as the analysis reports. Across the whole of Slovenia, the risk rose in the third period and was significantly higher than in the first period. There were no statistically significant region-by-region differences in the risk of developing leukaemia. Compared to Slovenia as a whole, the risk in the Spodnjeposavska region was average in all three periods. In the most recent period the risk has increased in Eastern Slovenia as well, although it was not possible to detect any specific areas in which there was a particularly higher

risk of leukaemia. The Municipality of Brežice is average in terms of the size of the risk. The incidence for the Spodnjeposavska region in the three periods referred to above is:
0.85–0.97 for the first period 1970–1983
0.71–0.84 for the second period 1984–1993
0.98–1.11 for the third period 1994–2003
The nationwide figures for people falling ill with leukaemia were 57 in 1970, 82 in 1983 and 122 in 2003 (75 men and 47 women). In the third period, the statistical regions with the highest incidence (1.12 and over) were Goriška, Obalno-Kraška, Jugovzhodna Slovenija and Zasavska.

BfS study
This study (Epidemiologische Studie zu Kinderkrebs in der Umgebung von Kernkraftwerken – KiKK-Studie), which advances a hypothesis that proximity to a nuclear power plant has a harmful impact on health, was commissioned by the German Federal Office for Radiation Protection (Bundesamt für Strahlenschutz, BfS). In its most recent announcement on 13 October 2021, (www.BfS.de), the Office states the following position on the study:
"....Es gibt derzeit keine plausible Erklärung für den festgestellten Effekt, der über die 24 Jahre des Untersuchungszeitraums ein insgesamt konsistentes Bild mit kleinen Schwankungen zeigt. (There is currently no plausible explanation for the observed effect, which shows a largely consistent pattern with minor fluctuations over the 24-year period studied.) Denkbar ist ein Zusammenspiel verschiedener Ursachen. (It could be a combination of different causes.) Die Interaktion verschiedener Faktoren und die grundsätzlichen Entstehungsmechanismen von Leukämien bei Kindern bilden daher die Schwerpunkte der derzeit laufenden Forschungsarbeiten. (The interaction of the various factors and the underlying mechanisms of childhood leukaemia are therefore the focus of current research.)"
It also published a notice on its website on 11 November 2016 in relation to the findings of a group of international experts:
"Ursachen von Leukämie bei Kindern aufdecken (Uncovering causes of leukaemia in children)
Viele Faktoren stehen im Verdacht, Leukämie bei Kindern auszulösen – darunter, neben z.B. Infektionen und Pestiziden, auch niedrige Dosen an Radioaktivität und niederfrequente Magnetfelder der Stromversorgung. (A large number of factors are thought to cause childhood leukaemia, including infections and pesticides, low doses of radioactivity and low-frequency magnetic fields from the power grid.) Trotz vielfältiger Ansätze und erster Erkenntnisse besteht nach wie vor Forschungsbedarf, da über die Ursachen der Krankheit weiterhin zu wenig bekannt interest. (Despite the different approaches and initial findings, there is still a need for research, as we know too little about the causes of the disease.)
Auf Einladung des BfS tauschen sich vom 14. bis 16. November 2016 in München Kinderärzte, Strahlenschutz-Experten, Epidemiologen, Genetiker und Wissenschaftler weiterer Fachrichtungen über ihre Forschungsergebnisse und den aktuellen Erkenntnisstand ihrer Disziplinen aus. (At the invitation of the BfS, paediatricians, radiation protection experts, epidemiologists, geneticists and scientists from other disciplines will exchange their research results and the current state of knowledge in their respective disciplines in Munich from 14 to 16 November 2016.) Ziel ist es, neue Ansatzpunkte für die Ursachenforschung zu ermitteln und Forschungsstrategien fortzuentwickeln. (The aim is to create new starting points for research into the causes and to further develop research strategies.)
Mit dem Workshop bringt das BfS bereits zum fünften Mal internationale Experten an einen Tisch, die sich mit den Ursachen der Leukämien bei Kindern befassen. (For the fifth time, the BfS workshop brings together international experts who are working on the causes of childhood leukaemia.) Ausgangspunkt für die Initiative des BfS sind zum einen Untersuchungen, die auf einen möglichen Zusammenhang zwischen niederfrequenten Magnetfeldern der Stromversorgung und dem Erkrankungsrisiko für Leukämie bei Kindern hinweisen. (The BfS initiative is based on the one hand on studies that show a possible connection between low-frequency magnetic fields from the power grid and the risk of leukaemia in children.) Zum anderen knüpfen die Diskussionen an die sogenannte KIKK-Studie an: Die Untersuchung aus dem Jahr 2007 zeigte für Kinder unter fünf Jahren, die im Nahbereich eines Kernkraftwerks wohnten, ein signifikant erhöhtes Risiko, an Leukämie zu erkranken. (A 2007 study showed that children under five living near a nuclear power plant had a significantly increased risk of leukaemia.) In beiden Fällen gibt es für die Ursachen der Erkrankungen keine wissenschaftlich

belastbaren Erklärungen. (In both cases, there were no scientifically reliable explanations for the causes of the disease.)"

Epidemiological research in the USA, UK and Switzerland

A number of detailed studies have been made of the hypothesis advanced by the BfS study regarding nuclear power plants. None of them have confirmed a correlation between leukaemia and proximity to a nuclear power plant. This finding is explained in more detail in the following two articles:

- "Childhood Cancer Incidence in Proximity to Nuclear Power Plants in Illinois", November 2012, a publication of the Illinois Department of Public Health, Division of Epidemiologic Studies, Springfield, Illinois, November 2012;
- "Nuclear power plants cleared of leukaemia link", Daniel Cressy, Nature (May, 2011);

"Investigation of cancer clusters should turn to non-radiation causes, say British researchers". Research into leukaemia incidence has also been undertaken in Switzerland. The paper below describes this issue in broad terms:

- "Nuclear power plants and childhood leukaemia: lessons from the past and future directions", Claudia E. Kuehni, Ben D. Spycher, Institute of Social and Preventive Medicine (ISPM), University of Bern, Switzerland; Swiss Med Wkly. 2014;144:w13912

C-14 measurements in the vicinity of Krško NPP

Another of the shortcomings of the BfS study is that it does not acknowledge or address actual measurements of potential contaminants, which present a hypothetical problem. Carbon C-14 was the substance most heavily highlighted in the study.

For a number of years, measurements have been carried out in the vicinity of Krško NPP that show the order of magnitude of concentrations in nature or the changes to the natural concentrations of C-14 from emissions. Very roughly speaking, the increase in the immediate vicinity of the facilities or at the perimeter fence is, on average, higher than the natural values for CO_2 by a factor of two during the period of nuclear refuelling, while dilution in the atmosphere is significantly greater at a distance of more than one kilometre; therefore, there cannot be more significant deviations from naturally occurring C-14 values. We can also model CO_2 emissions into the atmosphere more accurately using the Lagrange "in-cell" model and take C-14 measurements at the ventilation outlets into consideration. More detailed monitoring of C-14 during refuelling was reported in 2008 ("Verification of the dispersion model by airborne carbon C-14", Breznik et al.; INIS-A-RC—900 online inis.iaea.org)

In relation to measurements in the environment, papers and internal reports are regularly published by internationally recognised experts from the Ruđer Bošković Institute in Zagreb. The initial results of two cases available online (inis.iaea.org) are illustrative: 'Activity of ^{14}C in the atmosphere and vegetation in the vicinity of Krško nuclear power plant 2006–2010", Ines Krajcar Bronić, Bogomil Obelić et al.; and "Six years of the systematic monitoring of ^{14}C in the atmosphere and vegetation in the vicinity of Krško nuclear power plant (Krško NPP)".

They report slightly elevated values in plants in the course of sampling after refuelling relative to the reference or normal value of C-14 in carbon, which is up to around 104 pMC ("percent Modern Carbon"). According to the definition, 100 pMC corresponds to 226 Bq/kgC and, in the case of CO_2 in the air, natural activity in the air is 46 mBq/m^3. Only after refuelling were the values in plants at the Krško NPP perimeter around 120 pMC. At a distance of 1 km, the values were 110 pMC. In a year without refuelling, the C-14 values in plants at a distance of 1 km were similar to those at a distance of around 10 km, i.e. 104 pMC.

The calculated doses under the applicable scientific assumptions in the hypothetical case of the consumption of large quantities of these plants are negligible. Even inhaling air throughout the year does not lead to any noteworthy increase in the individual's dose at the Krško NPP perimeter.

Monitoring of unbound and organically bound tritium via atmospheric exposure pathways

The concentration of naturally occurring tritium in rainwater is approximately 1 Bq/l, which causes the natural presence of tritium in food and living organisms via moisture in the air and via water. Tritium is a constituent of water (HTO). The possibility of organically bound tritium (OBT) affecting living organisms has been highlighted in recent years. Measurement methods enable us to trace the presence of tritium in the environment in an extremely precise way. For example, in 2021 the IRB Zagreb laboratory conducted periodic special sampling of apples and corn in the immediate vicinity (the sampling was

commissioned by Krško NPP) and found OBT in both materials. Only at one point in the immediate vicinity of the facility (by the perimeter fence) was the measurement four times higher than the wider surroundings, while at other places the difference was lower.
In that case, the difference in the tritium measurement right by the buildings of the plant was the result of the continuous ventilation of the premises (at a discharge height of around 40 m above the ground). The majority of the ventilation filters release steam. Because the atmospheric releases are diluted, concentration decreases rapidly with distance. The annual reports on the monitoring of the surrounding area contain statistical data on the dispersion coefficients.
Krško NPP determines the dose from the inhalation of H-3 at a distance of 500 m from the reactor on a monthly basis, following continuous sampling and laboratory measurements carried out by the Jožef Stefan Institute in Ljubljana. The annual value of an individual's internal dose at this distance is, together with the impact of other radionuclides (including C-14), no more than 1 or 2 microSv
(conservative ground discharge assumption applied). This is a negligible amount and one that does not increase cancer risk.
In addition to the large number of H-3 measurements performed in the Sava, in boreholes and at drinking water pumping stations, H-3 measurements of precipitation and sediments are also carried out at the following locations:

- Stara Vas, continuous monthly sample, collected every 31 days, 12 measurements a year;
- Brege, continuous monthly sample, collected every 31 days, 12 measurements a year;
- Dobova, continuous monthly sample, collected every 31 days, 12 measurements a year.

If we wish to estimate the impact of OBT on the health of the population, the calculation shows us that its contribution to the dose after the consumption, for example, of several hundred kg of apples is completely negligible. The effective dose or total contribution of all forms of tritium (unbound and organically bound) is 0.05 µSv ($5.0E^{-5}$ mSv) from the consumption of water and food at Brege, and around 0.1 µSv ($1E^{-4}$ mSv) from the consumption of water from the Sava (JSI estimates for 2021).
Tritium does not accumulate or build up in living organisms (see "An updated review on tritium in the environment", Eyrolle Frédérique et al., Institut de Radioprotection et de Sûreté Nucléaire (IRSN), November 2017, Journal of Environmental Radioactivity). Its radiotoxicity remains less significant than that of other naturally occurring or typical artificial radionuclides.
The impact of tritium in the case of heavy water (CANDU) reactors can be much more significant for the population because they produce much more tritium than light water reactors. In the case of future fusion reactors as well, tritium could appear in greater quantities or have an impact on the surrounding area in the event of an accident.

Question 5: There is no specific plan for the permanent disposal of high-level radioactive waste from Krško nuclear power plant – this plan must be supplied. Spent fuel must be transferred as quickly as possible from the spent reactor fuel pool to a safer dry storage location – the timetable presented is too slow.

The ministry explains that under Act Ratifying the Treaty between the Government of the Republic of Slovenia and the Government of the Republic of Croatia on the Regulation of Status and Other Legal Relations Regarding Investment in and the Exploitation and Decommissioning of Krško Nuclear Power Plant (Official Gazette of RS [Mednarodne pogodbe], No. 5/03, hereinafter: Intergovernmental Treaty), the Intergovernmental Commission tasked with monitoring the Treaty and performing other tasks in accordance with the Treaty (hereinafter: Intergovernmental Commission) approved the Third Revision of the Krško NPP Decommissioning Programme and the Programme for the Disposal of Radioactive Waste (RW) and Spent Fuel (SF) from Krško NPP on 14 July 2020. Every five years at least, periodic revisions of the programme are carried out with the aim of updating the reference disposal concept in line with the latest technical solutions and information. Under the third and fourth paragraphs of Article 10 of the Intergovernmental Treaty, the Krško NPP Decommissioning Programme and the Programme for the Disposal of RW and SF from Krško NPP are the two relevant documents that contain an estimate of the funds required to carry out the activities that the programmes deem to be necessary. In

accordance with the provisions of the Intergovernmental Treaty, costs are funded by regular payments into two special funds: “Sklad NEK” in Slovenia and the “Fond za financiranje razgradnje i zbrinjavanja radioaktivnog otpada i istrošenoga nuklearnog goriva NEK” in Croatia. Based on the adopted programmes, the Slovenian government set a new amount of the contribution to be paid into the Krško NPP Fund by GEN energija. Since September 2020, the amount of that contribution has been EUR 0.0048 for every received kWh of electricity generated by Krško NPP. That figure rose to EUR 0.012 on 1 January 2022. Every year, HEP d.o.o. pays EUR 14.25 million into the Croatian Fond NEK in accordance with a Croatian government decree.
Krško NPP is planning to relocate spent fuel elements from wet to dry storage as a risk-reduction measure. As far as planning the relocation timetable is concerned, it will rely on its own experience and the timetables of similar storage facilities. Safety and the use of a highly qualified technical workforce will be key to the process; and while speed of relocation of the spent fuel is important, it does not take precedence over other criteria, particularly the criterion of safety. Krško NPP has adjusted the timetable to optimise the relocation process. It believes that it is not too slow and that it complies with the environmental protection consent granted.
Completion of SF dry storage was planned and carried out at the end of 2022, while the relocation of 592 fuel elements from the spent fuel pool to dry storage will take place in the first half of 2023. When the dates of the envisaged campaigns of relocation to dry storage were being planned, consideration was given to the factors of technical feasibility, radiation and nuclear safety, and cost-effectiveness. The date of the campaigns and the number of fuel elements to be relocated have been acknowledged as optimal.
Krško NPP will continue to review the timetable of the relocation of spent fuel from the spent fuel pool to dry storage, and adjust it as required to minimise the risks associated with spent fuel.

<u>Question 6</u>: Alternative scenarios with realistic data on sustainable energy, such as wind and solar, should be addressed, as should the energy-saving possibilities. The assumptions underlying the EIA Report are out of date. Moreover, nuclear technology is obviously given precedence without adequate attention being given to the advancing climate crisis and its consequences: a fall in water levels and rising temperatures in rivers, which are used to cool nuclear plants, means that production from nuclear plants will have to be reduced with greater frequency.

The ministry adds that the project basis is provided by Slovenia’s 2021 Integrated National Energy and Climate Plan (NECP) and Croatia’s 2020 Integrated National Energy and Climate Plan, which were drawn up and presented to the European Commission in accordance with Regulation (EU) 2018/1999 of 11 December 2018 on the Governance of the Energy Union and Climate Action. All scenarios of future energy use and supply defined in the national energy and climate plans are based on the lifetime extension of Krško NPP in order to enable the energy and climate policy targets to be met. The analyses carried out as the basis for the National Energy and Climate Plans have shown that increasing the use of renewable and non-carbon resources and increasing energy efficiency are not in themselves sufficient to enable the targets to be met if we take the estimated electricity needs and the increased requirements for reducing greenhouse gas emissions into account.
A study titled “Energy, systemic, economic and ecological aspects of the extension of the operational lifetime of Krško NPP”, which was drawn up by Elektroinštitut Milan Vidmar and the Faculty of Electrical Engineering at the University of Zagreb, showed that Krško NPP would be irreplaceable during the period of the proposed lifetime extension. Without Krško NPP, both countries will be reliant on electricity imports, where and if available. EU Member States’ national energy and climate plans show a net energy deficit, meaning that electricity imports will not always be available and that reducing consumption will be the only alternative in crisis situations. This runs contrary to the first dimension of the energy Union: “Energy security, solidarity and trust – diversifying European energy sources and ensuring energy security through solidarity and cooperation between Member States”. Extending Krško NPP operation to 2043 is the starting point on the path to decarbonisation and long-term energy independence. It will not be possible for either country to maintain short-term energy security without Krško NPP. Due to the planned increase in electrification of traffic (use of electric vehicles), heating (use of heat pumps), and

the electrification and phasing out the use of fossil fuels in other sectors, both countries will require an ever-increasing share of stable energy in the form of electricity. According to estimates, the electricity deficit will continue to rise in Slovenia (for several years now, Slovenia has been importing electricity to cover about 20% of its consumption). By 2030, Slovenia will have a deficit of at least 1 TWh/year of electricity if Krško NPP continues to operate, regardless of development of technology, significantly more efficient consumption of electricity and the intensive introduction of new renewable energy sources. The gradual reduction in the use of fossil fuels therefore further highlights the role of nuclear energy, which is a seasonally stable, low-carbon source of energy. Current and projected developments do not show that we are yet at the point where current electricity production capacities can be met entirely by energy from renewables while satisfying the need, today and in the future, for energy supply that is reliable, secure, environmentally sound and cost-effective. The need to work within spatial restrictions and preserve natural and other assets hinders the development of the new renewable energy sources that could otherwise replace Krško NPP in the next 20 years. Based on the analysed scenarios, the energy balance sensitivity analyses and the projected required power, the lifetime extension of Krško NPP is shown to be the most favourable solution from the technical, environmental and economic standpoints. Events in recent months, which have seen a steep rise in fuel and electricity prices, are further confirmation of the urgency of maintaining production at Krško NPP, as it guarantees affordable and sufficient supply of the electricity that industry and commerce so desperately need. If the operational lifetime of Krško NPP is not extended, Slovenia and Croatia will no longer be able to meet the requirements of the strategies and commitments referred to above. Moreover, it will endanger the stability and reliability of operation of the electricity system, which could lead to slower progress towards climate neutrality.

The overheating of the Sava River is prevented by means of a number of measures, including a combined cooling system and the activation of the cooling towers. In 2008 Krško NPP expanded its cooling capacity with the construction of a third block of cooling towers, leading to a total cooling capacity of 627.8 MW. The upgrading of the cooling towers in 2008 increased cooling capacity by 36%, This has reduced the likelihood of situations in which the plant is required to reduce power in response to a possible exceeding of the 3°C level. Section 5.6.1 of the EIA Report gives an estimate of the days in which the need could arise for the plant's power to be reduced. As the likelihood of such events is extremely small, additional measures are not required (Table 123) – indeed, plant power has not had to be reduced on a single occasion since the cooling towers were upgraded in 2008. The cooling towers can disperse 49.5% of the power plant's total waste heat, which means it has large reserve capacity for heat removal. Between 2010 and 2020, the average temperature of the Sava at the point of full mixing rarely exceeded 27°C in one day (four times in July 2015, once in August 2017 and four times in August 2018), but it never exceeded 28°C. The projected trend in the rise of the average temperature in the summer months is between 0.3 and 0.4°C per decade for the area of the Lower Sava ("Estimate of climate change in Slovenia up to the end of the 21st century". Synthesis report – Part One, ARSO, November 2018). In relation to the measurements contained in the study titled "Energy buildings along and on the Sava – Analysis of river temperatures in the Lower Sava in July and August 2019 and the verification of previous studies" (Revision A, IBE, April 2020), the reservoir of the Brežice hydropower plant has an additional cooling effect on the water.

The alternative to lifetime extension is presented in Section 3 of the EIA Report. The Espoo Convention requires an assessment to be made of the possible alternatives to a proposed activity, while the EIA Directive requires reasonable alternatives to be examined. Possible (i.e. reasonable) alternatives must be capable of satisfactorily achieving the objectives of the proposed activity, and must also be feasible in terms of the technical, economic, political and other relevant criteria. It must be realistic to realise the alternatives at the time the decision on the project is taken. Constructing a power plant or plants (including those that use renewables in combination with other sources) to replace production at Krško NPP is currently not a realistic proposition. In addition, the UNECE Good Practice Recommendations on the Application of the Convention to Nuclear Energy-Related Activities, Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention), explain that alternative means of energy production are national issues of the party of origin and are therefore more properly addressed at the political and strategic level, as they are in the Integrated National Energy and Climate Plan.

The conclusions of a study produced by Vienna University of Technology, which sets out the options for the future use of renewables for energy purposes, highlight the natural conditions, such as solar radiation and the presence of wind, in Slovenia and Croatia. Unfortunately, they do not take into account any other equally important factors for the survival of mankind and other species on our planet in the light of climate change.
The new EU Strategy for Biodiversity 2030 requires Member States to redouble their efforts to preserve biodiversity and to protect 30% of their land and sea areas (10% under strict protection conditions) by 2030. The Convention on Biodiversity (CBD), which is the global framework for biodiversity, will have similar coverage requirements after 2020. This means that the network in the EU will have to be expanded over the next decade, by approximately 4% on land and by 19% on sea.
Slovenia and Croatia are, in European terms, two countries with an above-average percentage of land area given over to protected and Natura 2000 areas (and an above-average number of such areas). Slovenia has 2,260 protected areas covering 40.4% of the land surface and 2.48% of the marine surface of the country. Croatia has 1,192 protected areas covering 38.02% of the land surface and 9.28% of the marine surface of the country. For comparison, Austria’s 1,584 protected areas cover 28.06% of the surface of the country, which is close to the average for EU countries (25.9% land and 11.1% sea).

However, the ministry stresses that activities to increase the share of renewables are taking place in Slovenia, regardless of whether the lifetime of Krško NPP is extended.

Slovenia and Austria have agreed to carry out technical consultations and public presentations. Austria has submitted technical observations and questions/recommendations, which the ministry has sent to Krško NPP for clarification. In letter no. ING.DOV-199.22 (document no. 35409-282/2020-2550-72) dated 17 May 2020, Krško NPP drafted responses in the German language.

1 Procedure and alternatives

1.1 Preliminary recommendations

<u>Preliminary Recommendation 1</u>: We recommend that the EIA does not exclude a study of alternative solutions to the lifetime extension of the plant.

The ministry explains that the project framework is provided by Slovenia’s 2021 Integrated National Energy and Climate Plan (NECP) and Croatia’s 2020 Integrated National Energy and Climate Plan, which were drawn up and presented to the European Commission in accordance with Regulation (EU) 2018/1999 of 11 December 2018 on the Governance of the Energy Union and Climate Action. All scenarios of future energy use and supply defined in the national energy and climate plans are based on the lifetime extension of Krško NPP in order to enable the energy and climate policy targets to be met. The analyses carried out as the basis for the National Energy and Climate Plans have shown that increasing the use of renewable and non-carbon resources and increasing energy efficiency are not in themselves sufficient to enable the targets to be met if we take the estimated electricity needs and the increased requirements for reducing greenhouse gas emissions into account.
A study titled “Energy, systemic, economic and ecological aspects of the extension of the operational lifetime of Krško NPP”, which was drawn up by Elektroinštitut Milan Vidmar and the Faculty of Electrical Engineering at the University of Zagreb, showed that Krško NPP would be irreplaceable during the period of the proposed lifetime extension. Without Krško NPP, both countries will be reliant on electricity imports, where and if available. EU Member States’ national energy and climate plans show a net energy deficit, meaning that electricity imports will not always be available and that reducing consumption will be the only alternative in crisis situations. This runs contrary to the first dimension of the energy Union: “Energy security, solidarity and trust – diversifying European energy sources and ensuring energy security through solidarity and cooperation between Member States”. Extending Krško NPP operation to 2043 is the starting point on the path to decarbonisation and long-term energy independence. It will not be possible for either country to maintain short-term energy security without Krško NPP. This becomes even more urgent in terms of future energy use, as electricity is the predominant form of energy in industry, transport and services, and a major source of energy in households. The gradual reduction

in the use of fossil fuels therefore further highlights the role of nuclear energy, which is a seasonally stable, low-carbon source of energy. Current and projected developments do not show that we are yet at the point where current electricity production capacities can be met entirely by energy from renewables while satisfying the need, today and in the future, for energy supply that is reliable, secure, environmentally sound and cost-effective. The need to work within spatial restrictions and preserve natural and other assets hinders the development of the new renewable energy sources that could otherwise replace Krško NPP in the next 20 years. Based on the analysed scenarios, the energy balance sensitivity analyses and the projected required power, the lifetime extension of Krško NPP is shown to be the most favourable solution from the technical, environmental and economic standpoints. Events in recent months, which have seen a steep rise in fuel and electricity prices, are further confirmation of the urgency of maintaining production at Krško NPP, as it guarantees affordable and sufficient supply of the electricity that industry and commerce so desperately need. If the operational lifetime of Krško NPP is not extended, Slovenia and Croatia will no longer be able to meet the requirements of the strategies and commitments referred to above. Moreover, it will endanger the stability and reliability of operation of the electricity system, which could lead to slower progress towards climate neutrality.
The alternative to lifetime extension is presented in Section 3 of the EIA Report. The Espoo Convention requires an assessment to be made of the possible alternatives to a proposed activity, while the EIA Directive requires reasonable alternatives to be examined. Possible (i.e. reasonable) alternatives must be capable of satisfactorily achieving the objectives of the proposed activity, and must also be feasible in terms of the technical, economic, political and other relevant criteria. It must be realistic to realise the alternatives at the time the decision on the project is taken. Constructing a power plant or plants (including those that use renewables in combination with other sources) to replace production at Krško NPP is currently not a realistic proposition. In addition, the UNECE Good Practice Recommendations on the Application of the Convention to Nuclear Energy-Related Activities, Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention), explain that alternative means of energy production are national issues of the party of origin and are therefore more properly addressed at the political and strategic level, as they are in the Integrated National Energy and Climate Plan.

2. Spent fuel and radioactive waste
Questions
Question 1: When will the facility for the temporary dry storage of spent fuel be ready for operation?

The ministry responds by saying that the dry storage is under construction until the end of 2022 and that the first 592 fuel elements will be relocated from the spent fuel pool to dry storage in the first half of 2023.

Question 2: Are there plans to use the KBS-3 method despite the problematic findings regarding copper corrosion? What do you intend to do about the problem of copper corrosion?

After studying Krško NPP's statements, the ministry explains that regarding the Swedish KBS-3 disposal technology, research into and the development of different deep geological disposal concepts will be monitored and the options assessed in the light of scientific progress before any final decision on the disposal concept is taken. A licensed, state-of-the-art solution will be chosen, as was the case with the spent fuel dry storage, for which the tried-and-tested HOLTEC technology was selected.

Question 3: Is Slovenia interested in a regional/multinational repository? If yes, for which types of radioactive waste? What activities are being carried out in connection with this?

The ministry responds by saying that the Resolution on the National Programme for Radioactive Waste and Spent Nuclear Fuel Management 2016-2025 (ReNPRRO16–25, Official Gazette of RS, No. 31/16) also provides for the possibility of reaching an agreement on a multinational or regional repository for spent fuel and high-level radioactive waste. However, the reference scenario involves the construction of Slovenia's own repository in suitably hard rock. Slovenia is a member of the European Repository

Development Organisation, which comprises a group of countries examining models for the development of joint solutions in one or more joint geological repositories in Europe. Low- and intermediate-level radioactive waste (LILW) will be deposited at the LILW repository at Vrbina, Krško.

Question 4: When will a decision be made on whether or not to process spent fuel?

The ministry explains that under the Resolution on the National Programme for Radioactive Waste and Spent Nuclear Fuel Management 2016–2025 (ReNPRRO16-25, Official Gazette of RS, No. 31/16) and the Third Revision of the Programme for the Disposal of Radioactive Waste and Spent Fuel from Krško NPP, Krško NPP is required to analyse the option of treating spent fuel by 2025.

Question 5: To which contractors abroad is low- and intermediate-level radioactive waste sent for conditioning? Do the transport routes pass through Austria?

Based on Krško NPP's comments, the ministry states: All treatment and processing of LILW has, up to now, been carried out in Sweden by the Studsvik company (which has been renamed "Cyclife"). Eight combustible radioactive waste incineration campaigns and two radioactive waste metal melting campaigns have taken place so far. The transport routes pass through Austria by road, in compliance with the rules applying to the transport of radioactive waste and after all the necessary permits required by the rules, European directives, and agreements such as the European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR) have been obtained.

Question 6: What is the situation regarding the permits for and construction of the Vrbina low- and intermediate-level radioactive waste repository?

The ministry explains that the Agency for Radwaste Management (ARAO) obtained an environmental protection consent for the LILW repository at Vrbina in September 2021. ARAO is in the process of re-publishing the invitation to tender for construction of the repository, as the tenders received in the first invitation to tender did not meet the prescribed conditions.

Question 7: When will the Vrbina LILW repository begin operating?

The ministry notes that the date of commencement of operation of the LILW repository is not the subject of this specific procedure. However, it nevertheless explains that the building permit has already been issued and the precise date of commencement of operation has not yet been determined.

Question 8: How will the LILW be temporarily stored if the Vrbina repository is not ready to commence operation in 2023?

The ministry responds by saying that if the Vrbina repository is not ready to commence operation in 2023, the radioactive waste will continue to be stored under close supervision in the dedicated LILW storage facility at Krško NPP. The process of moving measuring equipment (gamma-ray spectroscopy, scales, handling equipment, etc.) and the supercompactor from storage is currently being completed, freeing up additional storage capacity in the existing facility. Studies are being drafted that will also address the options for the processing, treating and conditioning of radioactive waste packages by external contractors abroad, where the final disposal containers would be prepared for direct disposal in a repository or a long-term storage facility in Slovenia and Croatia.

Question 9: What is the situation regarding the Croatian radioactive waste management centre at Čerkezovac?

A project is under way to establish a radioactive waste management centre at Čerkezovac. It comprises the following activities: field research at the site of the centre, zero radioactivity measurements, a safety study and reports, project design documentation, and an EIA for the acquisition of a site and building permit.

Question 10: Are alternatives planned in the event that Croatia is unable to take its share of the radioactive waste as planned, e.g. if the storage facility there is not finished on time?

On the basis of Krško NPP's comments, the ministry responds by saying that Croatia will take its half of the radioactive waste, as per the terms of the Treaty between the Government of the Republic of Slovenia and the Government of the Republic of Croatia on Regulation of the Status and Other Legal Relations Regarding Investment in and the Exploitation and Decommissioning of Krško NPP (Official Gazette of RS, No 23/03), between 2023 and 2025. If the radioactive waste management centre at Čerkezovac is not ready to commence operation in 2023, the radioactive waste will continue to be stored under close supervision in the dedicated LILW storage facility at Krško NPP.

Preliminary recommendations

Preliminary Recommendation 2: In order to reduce the risk associated with the Krško NPP site, spent fuel that has been sufficiently cooled should be relocated as soon as possible to dry storage.

The ministry responds by saying that Krško NPP is planning to relocate spent fuel elements from wet to dry storage as a risk-reduction measure. As far as planning the relocation timetable is concerned, it will rely on its own experience and the timetables of similar storage facilities. Safety and the use of a highly qualified technical workforce will be key to the process; and while speed of relocation of the spent fuel is important, it does not take precedence over other criteria. Krško NPP has adjusted the timetable to make it optimal.
When the dates of the envisaged campaigns of relocation to dry storage were being planned, consideration was given to the factors of technical feasibility, radiation and nuclear safety, and cost-effectiveness. The date of the campaigns and the number of fuel elements to be relocated have been acknowledged as optimal. Krško NPP will continue to review the timetable of the relocation of spent fuel from the spent fuel pool to dry storage, and adjust it as required to minimise the risks associated with spent fuel.

Long-term operation of a reactor of this type

Question 11: What are the current results regarding the appearance of brittleness in the reactor vessel at Krško NPP (reference temperature for nil ductility transition/RTNDT, safety analysis for brittle fracture)?

After studying Krško NPP's statements, the ministry explains that the maximum temperature for nil ductility transition (ARTNDT) is currently 78.3ºC for an operational lifetime of 60 years. This temperature relates to the inside of the reactor vessel and the basic reactor vessel material.
In nuclear power plants regulated by the provisions of 10 CFR 50, resistance to brittle fracture is ensured by the p-T limiting curve and the Charpy test upper-shelf energy of the reactor vessel material. The p-T limiting curve constitutes the temperature and pressure spectrum within which operation is permitted, and is fixed on the basis of the ARTNDT and the maximum neutron flux (n/cm^2) of fast neutrons in accordance with the provisions of 10CFR50 Appendix G. In this sense, it guarantees operation within the pressure-temperature limiting curve of resistance of the reactor vessel to brittle fracture. The pressure-temperature limiting curve is therefore part of Krško NPP's Technical Specifications. Another way of ensuring resistance to brittle fracture is by having material with a sufficient Charpy test upper-shelf energy, which is the energy required to fracture materials using the Charpy test. The minimum value of this energy is set in 10 CFR 50 Appendix G and amounts to 68 J at the end of the operational lifetime. For Krško NPP, the upper-shelf energy is a minimum of 83.8 J for an operational lifetime of 60 years.

Question 12: When will the WENRA Safety Reference Levels 2020 be incorporated fully into Slovenian regulations? When will a check be made as to whether Krško NPP meets the WENRA SRL 2020?

The SNSA is in the process of amending regulations to bring the legislation into line with the recent updates to the key IAEA international standards and the WENRA requirements. These amended regulations will incorporate the WENRA 2020 requirements, be compiled by the end of 2022 and adopted in 2023. Krško NPP's compliance with the WENRA Safety Reference Levels for Existing Reactors 2020 will be checked in the course of the third Periodic Safety Review, which is currently under way. According to the preliminary results of an independent review, Krško NPP does comply with the WENRA Safety Reference Levels for Existing Reactors 2020. If deviations are found, corrective measures will be introduced to eliminate them.

Question 13: Does the Krško NPP AMP already contain requirements regarding technological obsolescence?

Krško NPP has an established process for proactively monitoring technological obsolescence. Obsolescence is monitored using a special tool that monitors the deliverability of parts from all manufacturers. If obsolescent equipment is identified, activities are in place that enable us to renew components, replace them with similar components, make additional enquiries regarding stock levels at other plants, or replace the whole system via a modification system. The process of monitoring obsolescence is described in the Krško NPP Technological Obsolescence Programme, which is a constituent part of the Krško NPP Long-Term Operation Programme.
The purpose of the programme and the procedure is to define the (proactive) implementation and monitoring of processes with the aim of adequately identifying whether equipment important for the safety and smooth operation of the plant is obsolescent and of drawing up a list of priorities. If obsolescence is identified, the method of resolving it by means of short- or long-term campaigns is determined, an action plan is drawn up, the approved solution is carried out and the process is completed with the updating of the information in the Krško NPP database for the maintenance of configuration controls (eBS) and the proactive obsolescence management system (POMS). All equipment susceptible to aging is placed on the master equipment component list (MECL). This list of equipment with the necessary attributes is periodically exported into POMS. The POMS application is then used to check the availability of parts, and reports are generated on problems relating to equipment obsolescence. Data is exported from the MECL and imported into POMS on a routine basis. The process of identifying obsolescence enables us to recognise and resolve problems with equipment before it needs to be installed and before it fails (proactive approach).

Question 14: How far advanced is the implementation of the Topical Peer Review national action plan for aging management? Has the Aging Management Programme already been harmonised with or adjusted (if required) to the requirements of the IAEA SSG 48 safety standard?

The ministry explains that the status of the implementation of the action plan is precisely described in the SNSA report titled "ENSREG First Topical Peer Review Updated National Action Plan on the Krško NPP Ageing Management Programme" (May 2021). The Slovenian Nuclear Safety Administration (SNSA) is monitoring the implementation of the TPR action plan.
Krško NPP's AMP has been drawn up in accordance with the American 10 CFR 54 regulation. As part of its five-year periodic review of the AMP, Krško NPP has updated the programmes, coordinated all GALL programmes, made further IGALL reviews, and updated the existing AMPs where required.
The Krško NPP AMP was thoroughly reviewed with reference to IAEA SSG 48 (Ageing Management and Development of a Programme for the Long-Term Operation of Nuclear Power Plants) during the pre-SALTO mission to Krško NPP. The action plan for this review has been approved and is being implemented.
The Krško NPP AMP is also being reviewed as part of the Periodic Safety Review conducted in

accordance with IAEA SSG 25. The review is under way and is not expected to produce recommendations of significant importance to the plant's nuclear safety.

Question 15: Have checks already been made of the functionality of cables under loads that exceed the design loads (DEC-B), as envisaged in the national aging management action plan? Were measures required? If so, have they already been carried out?

The ministry responds by saying that the functionality of cables under design-extension conditions (DEC-B conditions) has been checked within the scope of the qualifications to environmental conditions (qualification programme). The cables, which must be operable during or after a DEC-B accident, are qualified to the relevant local conditions. The qualification testing of equipment (which includes cables) includes a simulation of equipment aging. Systems (equipment) that are required to work under DEC-B conditions have recently been installed or modified as part of a safety upgrade. As a result, the DEC-B-classified cables are also new.
In addition to the verification of cable qualifications, cable aging is continuously monitored by means of checks on the condition of cable insulation, thereby confirming the remaining service life of the cables. The qualification programme and the AMP for cables require the implementation of corrective actions if any deviations are detected.
All the measures listed ensure the functionality of DEC-B-classified cables until the end of their qualified service life, including during a DEC-B accident.

Question 16: Are the results of the third Periodic Safety Review (PSR3) already available in full or in part? If so, what are the results of the review?

The ministry responds by saying that the results of PSR3 are not yet available. This is because the review is currently under way and will be completed in 2023 when the plan of measures is approved by the SNSA. This means that a global safety assessment will be performed that evaluates, using expert methods, all the positive and negative findings and their overall effect on safety. The global safety assessment will be performed with reference to Slovenian nuclear legislation and IAEA SSG-25. The SNSA is assessing and reviewing the reports on the review of individual safety factors, the global assessment and the plan of measures, and will give recommendations that must be implemented. The plan of measures must contain a detailed description of all measures and the deadlines for each measure separately. Under Slovenian legislation, any deviations established during a PSR must be eliminated at the earliest opportunity, with due regard to their significance for nuclear safety. Deviations that could threaten the nuclear safety of the facility must be eliminated without delay. The preliminary results, which are currently being assessed by the SNSA, show that there are no major safety-related deviations or findings that would require immediate action. The deviations that have been found relate mainly to improvements to procedures and programmes and do not directly concern nuclear safety. A successful PSR is a precondition for extending operation of the plant for a further ten years.
Under the terms of the bilateral agreement between Slovenia and Austria, details of the status of PSR3 will be presented at the regular annual meetings at which information relating to nuclear and radiation safety is shared.

Question 17: Are the results of the second Topical Peer Review under Article 8e of Directive 2014/87/Euratom on fire safety at Krško NPP already available?

The national report is not yet available; this is because Topical Peer Review II (TPR II) is still being drafted. Interested parties (including the general public) may submit observations on the draft documents concerning the TPR II procedure (https://https://www.ensreg.eu/tpr-2-public-engagement). Following a public consultation process, the revised final versions of the draft documents will be submitted to the European Nuclear Safety Regulators Group (ENSREG) for approval in June 2022. This will be followed by the next phase of the TPR II process, i.e. the production of national reports, in 2022–2023. As with the first TPR, an action plan, to be sent to ENSREG, will be compiled after completion of the comparative review and the creation of generic and specific findings. The action plan will define the scope and time frame of implementation of the necessary improvements and actions that have been identified during the TPR process. As with the first review, all the findings of the TPR will be taken into account. Reporting to ENSREG on the status of the implementation of actions from the TPR action plan will take place in accordance with the deadlines set.

Question 18: Can you outline the recommendations and proposals of the pre-SALTO mission of October 2021 and how they have been implemented?

The ministry responds by saying that, according to Krško NPP, the purpose of international missions is for external assessors to suggest improvements to processes. These proposals are in the forms of "recommendations" or "suggestions". The plant then produces an action plan to implement the recommendations. Every mission proposes improvements because the drive for excellence is a continuous process. Work on implementing the improvements suggested by the pre-SALTO mission is under way, under the supervision of the SNSA, which is also the entity responsible for granting Krško NPP's operating licence.

On the basis of the results of the pre-SALTO inspection, Krško NPP has compiled an action plan that takes all of the recommendations and suggestions into account. The action plan defines a precise plan of implementation, with entities and deadlines, for each recommendation and suggestion. The action plan is drafted in line with the areas of review set out by the IAEA:

- Area A (Organization of Ageing Management and LTO Activities)
- Area B (Scope Setting, Plant Programmes and Corrective Action Programme)
- Area C (Ageing Management of Mechanical SSCs)
- Area D (Ageing Management of Electrical and I&C SSCs)
- Area E (Ageing Management of Civil SSCs)
- Area F (Human Resources, Competence and Knowledge Management for LTO)

The action plan in question is also incorporated into the action plan for PSR3, which will confirm implementation.

Most of the actions relate to minor adjustments/additions to Krško NPP programmes and procedures, with supplements and improvements to aging and qualification programmes, as well as recommendations for improvements in human resource management and the management of competencies and knowledge.

A SALTO mission will review implementation of the pre-SALTO action plan and PSR3 at Krško NPP in 2024 and 2025, and produce new findings on the plant's operation.

All pre-SALTO findings and the action plan derived from these findings are entered in PSR3 Safety Factor 4 (Aging). This is part of the PSR3 procedure and the regulator's review as required by nuclear legislation.

Question 19: What manual procedures are required to start up the systems in the BB2 building and how much time is required for these procedures?

The ministry responds by saying that newly built systems can be started manually from the main control room as required by establishing island power from the MD#3 busbar (DG#3 start-up), starting the pumps and establishing flow paths in a period of time estimated to be less than five minutes.

Question 20: On what bases (processes, assumptions) was the need for or quantity of water in the BB2 building estimated and what processes did this involve? For how long can emergency core-cooling be provided? How is the water tank refilled? How much water per hour is needed to cool the reactor core when the primary circuit is running?

The design-extension conditions (DEC) assume that coolant is not available from the refuelling water storage tank (RWST) and the two condensate storage tanks (CST).

In the event of a loss of coolant accident (LOCA), the quantity of coolant in the alternative safety injection

(ASI) tank ensures that there is a sufficient level in the containment sump after the injection phase is completed. This enables the long-term removal of residual heat with the alternative residual heat removal (ARHR) system in the recirculation mode. At a conservative estimate, the ASI tank has an additional coolant reserve of around 30%. The ASI tank can be filled from an underground well with a capacity of approximately 30 m^3/h. The boration of the additional coolant is guaranteed.
The quantity of water in the alternative auxiliary feedwater (AAF) system tank ensures that the plant is cooled through the secondary circuit over a period of approximately three days (80 hours). The AAF tank can be filled from an underground well with a capacity of approximately 30 m^3/h. This ensures the long-term removal of residual heat.

Question 21: What steps are taken to ensure that functions can be performed as required when new systems are connected to existing systems? Is there a conservative estimate for all these structures, systems and components (SSCs) affected by this connection whereby they are assumed to be able to bear loads equivalent to a seismic load of PGA = 0.56 g? Does this analysis accord with the WENRA (2020c) guidance?

New systems are connected to existing systems so that the full functionality of at least one line of redundant engineered safety features is ensured at any given moment. Seismic vulnerability analyses have been performed for all existing SSCs to which new systems are connected. These analyses have shown that the systems can withstand a seismic load at the PGA value referred to above (0.56 g) with a high level of conservativism. The HCLPF capacity is determined in accordance with the WENRA guidance.
The PGA value of 0.56 g is a median PGA value with a recurrence interval of 10,000 years (PSHA, 2004). The stress tests carried out in 2011 showed that, on account of the safety factors taken into consideration during the project design process, Krško NPP could operate safely and maintain long-term cooling operations in the event of an earthquake with a PGA greater than 0.56 g at surface.
Analyses of Krško NPP's seismic safety and seismic response are repeated and will continue to be repeated and upgraded periodically throughout the entire operational lifetime of the plant in accordance with Slovenian law and international guidelines and standards in the field. These analyses are the basis for the ongoing verification, assurance and proof of the high degree of seismic and nuclear safety of the original Krško NPP design.

Question 22: Have the analyses of the presence of hydrogen in unexpected places been completed? What is the result? Are follow-up measures planned? If yes, what is the timeline for their implementation?

The ministry responds by saying that the analyses of the presence of hydrogen have been completed and form the basis of the Safety Upgrade Programme (SUP). All the necessary modifications have been made in response to the safety upgrade: the installation of passive autocatalytic hydrogen recombiners in the containment (PARs), alternative cooling of the spent fuel pool (a new spray system, a pool-cooling system with a mobile heat exchanger and a pressure relief damper in the spent fuel handling building). The analyses performed and the explosion risk report all show that no additional measures other than those mentioned above are required.

Question 23: What is the maximum amount of time that the filter system for removing air from the containment can operate while still maintaining its function?

Following the technical clarifications provided by Krško NPP, the ministry explains that the design of the passive containment filtered venting system (PCFVS) incorporates the maximum possible mass of fission products, i.e. it ensures long-term filtration.
The PCFVS has been conservatively designed in accordance with functional requirements that determine the size of the aerosol and iodine filters and the required quantity of adsorption material. The required design parameters are: volumetric flow rate, decay heat, aerosol mass and containment

efficiency. The system will not lose functionality over time as the integral mass of the aerosol/iodine is constant and the filter containment has been designed on the basis of the maximum mass flow rate and the maximum mass of fission products. Therefore, if the system is required to operate over a longer period, the total mass of the fission products will not only not change, but will also decay. There is no limit to the number of opening cycles. Based on the accident analysed, the PCFVS should operate for seven days and even up to 30 days, depending on the measures to mitigate the effects of the accident.

Question 24: According to the SNSA (2020), the newly installed spray system around the spent fuel pool can also remove residual spent fuel heat in the event of a larger release from the pool.
What is the maximum amount of release that can successfully replace the loss of water?

The ministry responds by saying that the newly installed spray system enables the fuel elements in the spent fuel pool to be cooled even if it is completely empty (i.e. without water). The system has been designed so that the spraying covers all the fuel elements inserted in the spent fuel pool, thereby ensuring that the residual heat is removed adequately. The configuration of this system is also completely independent of the other active systems at Krško NPP.

Question 25: How many people are there in the operating crew and how much time is required to connect the mobile heat exchanger to the spent fuel pool (SFP), the containment sump or the reactor cooling system?

The ministry responds by saying that three (3) people are required to connect the mobile exchanger for the cooling of the SFP; they are able to prepare the system for operation within three hours. Three (3) people are required to set up the fixed exchanger for the cooling of the containment sump or the primary circuit; they are able to prepare the system for operation within one hour.

Question 26: How many people are there in the operating crew and how much time is required to connect the mobile DG?

The ministry responds by saying that one (1) person is required to set up the 2 MW mobile diesel generator. They can prepare the system for operation within 30 minutes.

Question 27: What is the national strategy for handling large quantities of contaminated water after and during a major accident?

The ministry responds by saying that in the event of an emergency, Krško NPP controls the collection, containment, recirculation and cooling of contaminated water. This is enabled by the design systems of the plant, as well as the upgrade systems using procedures that are validated through a training programme and tested in training and exercises (actual use of equipment). Large quantities of contaminated water are not expected. All water will be collected in the containment and, over time, in the auxiliary building.
Precisely because of the above, the national plan has no explicit obligations; rather, there are several chapters on long-term provision and assistance (special civil protection, army, firefighting, etc. vehicles).

Question 28: To what extent have international documents (IAEA, WENRA) been used in a binding manner in relation to the lifetime extension?

Slovenian legislation is binding for the extension of Krško NPP's operational lifetime. IAEA safety standards and WENRA reference safety levels, which have been implemented in Slovenian legislation, are binding. An assessment of compliance with the applicable international safety standards and requirements is performed during Periodic Safety Reviews.

Question 29: Has a systematic assessment been made of Krško NPP project deviations from the applicable international safety standards and requirements?

The ministry responds by saying that Krško NPP carries out a periodic review of international requirements and of its compliance with these requirements. The SNSA is responsible for ensuring that compliance. The findings and reviews are documented in the relevant documents and sent to the SNSA. In addition, as a tool that complements the continuous safety verification process, a Periodic Safety Review is performed every ten years in accordance with Slovenian law and IAEA SSG-25. A systematic review of the Krško NPP project is part of the PSR and is carried out for the purpose of confirming, within the assessment process, the adequacy of the facility and its documentation in relation to the current basis of the operating permit and the Slovenian and international standards, requirements and practices. The third PSR is currently being prepared and will be completed in 2023.

Question 30: Which technically possible improvements aimed at the fulfilment of modern safety requirements have not been regarded, within the framework of the lifetime extension, as “reasonably practicable” for Krško NPP?

The ministry responds by saying that the Krško NPP Safety Upgrade Programme was defined on the basis of the defence-in-depth principle and the effectiveness and importance of improvements in reducing the overall core damage frequency and the frequency of release categories. The initial Safety Upgrade Programme was revised and the following improvements amended, as the following initial solutions were not regarded as “reasonably practicable”:

- The injection of cooling liquids into the primary pump seals is replaced by the installation of high-temperature primary pump seals.
- In place of an alternative heat sink, 30-day cooling of the reactor using steam generators is ensured (injection of cooling liquids from the additional tank, which can be filled from underground wells).
- In addition to the planned alternative pumps for the long-term removal of residual heat, an accompanying heat exchanger has been installed (the original plan was to use a mobile heat exchanger).

The revised Safety Upgrade Programme has been approved by the SNSA.
Deterministic and probabilistic analyses were used to determine the most effective upgrades for improving nuclear safety. Tried-and-tested solutions were used because we did not want to install untested variants.
High-temperature seals have a high degree of reliability in comparison with the alternative solution of injection into the primary pump seals.
The alternative UHS system was not acceptable from the point of view of seismic risk. The more acceptable variant therefore involved the construction of a seismically designed reinforced building with two separate seismically stable tanks for primary and secondary injection.
The solutions implemented have also provided the highest level of protection against seismic events, and enabled the plant to enjoy a level of safety comparable with that of new nuclear power plants.

Preliminary recommendations
Preliminary Recommendation 3: We recommend that all the technically available safety improvements for preventing accidents be carried out.

The ministry responds by saying that Krško NPP has carried out a thorough analysis of beyond-design-basis accidents and drafted a Safety Upgrade Programme based on the national action plan within the framework of the EU stress tests. The SUP includes a large number of improvements and additional systems for managing beyond-design-basis accidents. The essential upgrades were carried out in the areas of seismic safety, flood protection, mitigation of the effects of fire, and the provision of additional sources of supply in emergency situations or when external AC power is lost, etc. (EIA Report, Section 2.8).

Preliminary Recommendation 4: We recommend that all the requirements of the WENRA Safety

Reference Levels 2020 be met in the course of the third Periodic Safety Review (PSR3). The reasons for any deviations should be explained.

The ministry responds by saying that Krško NPP's compliance with the WENRA Safety Reference Levels for Existing Reactors 2020 will be checked in the course of PSR3, which is currently under way. According to the preliminary results of an independent review, Krško NPP does comply with the WENRA Safety Reference Levels for Existing Reactors 2020.

Preliminary Recommendation 5: We recommend that the following additional information be provided:
c) detailed descriptions of engineered safety features, including information on the requirements applying to safety-related systems and components and, in addition to this, a detailed description of the measures adopted to control severe accidents and mitigate their consequences;
d) a clearly comprehensible presentation and overall assessment of all deviations from the current acknowledged state of the art. This presentation should cover:
• all deviations from current requirements regarding redundancy, diversity and the independence of safety levels;
• the incomplete nature of the database and the systems documentation used;
• all safety technical assessments or all determinations of parameters made using "engineering judgement";
• deviations from the state of the art regarding the analytical methods used, the technical assessments and the calculation methods;
• the available safety margins for individual safety-related components (particularly for the reactor pressure vessels) and changes to their original status brought about by aging.

The ministry responds by saying that the additional information requested goes beyond the scope of the EIA. This data is included in the Krško NPP Safety Analysis Report and other documentation, which is regularly reviewed and approved by the SNSA. The results have been included in the EIA, to which the SNSA contributes its opinions. The required information also includes sensitive data that cannot be disclosed.

Analysis of accidents (DBA and BDBA)

Question 31: What are the leakages of radioactive material (source terms) in beyond-design-basis accidents for release categories RC6, RC7A, RC7B, RC8A and RC8B calculated at the PSA 2 level? What probabilities have been established in relation to this?

The ministry notes that the required frequencies of all release categories were calculated under NUREG-1935 and IAEA EPR-NPP (Actions to Protect the Public in an Emergency Due to Severe Conditions at a Light Water Reactor IAEA, 2013) in relation to all internal and external initiators referred to in the PSA Level 2 analysis.
The representative severe accident scenario used to assess the impacts on the environment for calculating the radiological impact on the environment has been drawn up independently of the Krško NPP PSA calculation by independent external certified organisations, although they do take the Krško NPP PSA calculation into account. The initiator of the representative scenario is the loss of all AC power (SBO) with leakage from the reactor coolant system (RCS) and without mitigation in the first 24 hours. Account is taken of design-basis leakage from the containment into the environment and release through the PCFVS after passive activation. Mitigation of the accident is assumed after 24 hours with the use of qualified DEC engineered safety features.
Krško NPP has implemented a Safety Upgrade Programme, which meets the requirements of WENRA SRL (2014 and 2020) and IAEA – SSR 2/1, Rev. 1. This SUP has practically eliminated all large releases, the installation of PCFVS and PAR has provided additional protection of the containment pressure barrier, and the installation of DEC-A systems (ASI, AAF, ARHR) has reduced the sequences that bypass the containment barriers.

RC6 represents the early failure of the containment and has a frequency of 4.89 E^{-9}/year. RC7A represents the failure of the isolation of the containment without molten core concrete interaction (MCCI) and has a frequency of 7.02E^{-10}/year. RC7B represents failure of the containment with MCCI and has a frequency of 8.60E^{-10}/year. RC8A represents the purified bypass of the containment and has a frequency of 1.0E^{-7}/year. RC8B represents the unpurified bypass of the containment and has a frequency of 2.93E^{-8}/year.

In addition to the above, and in accordance with GL NRC No 88-20, Appendix 2, sequences that cause a bypass of the containment with a frequency of 1E^{-7}/year, or account for fewer than 5% of all releases, are not subject to the calculation of radiological consequences. The calculation therefore does not take radiological impacts on the environment into account.

A representative accident is used that represents the envelope of radiological releases for all other release categories:

- RC2 (without damage to the containment), with a frequency of 3.4E^{-6}/year, concerns design leakage from the containment. The radiological source within the containment is equal to or lower than the representative accident and the releases from the containment are smaller.
- RC4 (penetration of the concrete foundation), with a frequency of 6.79E^{-7}/year, does not involve direct release into the atmosphere.
- RCV3A, RCV3B and RCV5A, with frequencies of 1.03E^{-7}, 1.72E^{-6}, and 2.52E^{-6}/year, respectively, are filtered releases from the containment with releases from the containment that are lower than or equal to the representative accident.

Taking all of the above into account, the representative accident constitutes the envelope of radiological releases for every event involving release from the plant caused by internal or external initiators, with a release category frequency of 1E^{-6}/year or more. The frequencies of the release categories have been calculated in accordance with NUREG-1935 and IAEA EPR-NPP, as required for the planning of measures in the environment.

The time-dependent radiological sources (source terms) used at Krško NPP PSA Level 2 and in the analysis of radiological impact on the environment are copyright-protected and cannot be distributed.

The results of the Krško NPP PSA are published in the Update of the Slovenian Post-Fukushima Action Plan (December 2021). That report is available.

Question 32: What are the technical justifications for the beyond-design-basis accident selected for the calculation of the possible transboundary impacts? Is this accident regarded as also covering an aircraft crash?

The ministry responds by saying that the representative accident in the EIA Report was selected on the basis of the Krško NPP Safety Analysis Report, probabilistic safety assessments, and internationally recognised nuclear safety standards, in line with industrial and regulatory practice. An explanation of the selection of the representative accident is given in Section 6.4 of the EIA Report. The selected BDBA, which has a very conservative (almost impossible) scenario, covers all other accidents with regard to transboundary impacts. An explanation is also given in the response to Question 31. The loss of integrity of the double containment cannot be expected as a result of an aircraft crash, as shown in the analysis of the impacts of an aircraft accident on Krško NPP and in generic analyses for the same type of containment conducted by the US NRC as part of preparation of the B.5.b requirements. In all other aspects, the selected representative accident also covers an aircraft accident.

Krško NPP has compiled an analysis of the impact of an aircraft accident on the plant, as well as an action plan, and carried out a variety of safety improvements on the basis of the NEI 06-12 B.5.b Phase 2 & 3 Submittal Guideline requirements (Rev. 2) or the US NRC B.5.b requirement, which was published in 2002 (following the WTC attack in the USA on 11 September 2001 and as part of moves to prepare nuclear power plants for such an event). The ENSREG stress tests/extraordinary safety review showed that Krško NPP was well-designed and constructed and that, with the additional severe accident management equipment available at the site, was well-prepared for such events. Krško NPP has redundant engineered safety features that are physically separate from each other. As part of the Safety Upgrade Programme, Krško NPP has installed additional engineered safety features within two bunkered (reinforced safety) buildings that are physically separate and at a suitable distance from the main island of the power plant, which is where the reactor is located in a double-shell containment area. This ensures that the plant's operation can be safely halted in the event of a large commercial airliner crashing into it. Owing to the sensitive nature of physical security at Krško NPP, the safety analyses and information on protection against an aircraft accident are classified.

<u>Question 33</u>: How would the meltdown of the foundations be prevented in the event of an accident involving core meltdown? What is the calculated probability for this course of events (RC4)?

The ministry gives the following clarification: Prevention of the meltdown of the foundations of the Krško NPP containment is ensured by means of a "wet cavity" design. Cooling water is led into the space below the reactor, which prevents molten core concrete interaction (MCCI). Several new plants designed without "core catchers" (e.g. the Westinghouse AP1000 or the Korean APR1400) also have the same design. The design guidelines for such plants, such as the APR1400, require the concrete between the reactor cavity and the steel membrane (containment liner) to be at least 3 ft (0.914 m). At Krško NPP, the thickness of the concrete, measured vertically below the reactor vessel, is 7.46 m.
As part of the Safety Upgrade Programme, an additional line was constructed to flood the containment and the space below the reactor. Timely flooding of the reactor cavity prevents the reactor vessel from rupturing ("in-vessel retention" strategy – external cooling of the melted core within the vessel), or MCCI in the event that the reactor vessel does rupture and molten core leaks into the cavity.
With the initial cooling/debris quench, which is most likely ensured by the design of the cavity and the modification carried out as part of the SUP, the key function for preventing the foundation from melting in the long term is to ensure the presence of water in the cavity from external sources (i.e. preventing the cavity from subsequently drying out). This is ensured, in addition to systems from the original design – the residual heat removal (RHR) system, safety injection (SI) and the containment spray system (CSS) – by numerous additional options installed as part of the SUP; these include the alternative residual heat removal system (ARHR), alternative safety injection (ASI), with own tank, various combinations of pumps/flow routes (CSS with RHR and ARHR), and the options provided by the use of mobile equipment in accordance with the Severe Accident Management Guidelines (SAMG).
On the basis of the above, the probability of MCCI that could cause meltdown of the foundation (release category RC4) is calculated at $6.79E^{-07}$/year. Meltdown could occur within approximately 15 days.
Krško NPP has been using the SAMG for a number of years (these envisage the complete flooding of the containment in such cases) and has, since the SUP was completed, had the additional water sources referred to in a separate bunkered building. The likelihood of the foundation of the containment melting down is therefore substantially lower – in fact, it is extremely low.
Krško NPP has a "large dry containment", i.e. a large empty space, which also makes a steam explosion very unlikely (probability estimated at 1^{E-9}/year), and any accompanying shock wave (leakage of molten core into the water below the reactor vessel) would not be able to jeopardise the integrity of the containment. These conclusions are derived from generic analyses conducted in the USA for this type of containment and from analyses specific to Krško NPP.

<u>Question 34</u>: Did the EIA procedure involve an analysis of the crash of a representative commercial passenger airliner and representative military aircraft?

The ministry finds that Krško NPP has compiled an analysis of the impact of an aircraft accident on the plant (representative commercial passenger airliner and representative military aircraft), as well as an action plan, and carried out a variety of safety improvements on the basis of the NEI 06-12 B.5.b Phase 2 & 3 Submittal Guideline requirements (Rev. 2) or the US NRC B.5.b requirement, which was published in 2002 (following the WTC attack in the USA on 11 September 2001 and as part of moves to prepare nuclear power plants for such an event).
The ENSREG stress tests/extraordinary safety review showed that Krško NPP was well-designed and constructed and that, with the additional severe accident management equipment available at the site, was well-prepared for such events. Krško NPP has redundant engineered safety features that are

physically separate from each other. As part of the Safety Upgrade Programme, Krško NPP has installed additional engineered safety features within two bunkered (reinforced safety) buildings that are physically separate and at a suitable distance from the main island of the power plant, which is where the reactor is located in a double-shell containment area. This ensures that the plant's operation can be safely halted in the event of a large commercial airliner crashing into it. Owing to the sensitive nature of physical security at Krško NPP, the safety analyses and information on protection against an aircraft accident are classified.
Krško NPP was not originally designed with an aircraft crash in mind. This shortcoming was detected in the wider nuclear power plant community, and subsequent studies and experiments were carried out in the USA that confirmed the adequacy of the plant's design.
Krško NPP is equipped with a double-shell containment. It comprises an external iron-concrete protective structure and a separate, withdrawn internal steel pressure vessel. The reinforced concrete shell is 76 cm thick. The space between the concrete shell and the steel pressure vessel measures 163 cm. The walls of the steel pressure vessel are 38 mm thick.
Generic studies, mainly in the USA, have looked at the effects of the impact of F4 and F15 military aircraft on various thicknesses of concrete, on various equipment arrays and at various speeds. F4 speeds of between 150 and 250 m/s were analysed and tested on concrete up to 160 cm thick. The tests found that the depth of the concrete crater at a speed of 215 m/s was approximately 21 cm. Different methods were used to calculate the force and weight distribution during such a collision.
Analytical research into an F15 aircraft strike was based on mathematical finite element models. It covered speeds of between 112 and 190 m/s. Using the finite elements method, the plastic deformation of the wall and the local area of penetration were established. It was concluded that further research using numerical methods was needed. We can conclude that the impact of a military aircraft would lead to the concrete structure being scattered into the space between the shell and the pressure vessel. The internal steel shell, which is 38 mm thick and is 163 cm away from the iron-concrete cladding, would provide effective protection against concrete projectiles from inside the reinforced concrete shell.
Studies have also been conducted of the impact of a Boeing 767-400 aircraft containing 23,980 gallons of fuel and travelling at a speed of 350 miles an hour. The findings show that nuclear power plants are robust enough and that they protect nuclear fuel against the impacts of such types of aircraft.
Krško NPP carried out a study of the risk of an aircraft accident even before the safety upgrade of the plant. It considered the destruction of equipment resulting from aircraft impact and from the fire that would occur upon the leakage of fuel from the aircraft. The aircraft considered in the study were: large commercial airliners, general aviation aircraft (Pilatus PC-9xx, L-410) and various types of military aircraft (C-130, C-5, F-18). It was determined that the risk of damage to the core was approximately $2E^{-07}$/year. Since the safety upgrade, which took account of the instructions from B.5.b, all new systems have been housed in separate, withdrawn, reinforced buildings, which has reduced the risk of damage to the core from an aircraft still further.
An analysis for F4 and Boeing 747-400ER aircraft was performed for the dry storage. The guide quantities of fuel for the F4 were 1,994 US gallons (1,660 imperial gallons, i.e. 7,550 l) in the internal tank and 3,335 US gallons (2,777 imperial gallons, 12,620 l) and 2 x 370 US gallons (310 imperial gallons, i.e. 1,400 l) in the external tank on the wings. Boeing's specifications give the nominal value of the fuel quantity as up to 63,705 US gallons (241,150 l) of kerosine. The analysed speeds were 215 m/s for the F4 and 100 m/s for the Boeing 747-400ER, in accordance with the available data given in the generic documents of the analyses. It was confirmed that the impact of such an aircraft did not cause the radioactive release of stored spent fuel from containers into the environment.

Question 35: Was a DEC-B analysis carried out to determine the reasonably practicable measures for mitigating the consequences of significant damage to fuel or the conditions that could cause early or large radioactive releases, if such damage or conditions have not been defined with a high degree of reliability as extremely unlikely?

Yes, the deterministic and probabilistic analyses documented in the NEK ESD-TR-09/11 technical document "NPP KRŠKO Analyses of Potential Safety Improvements" have been carried out. As a reasonably practicable measure for mitigating the consequences of significant damage to fuel or preventing large releases, a proposal was made to install a passive containment filtered venting system (PCFVS) and passive autocatalytic recombiners (PAR). The other consequences are defined as extremely unlikely.

Question 36: Have target values for probability been defined in the Slovenian regulations for design-basis accidents (DBA), and beyond-design-basis accidents (DEC) without significant damage to the core (DEC-A) and with core meltdown (DEC-B)?
What are the relevant values for Krško NPP?

The ministry explains that the requirement applying to Krško NPP is that the total probability for core meltdown during operation at power is less than 10^{-4}/year and the probability of a large uncontrolled release of radioactive material from the power plant during operation at power is less than 5×10^{-6}/year.

Question 37: Have internal events already been addressed as part of current safety analyses in accordance with WENRA RL SV?

The ministry responds by saying that Krško NPP has conducted a review of internal hazards that shows that all internal hazards have been adequately considered in Krško NPP analyses and procedures. Krško NPP's compliance with the WENRA Safety Reference Levels for Existing Reactors 2020 will be checked in the course of the third Periodic Safety Review, which is currently under way. According to the preliminary results of an independent review, Krško NPP does comply with the WENRA Safety Reference Levels for Existing Reactors 2020, including internal events (Issue SV).

Preliminary recommendations
Preliminary Recommendation 6: We recommend that the WENRA Safety Objectives for New Nuclear Power Plants be used to define the reasonably practicable safety improvements at Krško NPP. Even if the probability of an accident scenario is very low, all additional, reasonably practicable safety improvements must be performed to minimise the risk. We recommend that the concept of practical exclusion be applied to accidents with early or large releases.

The ministry explains that Krško NPP has already carried out a thorough analysis of beyond-design-basis accidents and drafted a Safety Upgrade Programme based on the national action plan within the framework of the EU stress tests. The SUP covers a large number of improvements and additional systems for managing beyond-design-basis accidents. The essential upgrades were carried out in the areas of seismic safety, flood protection, mitigation of the effects of fire, and the provision of additional sources of supply in emergency situations or when external AC power is lost, etc. (EIA Report, Section 2.8).

Preliminary Recommendation 7: We recommend that the following information be secured on accident analyses and the results of PSA 2 so as to provide a persuasive assessment of the potential threats to Austria:
- the large early release frequency (LERF);
- the share of accidents that involve core meltdown causing failure of containment;
- a list of beyond-design-basis accidents (BDBA) and the radioactive releases associated with them (source terms).

The ministry responds by saying that Section 6.4 (Transboundary impacts in the event of an emergency/accident) contains the expected radiological consequences for Austria in the event of an accident, and the methodology that led to this result.
This information is included in the Krško NPP Safety Analysis Report and the other documentation regularly reviewed and approved by the SNSA.

Accidents caused by external events

Question 38: Have combinations of hazards been accounted for and assessed during safety reviews for the location in question?

Krško NPP has taken into account and assessed all combinations of hazards as set out in the WENRA RHWG Guidance Document Issue T: Natural Hazards – Head Document, and in accordance with the explanations given in the WENRA Guidance Document Issue T: Natural Hazards (21 April 2015), which were presented as lessons learned from the TEPCO Fukushima Dai-Ichi accident.
The combinations of external events addressed in the most recent Periodic Safety Review are: earthquake and fire, earthquake and external flooding, earthquake and extreme drought, and extreme combinations of long-lasting external events.
Krško NPP's compliance with the WENRA Safety Reference Levels for Existing Reactors (2020) and with the instructions contained in the External Hazards, Head Document (10 January 2020, with appendices on external flooding, extreme weather conditions and seismic events) is being checked in the course of the third PSR, which is currently under way. According to the preliminary results of an independent review, Krško NPP does comply with the WENRA Safety Reference Levels for Existing Reactors 2020.

Question 39: Have the design-basis events and all possible combinations of hazards with a probability of occurrence of a maximum of 10^{-4}/year been defined for all external impacts at this location?

Yes, the Safety Upgrade Programme has taken into account the external hazards referred to in the WENRA SRL with a recurrence interval of at least 10,000 years. All relevant combinations of events have also been reviewed.
We use compensation and mitigation measures for some areas of the plant. Regular patrols of the plant are carried out during the winter months. In the event of extreme snowfall or extremely low temperatures, snow has to be cleared from some small areas or, in the latter case, heat recirculated in certain tanks.

Question 40: Are there conservative analyses for all the safety-related structures, systems and components (SSCs) that show that they are able to bear loads equivalent to a seismic load of PGA = 0.56 g (on the open surface)? How was this safety analysis performed? Does the analysis accord with the WENRA guidance (WENRA 2020c, TU5.1, pp. 16–17)?

Seismic vulnerability analyses have been performed for all existing SSCs to which new systems are connected. These analyses have shown that the systems can withstand a seismic load at the PGA value referred to above (0.56 g) with a high level of conservativism. The HCLPF PGA capacity is determined in accordance with the WENRA guidance. The methodology for determining the HCLPF PGA for SSCs is based on the EPRI methodology.
The PGA value of 0.56 g is a median PGA value with a recurrence interval of 10,000 years (PSHA, 2004). The stress tests carried out in 2011 showed that, on account of the safety factors taken into consideration during the project design process, Krško NPP could operate safely and maintain long-term cooling operations in the event of an earthquake with a PGA greater than 0.56 g at surface.
Analyses of Krško NPP's seismic safety and seismic response are repeated and will continue to be repeated and upgraded periodically throughout the entire operational lifetime of the plant in accordance with Slovenian law and international guidelines and standards in the field. These analyses are the basis for the ongoing verification, assurance and proof of the high degree of seismic and nuclear safety of the original Krško NPP design.

Question 41: Krško NPP (2021, pp. 49–51) refers to the reactor safety improvements brought about by the replacement of the steam generators, the reactor coolant pumps, the electrical switchyard and the AC safety power supply (DG3), the installation of autocatalytic hydrogen recombiner systems and a filter system for containment depressurisation, alternative cooling systems for the spent fuel pool and the reactor, etc. What is the seismic design basis (PGA) for the design of these new systems and components?

After studying Krško NPP's statements, the ministry responds by saying that systems that were part of the original design (including the steam generators and reactor coolant pump motors) and that were replaced were qualified for the original design seismic loads (for more on this, see also the first paragraph of the response to Question 42). The DG3 diesel electricity generator was qualified for a 50% increased load (0.45 g on the open surface). Owing to design factors and conservative engineering assumptions, the design capacity in HCLPF PGA terms is approximately equal to twice the design ground acceleration and, in some cases, even greater. The seismic design load in PGA terms at surface for new engineered safety features on the main Krško NPP island (including the above-mentioned safety features) was 0.6 g. When the new safety features were being designed, the beneficial effect of the dissipation of energy from the interaction of movement between the ground and the structure was limited. The new facilities and systems, which are separated from the foundations of the main island, have been designed for a PGA at surface that is an additional 30% higher (0.78 g).

Question 42: Why does the description of the design bases for the upgrades carried out as part of the Safety Upgrade Programme and the National Action Plan (NAcP) following the European stress tests refer to the "design-extension conditions" (DEC, e.g. design for a seismic load of 0.6 g) and not to the design bases?

Krško NPP's seismic design load comprises the RG 1.60 design acceleration spectrum with a PGA of 0.3 g at the level of the foundations of the main Krško NPP complex. The Krško NPP design spectrum roughly corresponds to the uniform hazard spectrum, with a recurrence interval of 10,000 years, as calculated for the level of the foundations of the main Krško NPP complex in the PSHA (2004). Subsequent seismic analyses of the ground and seismic analyses that take into account the interaction of the structure and the ground proved that the seismic impact when the plant was being designed is comparable with the seismic impact determined by taking into consideration the design spectrum, scaled to a peak ground acceleration (PGA) of 0.6 g at surface, which roughly corresponds to a PGA value with a recurrence interval of 10,000 years (PSHA, 2004).
The seismic design load for the design of the new engineered safety features on the main Krško NPP island that were constructed for accident management in design-extension conditions (DEC) and to which the national action plan refers was determined conservatively relative to Krško NPP's original seismic criteria. A PGA of 0.6 g at surface was taken into account. In the seismic assessment, the beneficial effect of the dissipation of energy from the interaction of movement between the ground and the structure was limited. For the new facilities from the Safety Upgrade Programme constructed away from the foundations of the main Krško NPP island, a 30% higher was applied (0.6 g × 1.3 = 0.78 g). During the construction of these new facilities, the acceptance criteria with regard to the analysis of seismic vulnerability were also determined using HCLPF PGA.

Question 43: Are the three cooling tower blocks completely independent of the supply of cooling water from the Sava River?

The ministry responds by saying that the cooling towers are used for the operation of the power plant and have no safety functions. The operation of the power plant and the cooling towers depends on the Sava flow rate.

Question 44: What is the design basis of the cooling towers against seismic loads (PGA)?

The ministry responds by saying that the cooling towers are not important to nuclear safety. The original buildings of the conventional part of the plant, which include the cooling towers, were designed for a seismic design load corresponding to 10% of their own weight (PGA of 0.1 g). The new (third) block of cooling towers has been designed to be earthquake-resistant in accordance with Eurocode 8.

Question 45: How was the combination of fire hazards caused by an earthquake taken into account in the Krško NPP safety plan? Are firefighting equipment and systems designed for seismic loads with a PGA of 0.56 g?

After studying Krško NPP's positions, the ministry responds by saying that combinations of earthquake and fire are addressed. It has been confirmed that, following the implementation of the Safety Upgrade Programme, there was no requirement to use mobile equipment to tackle a combination of fire and other events. The firefighting and mobile equipment buildings have been designed for PGAs at surface of 0.6 g and 0.78 g, respectively (new building).

Question 46: Research for a reassessment of Slovenia's seismic hazard in the Database of Active Faults in Slovenia has documented numerous active and possibly active faults in the Krško area (Artiče fault, active, <5 km west of Krško; Orlica fault, probably active, <5 km east of Krško; Dobovec-Hrastnik fault system, probably active, approx. 10–20 km east of Krško; Orehovec-Poštena Vas fault, probably/possibly active, >7 km south of Krško; eastern part of the Dinaric fault system, speed of displacement 1–2 mm/year, >25 km south-west of Krško). Have these faults been paleoseismologically researched so that their contribution to seismic hazard in the PSHA can be taken into consideration? Are paleoseismological studies of these faults planned?

On the basis of the information submitted by Krško NPP and the SNSA, the ministry responds by saying that updated paleoseismological studies of faults in the region are being conducted, and faults are systematically studied. Their contribution will be taken into consideration in the new PSHA for the vicinity of Krško NPP, which is under way. From the point of view of seismic safety, the most important faults are the closest ones, i.e. Artiče and Orlica, while the analyses of the impact within the currently new PSHA currently under way have shown that the more distant faults do not have a significant impact. Consequently, it is the Artiče and Orlica faults that have so far been the focus of paleoseismological research. Structures in the southern part of the Krško syncline and the surrounding structures directly associated with them are addressed on the research currently under way. As well as the activities and geometric and kinematic parameters of the faults, the parameters of the attenuation of seismic waves with distance are also important for assessing earthquake hazard. Because of their distance from the site, more distant faults are not of essential importance to seismic hazard at the site and would not be expected to have a major impact on the seismic hazard parameters in the vicinity of the Krško NPP site.

Question 47: The new Seismic Hazard Map of Slovenia (2021) shows a considerably greater risk for the Krško area than the previous analysis (2001). Moreover, from the PSHAs for Krško NPP conducted in 2004 and 2014 and up to the present day, the databases have changed considerably (new seismotectonic models, databases on active faults). There is sufficient cause for suspecting that the PSHA results from 2004 and 2014 are no longer relevant. In light of this, is a new PSHA planned? If a PSHA is planned, when will it be carried out?

On the basis of the information submitted by Krško NPP and the SNSA, the ministry responds by saying that a project is currently under way to update the PSHA for the immediate vicinity of Krško NPP. The project, which began with field research just over ten years ago, is financed by GEN. The preliminary study covers 12 seismic source lines within a 200 km radius of the plant. In addition to seismic source lines, it also considers planar seismic sources or combinations of different types of seismic source. A new non-ergodic ground-motion model has also been developed for the location. This model takes into account the local characteristics of earthquakes on the basis of the ground-motion measurements that have been provided by ARSO for more than 20 years. The new updated seismic hazard analysis is expected to be completed at the end of 2022 and an independent review carried out in 2023. According to the preliminary results of the new PSHA, which is based on a new non-ergodic ground motion model, the final results of the new PSHA are not expected to deviate significantly from the results of the seismic study from 2004. An additional explanation is given in the FGG report titled "Overview of the non-ergodic ground motion model for Krško and preliminary PSHA results for the mean return period of 10,000 years"

(Rev. 0), which is enclosed as Appendix 1 to this response and is linked to the analyses and reports written in English. Under Slovenian legislation and EU practice, Krško NPP will, after the new PSHA analysis (which will be subject to an independent review and to approval by the SNSA) is completed, use it as the input data for updating the Krško NPP seismic PSA model, which is carried out once a year.

The operative part of the decision requires Krško NPP to draft an action plan for the third Periodic Safety Review (PSR3*) that includes an update of the PSHA for the Krško NPP site, submit it for approval to the SNSA no later than by the end of 2023 and, on this basis, carry out any additional measures required to increase the nuclear safety of the plant. The action plan must be drafted in accordance with the Ionising Radiation Protection and Nuclear Safety Act (ZVISJV-1) and the Rules on the operational safety of radiation and nuclear facilities (Official Gazette of RS, Nos. 81/16 and 76/17 [ZVISJV-1]) (point II/1.18 of the operative part of the environmental protection consent).

Question 48: Section 2.1.1.3 (p. 19) of the National Stress-Test Report (SNSA 2011) states that fragilities are developing, specifically in the passage: "... peak accelerations, maximum member forces, and floor acceleration time histories. These quantities were needed for fragility development." How were the fragility curves defined?

In relation to these questions, the ministry explains that, as described in the national report, a probabilistic assessment of the seismic response of Krško NPP facilities was carried out. The epistemic and aleatory uncertainties were taken into account. The seismic load was presented by means of 30 synthetic accelerograms. The synthetic accelerograms were generated in such a way that the median and the 84th percentile of the spectrum of accelerograms corresponded to the median or 84th percentile of a uniform hazard spectrum with a recurrence interval of 10,000 years. A calculation was produced of the probabilistic floor response spectra for the selected reference earthquake and the seismic forces on equipment. The HCLPF PGAs were calculated on the basis of the calculated seismic force, the seismic (bearing) capacities of equipment for the selected limit conditions, and the uncertainties of seismic response and seismic capacities. The EPRI methodology was applied. The HCLPF PGA includes a considerable degree of conservatism. According to the methodology used, in the event of an earthquake with a PGA at surface that is equal to the HCLPF PGA, there is a 95% probability that the selected limit condition of the equipment will not be exceeded at that PGA or that the selected equipment will function during and after the earthquake. This estimate of probability carries a high degree of confidence.

Question 49: Section 2.1.1.3 (p. 19) of the National Stress-Test Report (SNSA 2011) states that the peak floor spectra values from the original calculation (PGA = 0.30 g, simple interaction between the ground and the structure) are equal or similar to the floor spectra used during preparation of the stress-test report (i.e. with a PGA = 0.30 g, rigorous interaction between the ground and the structure).
Please explain in detail what this correspondence is based on.

In relation to this request, the ministry explains that Krško NPP's seismic design load comprises the spectrum of accelerations in accordance with the American RG 1.60 guidance, scaled to a peak acceleration of 0.3 g at the depth of the foundations (approx. 20 m below the surface). As PGA during an earthquake decreases with depth and the design PGA of 0.3 g was applied at the depth of the Krško NPP foundations, the original design accelerations cannot be directly compared with the accelerations at surface derived from the PSHA.
In 1996 and 2013, seismic analyses of the soil and of the facility were carried out that took into account the interaction between the structure and the ground in order to establish what seismic load on the surface would cause an approximately similar seismic impact on the Krško NPP facility and equipment to that determined when the plant was being designed (i.e. a PGA of 0.3 g at the foundations). In 1996 the seismic load in the analyses was presented using a uniform hazard spectrum, while in 2013 a design spectrum was applied in accordance with the American RG 1.60 guidelines, scaled to a PGA of 0.66 g at surface. It therefore makes most sense to compare the original floor spectra with the floor spectra

calculated in 2013. This comparison showed that, if the design spectrum under the American RG 1.60 guidelines were taken into account, scaled to a PGA of 0.6 g at surface, it would cause seismic impacts on the Krško NPP facility and equipment similar to those considered during the design stage. The favourable impact of the interaction between the Krško NPP structure and the ground (which scatters a significant amount of the energy) was also taken into account in the analyses carried out in 2013. The calculations showed that the floor spectral accelerations resulting from an earthquake with a PGA of 0.6 g at surface were approximately equal to or less than the original acceleration values for equipment with their own frequencies of between 4 and 16 Hz (or 20 Hz, as it depends on the location) which covers a wide range of engineered safety features and equipment at Krško NPP.
It is worth pointing out that all modifications and all equipment have been qualified, in line with the ENSREG recommendations, for the new floor seismic spectra, which were determined in 2013 and constitute the envelopes of the original and the new floor spectra, which were calculated with due regard to the RG 1.60 design seismic spectrum, scaled to a PGA of 0.6 g on the open surface at the Krško NPP site.

Question 50: The latest research findings (GREMER et al., 2019) show that the vertical component of floor acceleration can be several times greater than the horizontal floor acceleration. This directly impacts the mounting elements and the functionalities of the structures and systems. How does the mechanical model capture the vertical component of the floor acceleration and the combination with the horizontal floor acceleration? How is the resulting interaction between the horizontal and vertical internal forces of the mounting elements between the equipment and the structure captured?

Regarding these comments, the ministry explains that the study by eminent researchers was reviewed and, furthermore, that while we agree with the findings, the study is based on the assumptions that the floor spectra for the vertical direction are not normally taken into account and that the structure is rigid in the vertical direction. These assumptions cannot be made when the floor spectra of nuclear facilities are being calculated, even though the structures of nuclear facilities are significantly more rigid than the steel moment frames that were the focus of the researchers' investigations. The conclusions of the study are therefore not relevant to Krško NPP as the floor spectra are calculated by taking into account all the properties of the structure, the interaction between the structure and the ground, and the simultaneous operation of all three ground acceleration components; moreover, the impact of the key uncertainties is taken into account when determining the properties of the model.
Each individual component of the floor spectrum for Krško NPP facilities takes all the above-mentioned impacts into account. The impact of many more load combinations is taken into account when the mounting elements are being designed. An impact of 100% is taken into account for one component and an impact of 40% is taken into account for the other two components; this is the result of the application of the American standards or the consideration of the impact envelope of the American standards and the Eurocode standard. With the selected load combination, the seismic impact is evaluated by means of six combinations, as account must be taken of the operation of an earthquake in both directions.

Question 51: Section 2.1.2.5.1 (p. 30) of the National Stress-Test Report (SNSA, 2011) states: "The structural response analysis used to develop in-structure spectra for NPP was conducted in a very conservative manner". Please define "very conservative" in quantitative terms.

In relation to this observation, the ministry explains that factors that increase the conservativism of the results of the Krško NPP Probabilistic Seismic Response Assessment (Section 2.1.2.5.1, p. 30 of the National Stress-Test Report) are: the same target uniform hazard spectrum for the selection of accelerograms in all three directions of operation of seismic load, limitation of the dissipation of energy from the interaction of movement between the structure and the ground, consideration of the impact of uncertainty when determining the dynamic properties of the ground, and the method of determining the floor spectra, which prescribes the additional expansion and flattening of the floor spectra. Certain other reserves, for example the favourable impact of the conditional spectrum of accelerations, have so far not been taken into account when determining seismic safety.

Question 52: Section 2.1.2.3 (p. 26) of the National Stress-Test Report (SNSA, 2011) states: "For systems that could respond in multiple modes of vibration, 1.5 times the peak of the response spectrum was used". This sentence gives rise to the following questions:

- Why is the value 1.5 sufficient?
- The above-mentioned strategy appears conservative for the design of the structure if the factor of 1.5 is justified. However, the word "systems" (the second word in the sentence) means "equipment", for the design of which a floor spectrum is required. However, it is known that the maximum values of the floor spectra are a lot higher than 1.5 times the maximum value of the response spectrum (see Medina et al., (2006)). The procedure described above does not comply with the "Auxiliary Class 1 line systems" sections (p. 28) – a factor of 1.5 is not defined. How have the impacts on equipment design actually been established?
- On page 28, in the "Auxiliary Class 1 line systems" section, the term "response spectra" is always used in the list. The use of response spectra is questionable in this context because, by definition, they refer to seismic operation on the ground below the facility. The term "floor response spectra" should be used for the design. Please provide a more precise description of the actual procedure. Response:
- The value of the factor (1.5) was not determined at Krško NPP; rather, it was standardised with the American IEEE 344 standard for the seismic qualification of the components of nuclear power stations.
- The explanation of the use of the factor of 1.5 is not sufficiently detailed in the National Stress-Test Report (SNSA 2011). The multiplication factor of 1.5 is applied to the value of the acceleration from the conservatively defined floor spectrum of accelerations. The factor is not applied to systems that can be modelled by one degree of freedom, but for systems (equipment) that have, in addition to a predominantly oscillatory form, further higher oscillatory forms. In these cases, the equipment is designed for a spectral acceleration determined by the sum of the factor of 1.5 and the maximum spectral acceleration from the floor response spectrum. The Class 1 pipes referred to in the question above have been analysed by means of a modal analysis with response spectra, where the effects of the impacts of all oscillatory forms, which together contribute to the response of a significant portion of the mass of the system (usually 95%), are systematically taken into account. The associated spectral acceleration is taken into account for every oscillatory form and own frequency. The impacts of individual oscillatory forms and of the operation of the seismic load (spectra) in different directions are then combined using the methods defined by the standards for the seismic analysis of nuclear facilities and systems (including the American regulatory guidelines). The factor of 1.5 was therefore not applied in the analysis of the pipes referred to.

In response to the comment that this part of the National Stress-Test Report (SNSA, 2011) is not sufficiently detailed, the ministry explains as follows: In this case, the term "response spectra" relates to the floor response spectra. Equipment may not be designed in accordance with input acceleration spectra. Floor response spectra, which are calculated for a precisely defined location at the facility, are used in all analyses of the structures, systems and components at Krško NPP. The seismic analysis method described above, which uses a factor of 1.5, is an equivalent static analysis. It is used at Krško NPP primarily for the design of cable racks and instrumentation line conduits and distributors.

Krško NPP is one of the few nuclear power plants to have undergone a comprehensive PSA for seismic hazard (seismic PSA). An overview of the methodology of a seismic PSA is shown in the figure below (source: Seismic Risk Analysis of Nuclear Power Plants, Wei-Chau Xie, Shun-Hao Ni, Wei Liu, and Wei Jiang, Cambridge University Press 2019, ISBN 978-1-107-04046-5). Seismic assessments have been performed for all nuclear-safety-related systems. A modal analysis with response spectra is used to determine the seismic requirements for most of the systems at Krško NPP. Dynamic analysis is used to analyse facilities. The purpose of seismic analyses during the design phase was to qualify all engineered safety features for seismic load. As part of the seismic PSA, all systems were analysed in order to assess their seismic performance. The seismic fragility curves were calculated on the basis of the results of the seismic analyses and with due regard to uncertainty. Fragility curves were further considered in combination with the seismic hazard curve in the PSAs for Krško NPP. The results of these probabilistic assessments are addressed in the Krško NPP PSA model. The results of the PSA are incorporated into the Krško NPP EIA. Krško NPP updates the PSA on a regular basis (annually) and includes all newly installed or modified systems (including Safety Upgrade Programme systems).

Question 53: Section 2.11.1 (p. 108 and ff.) of the EIA Report (2022) sets out the statutory and other bases. The US NRC RG 1.60 and US NRC RG 1.61 documents were published in 1973 and revised in 2007 and 2014, respectively. What impact do these revisions have on the seismic design of the plant?

According to the ministry, they have no impact. Revision RG 1.60 of 2014 did not affect the value of the design acceleration and has no impact on the seismic safety of Krško NPP. For most types of equipment, the 2007 amendments to RG 1.61 permit the use of higher critical damping values. This is conservative when set against the results of the existing seismic qualifications at Krško NPP. For some equipment, the new version of RG 1.61 minimally reduces the critical damping ratios (by not more than 1%). These amendments therefore do not have a significant impact on the safety of the existing qualified components. The new version of the RG 1.61 more precisely defines the damping rate for active electrical equipment; again, this does not affect the qualification of such equipment at Krško NPP as the plant's active electrical equipment is qualified by means of dynamic tests, where accelerograms are generated on a dynamic table on the basis of floor spectra for the selected critical damping value. The selection of critical damping ratios for the target spectra for the generation of accelerograms for use in dynamic tests does not have a significant impact on the differences in the calculated accelerograms.

Question 54: The water level for probable maximum flood (PMF) is given as 155.61 m in Krško NPP (2021) and the EIA Report (2022), and as 157.53 m in SNSA (2017). Please clarify and confirm that protection against PMF is guaranteed.

The ministry explains that Krško NPP employs a multi-level flood protection system. The plant is protected against floods by embankments that overflow at 11,130 m^3/s (USAR 2.4.10). This corresponds to a frequency of less than $1E^{-06}$/year (additional statistical processing of the figure, USAR 2.4-6B). Floods capable of overflowing the embankments have been defined, with a high degree of reliability, as extremely unlikely (Gumbel extreme values distribution). PMF amounts to 7,081 m^3/s and represents the most unfavourable combination of extreme precipitation (probable maximum precipitation, or PMP, ANS-2.8 standard) and the melting of snow in the entire area of flow into the Sava. Moreover, consideration has also been given to fluctuations in the water level in the reservoir of the Brežice HPP, the most unfavourable wind levels and the appearance of surge waves in the reservoir. In the case of PMF, water fluctuations and the most unfavourable appearance of surge waves, the water level would reach 156.82 m (USAR 2.4.3.6), i.e. still 0.28 m below the safety level (level of buildings along the Sava 157.1 m E-004-404, MECL-ESW-01).

Probable maximum precipitation (PMP) that triggers PMF is assumed across the whole area of the flow into the Sava (i.e. around 40% of the entire surface area of Slovenia). PMP represents around twice the quantity of precipitation than the highest measured value. At the same time, the default is a 100-year snowpack that melts as a result of this precipitation. This combination of events has been defined, with a high degree of reliability, as extremely unlikely.

Barriers are also installed at the entrances into the facility (155.5 m) when the level of the Sava is close to or at an elevation of 155.5 m and/or extremely high river flow rates of over 4,500 m^3/s are predicted. These barriers protect the power plant from any potential collapse of the embankments in the event of a simultaneous seismic event involving PMF. The barriers are seismically designed for a PGA of 0.6 g. This ensures a very high level of flood protection for various simultaneous combinations of extreme events. The plant is therefore extremely well-protected against floods.

The power plants on the Sava are of the "run-of-river" type, i.e. they are hydropower plants in which there is little or no water storage. These power plants would have all their spillways completely open and be submerged if PMF occurred, meaning that they would not retain any water. The worst possible

combination of flood water (25-year flood) is taken into account, where the barriers at the hydropower plants are still partly closed and the maximum amount of water has accumulated. It is assumed that they would be breached in sequence or at the same time (two different scenarios). Under the most unfavourable combination, the flow rate at Krško NPP would reach 3,700 m^3/s, which would contribute to a Sava water level of 154.93 m. Assuming the simultaneous appearance of surge waves, the maximum water level would reach 155.34 m. The collapse of the barriers on the Sava would therefore not present an additional risk to Krško NPP. At higher flow rates, the barriers at these plants would be entirely washed away and their collapse would no longer make a considerable contribution to flood water quantities.
The risk analyses for Krško NPP will be updated as required as part of the third Periodic Safety Review (PSR3).

Question 55: Has the capacity of the drainage system been designed for rainfall (heavy rain) or a combination of hazards such as rain and snow melt with a probability of 10^{-4}/year?

Krško NPP's design ensures that rainwater is drained away in the event of extremely heavy rainfall or snow melt (USAR Chapter 2.4.1.1.4) with a probability of 10^{-4}/year.

Question 56: Safety buildings are designed to withstand winds of 140 km/h. What is the likelihood of winds of that strength occurring? Does this value comply with the WENRA requirement (2020a; probability of occurrence 10^{-4}/year)?

The frequency of occurrence of wind of a speed of 140 km/h is $5.48E^{-5}$/year and complies with the WENRA requirement (probability of occurrence 10^{-4}/year).

Question 57: What is the probability of occurrence of the extreme temperatures selected as the design basis (-28°C, +40°C)? Do these values comply with the WENRA requirement (2020a; probability of occurrence 10^{-4}/year)?

In reply to this question, the ministry explains that the WENRA criterion is satisfied for design-extension conditions (probability of occurrence 10^{-4}/year), and adequate measures have been introduced for major design systems.

Question 58: What are the probabilities of occurrence of snow loads selected as the design basis (120 to 374 kg/m^2)? Do these values comply with the WENRA requirement (2020a; probability of occurrence 10^{-4}/year)?

The ministry responds to this question by explaining that the values do accord with the WENRA requirement (probability of occurrence 10^{-4}/year). While the loads permitted for external tanks are lower, a medium with a temperature above 0°C is maintained so that the snow on the tanks melts and a thick snow cover is not created. If there is heavy snowfall, engineers work in shifts to conduct regular patrols around the complex and check whether urgent snow removal is required along the patrol routes and on equipment.

Question 59: Are the impacts of extreme weather conditions taken into account in the current PSA and in the core damage probability (CDP) $1.41E^{-5}$?

The ministry responds by saying that all external events, including the impacts of extreme weather conditions, are taken into consideration with the requirements of the WENRA SRLs.

Question 60: The EIA Report (2022, p. 347) states that the impact of safety-relevant climate change is "not significant". However, condition II/1/16 in the draft environmental protection consent (2022) requires extreme weather events to be monitored and analysed and the structures, systems and components of the plant to be upgraded if the design bases are exceeded. On what is this decision based?

The ministry assesses the impact as “not significant” on account of the mitigation measures taken. This condition is only one of the additional measures for ensuring safety laid down by the ministry in the operative part of this environmental protection consent (point II/1.18) and pursuant to SNSA opinion no. 3570-13/2020/27 of 7 December 2021.
In relation to this condition, the ministry again explains that the EIA does address the impact of extreme weather events and climate change on the safety aspects of the lifetime extension project (Section 5.6.1.2). The EIA assesses the impact of the activity and the overall impact in terms of the impact of climate change on the activity during operation as (3), i.e. impact not significant, on account of the mitigation measures that Krško NPP is already implementing and is required to continue to implement during the lifetime extension. Of these measures, the following are particularly important for maintaining nuclear safety:

- the structures, systems and components of the power plant are dimensioned to withstand extreme weather events and meteorological parameters by ensuring highly conservative margins;
- the Periodic Safety Review, which is performed every ten years, includes an in-depth analysis of the impact of extreme weather events on the safety of the power plant.

As a result of the climate changes that the EIA Report predicts will take place during the period leading up to the end of the Krško NPP lifetime extension, the frequency or impact of extreme weather events could increase. Krško NPP must therefore monitor such events particularly carefully, analyse them in detail and take the appropriate steps set out as a condition in the operative part of the SNSA opinion. The basis for addressing extreme events and planning power plant structures, systems and components so that they are able to withstand those events are requirements set out in the Rules on radiation and nuclear safety factors, particularly Annex 1, Chapter 5.

Question 61: The impacts of climate change relevant to safety are addressed in Condition II/1/16 in the draft environmental protection consent (2022). Why are conditions not set out for other hazards that affect nuclear safety, particularly regarding seismotectonic hazards (earthquakes)?

As explained in the response to Question 60, a condition relating to climate change has been set (point II/1.18 of the operative part of this environmental protection consent). Regarding the other external dangers or hazards that could affect nuclear safety, such as earthquakes, the ministry believes, including on the basis of the opinion obtained from the SNSA, that no additional conditions need to be inserted into the environmental protection consent as they are addressed to an adequate extent in the safety and topical reviews and, with particular care, in the context of the licensing procedures, in which an assessment is made of the adequacy of the project in relation to seismotectonic hazards. From the point of view of seismotectonic hazards (earthquakes), the entities tasked with issuing opinions (SNSA, ARSO), as well as the ministry in charge of the EIA procedure, regard the safety of the plant from the point of view of seismic hazard as good enough not to require additional measures. Those tasked with drawing up the EIA Report have also assessed the existing measures as sufficient, from the point of view of seismotectonic hazards (earthquakes), to ensure that the safety of the plant is high.

Preliminary recommendations
Preliminary Recommendation 8: We recommend that steps be taken to ensure that the design bases for measures to protect against extreme weather events accord with the WENRA regulations (2020a) and relate to design-basis events with a probability of occurrence not exceeding 10^{-4}/year.

In relation to this recommendation, the ministry explains that the protective measures against extreme weather events are in place in accordance with the WENRA SRL.

Preliminary Recommendation 9: We recommend that systematic paleoseismological research be conducted to determine the speed of displacement and the frequency and magnitudes of paleo-earthquakes, and to minimise the uncertainties associated with an assessment of active, probably active and perhaps active faults in the immediate vicinity of Krško (<25 km).

As already mentioned in the response to one of the questions in Section 8.5 of this document, a project is currently under way to update the Probabilistic Seismic Hazard Analysis in the wider surroundings of Krško NPP. The project, which began with field research just over ten years ago, is financed by GEN. The preliminary study covers 12 seismic source lines within a 200 km radius of the plant. In addition to seismic source lines, it also considers seismic sources that could arise in specific areas. A new non-ergodic ground-motion model has also been developed for the location. This model takes into account the local characteristics of earthquakes on the basis of the ground-motion measurements that have been provided by ARSO for more than 20 years. Moreover, GEN launched a major project at the beginning of 2022 whose aim was to precisely define the geometry, kinematic parameters and the parameters of the Gorjanci structure. The new seismic hazard analysis will be updated at the end of 2022 and an independent review carried out in 2023. Based on the preliminary results of this study, no significant changes in the results are expected in relation to the currently valid seismic hazard study from 2004.

Preliminary Recommendation 10: The results of the PFDHA are, to a large degree, dependent on the input data (speed of movement and frequency of earthquakes in the faults addressed) and the models used. We recommend that the PFDHA be reviewed in the light of the new methodological development and new data, and be repeated as necessary.

The PFDHA has been independently reviewed by independent expert institutions and the SNSA. As a result, and because of the negligibly small probability of minor permanent ground displacement at the Krško NPP site resulting from powerful earthquakes and the proven robustness of the Krško NPP systems, there is no need or requirement to update the PFDHA. When the new PSHA is completed, we will check the properties of the seismic source lines from the new PSHA against the properties of the seismic source lines from the PFDHA. No significant deviations are expected. However, if significant deviations do occur, an examination will be made as to whether the PFDHA should be updated.

Preliminary Recommendation 11: We recommend that the decision on lifetime extension be adopted on the following bases: (1) on the basis of the new PSHA, which corresponds to the acknowledged state of the art and technology; (2) on the basis of an analysis that shows that all structures, systems and components relevant to safety comply with the requirements stemming from the new PSHA.

In relation to this recommendation, the ministry explains that the safety assurance process at Krško NPP is dynamic and continuous, which means that everything listed will have to be carried out when the results of the new PSHA are known. As the implementation of the PSHA is a long-term process, in 2015 ARSO carried out an independent assessment of the impacts on the PSHA results from 2004. They established that the ground-motion models developed since 2004 could significantly increase seismic hazard. Owing to these uncertainties, Krško NPP took the position that the seismic design load for the new systems that have been constructed in recent years at Krško NPP and that are part of the plant's Safety Upgrade Programme should be increased to take account of a PGA of 0.78 g at surface. In addition, a non-ergodic ground-motion model for the immediate vicinity of Krško NPP began to be developed in 2018. A new non-ergodic ground-motion model was approved by an international peer-review panel in 2021. The new seismic hazard analysis, to include the new non-ergodic ground-motion model, is currently being updated and will be approved in 2023. Based on the preliminary results of the new PSHA and taking the non-ergodic ground-motion model into account, the expert conclusion is that no significant changes in Krško NPP's seismic hazard are expected in relation to the currently valid study of seismic hazard from 2004.

Preliminary Recommendation 12: We recommend that a condition for the environmental protection consent to the lifetime extension be set: for a new PSHA and safety upgrade to be carried out on the basis of the results of the PSHA (analogous to the conditions regarding extreme weather conditions and climate change).

A response has already been given to this recommendation (see the response to Preliminary Recommendation 11).

Preliminary Recommendation 13: We recommend that a study be made of the vertical components of ground acceleration at the mounting elements and of the functionality of the structures and systems.

In relation to this recommendation, the ministry explains that the effects of the vertical components of acceleration have been taken into account in the planning of all equipment at Krško NPP, including the appropriate combination with seismic impacts resulting from the horizontal components of ground motion and other impacts (e.g. own weight, temperature, liquid pressure and other impacts). Additional and more detailed explanations regarding these recommendations are given in the responses to Questions 50, 51 and 52.

Accidents caused by third parties

Question 62: What are the requirements for protecting Krško NPP in the event of the deliberate downing of a commercial airliner?

Krško NPP is constructed in such a way that its redundant engineered safety features are physically separate from each other. As part of the Safety Upgrade Programme (SUP), Krško NPP has installed additional engineered safety features, together with coolant tanks, in two bunkered buildings that are physically separate and at a suitable distance from the engineered safety features of the plant's main island. This ensures that the plant's operation can be safely halted in the event of a large commercial airliner crashing in its vicinity.

Question 63: What external attacks should the reactor building and other buildings relevant to safety be designed to withstand? Is this protection still ensured despite the adverse effects of aging?

This question has already been answered in the response to Question 62. Krško NPP implements an equipment aging programme and ensures that the original design requirements are met.

Question 64: How do you assess the result of the Nuclear Security Index 2020 for Slovenia? Are improvements planned in relation to "safety culture", "cyber-security" (38) and "protection against internal threats"?

In relation to this question, the ministry explains that the NTI has been developed on the basis of publicly available information (https://www.ntiindex.org/about-the-ntiindex/). The Economist Intelligence Unit (EIU) conducts all of the research for the NTI Index using publicly available information, such as national laws and regulations, treaty databases, and other primary and secondary sources. The NTI Index does not review on-the-ground security. As the details of the results for Slovenia show (https://www.ntiindex.org/country/slovenia/), the result "No, or information not publicly available" is given for many of the indicators and sub-indicators. This is obviously because of a lack of publicly available information, which is understandable given the sensitive nature of physical security. The assessment would obviously be considerably higher if the same 2020 NTI-Index EIU-Methodology and real information were used. Consequently, we cannot use the NTI Index assessment as a reference for the level of physical security of nuclear facilities and materials in Slovenia. Information on the physical security of Krško NPP is classified and therefore not publicly available.
As part of the third Periodic Safety Review (PSR3), which is currently under way, Krško NPP has committed itself to producing an assessment of Safety Factor 17 (Physical security). Because of the nature of the area, this part of PSR3 is treated as an internal matter and the results will not be made public. The purpose of the review of Safety Factor 17 is, of course, to review all aspects of the plant's

physical security (including cyber security and the approach to “security culture”, as required by WENRA). The results and data and the suggestions for improvement in this area will not be made public. To the best of our knowledge, Krško NPP is one of the first power plants to have undertaken to review Safety Factor 17 (Physical security) as part of the PSR.

Question 65: Has a mission by the IAEA’s International Physical Protection Advisory Service (IPPAS) been planned to improve the security of nuclear facilities?

There are no current plans for a mission by the International Physical Protection Advisory Service (IPPAS). However, Krško NPP’s physical security is being independently reviewed as part of PSR3, which is currently under way, in the review and production of an assessment of Safety Factor 17 (Physical security). The aim of the review of physical security is to determine whether the operator of the nuclear facility meets the requirements of Slovenian legislation, monitors and introduces the recommendations of the International Atomic Energy Agency and other relevant organisations (WENRA), and maintains a high level of security culture. The purpose of the review of Safety Factor 17 is to check whether all aspects of nuclear security (i.e. measures covering the prevention, detection and taking of measures in the event of theft, sabotage, unauthorised access, unlawful transfer or other malicious acts involving nuclear or radioactive material and facilities or activities associated with them) are adequate, sufficiently exhaustive and up to date with regard to the latest relevant requirements and standpoints. Because of the nature of the area, this part of the PSR is treated as an internal matter and the results will not be made public.

Question 66: What is the assessed threat to nuclear facilities in Slovenia resulting from military actions for the next 20 years? What protective measures are planned?

The police produce a threat assessment for nuclear facilities in Slovenia every year. The technical and physical security measures are adapted in response to this assessment. Equipment vital to the safe operation and the shutting down of operation is installed in secure concrete buildings. Owing to the sensitive nature of physical security at Krško NPP, the protective measures are classified.

Preliminary recommendations

Preliminary Recommendation 14: An EIA procedure must set out the general requirements regarding protection against the deliberate downing of a commercial airliner and other acts of terrorism and sabotage.

Krško NPP has compiled an analysis of the impacts of an aircraft accident on the plant (representative commercial passenger airliner and representative military aircraft) and of other acts of terrorism and sabotage on the basis of the NEI 06-12 B.5.b Phase 2 & 3 Submittal Guideline requirements (Rev. 2) or the US NRC B.5.b requirement, which was published in 2002 (following the WTC attack in the USA on 11 September 2001 and as part of moves to prepare nuclear power plants for such an event). An action plan was drafted and various safety improvements made in response to the analyses. The ENSREG stress tests/extraordinary safety review showed that Krško NPP was well-designed and constructed and that, with the additional severe accident management equipment available at the site, was well-prepared for such events. Owing to the sensitive nature of physical security at Krško NPP, the safety analyses and information on protection against an aircraft accident and other acts of terrorism and sabotage are classified.

Preliminary Recommendation 15: According to the results of the Nuclear Security Index, protection against cyber attacks and acts by insiders should be improved.

As has already been explained in the response to Question 64, the result of the NTI Index does not represent the actual situation. As the details of the results for Slovenia show (https://www.ntiindex.org/country/slovenia/), the result “No, or information not publicly available” is given for many of the indicators and sub-indicators. This is obviously because of a lack of publicly available information, which is understandable given the sensitive nature of physical security. The assessment would obviously be considerably higher if the same 2020 NTI-Index EIU-Methodology and real information were used. Consequently, we cannot use the NTI Index assessment as a reference for the level of physical security of nuclear facilities and materials in Slovenia. Information on the physical security of Krško NPP is classified and therefore not publicly available.

Preliminary Recommendation 16: A mission by the IAEA's International Physical Protection Advisory Service (IPPAS) would be required to support improvements to nuclear security and protection (IAEA 2022).

As has already been explained in the response to Question 64, the NTI result does not represent the actual situation. Krško NPP enjoys a high level of physical security, which is regularly reviewed and improved in response to the threat assessment produced every year by the police. Krško NPP's physical security is being independently reviewed as part of PSR3, which is currently under way, in the review and production of an assessment of Safety Factor 17 (Physical security).

Transboundary impacts

Question 67: Which two-day doses derive from calculations for a severe accident at a distance of 75 km and further, for both children and adults? What highest doses and doses for the 95th quantile are expected?
The ministry explains that it can answer these questions in two ways:
- By using the simulations from the RODOS modelling system (Dipcot and Lasat model), which are described in the EIA.
- For simulations using the AriaIndustry modelling system (SPRAY model), all calculations were made using the DOZE program (reference no. 200 in the EIA) because RADTRAD does not enable deposition to be calculated. We carried out simulations using the SPRAY model for three years (2018–2020), thereby considerably improving the precipitation statistics. The domain was also enlarged to 400 km x 400 km, while all other settings of the modelling system remained the same.

Calculations have been produced for the design-basis accident described in the EIA (design-extension conditions (DEC-B) or SBO below).
The DOZE programme enables calculations of two-day doses, while the RODOS programme enables calculations of three-day doses.

Question 68: Have you also calculated the weather situations in which wet depositions could appear on Austrian territory (from a cloud)? In these cases, what would be the maximum two-day doses for children and adults?

The ministry explains that all realistic weather situations have been used in the calculations for the simulations in the years in question, i.e. including all types of precipitation that cause wet deposition. All the results are already shown in the response to Question 67.

Question 69: What deposition values are possible in Austrian territory in the event of a severe accident? (Please provide data for Cs-137 and I-131, for wet and dry depositions).

The methodology for the calculations and the key to the graphs have already been provided in the response to Question 67.

Preliminary recommendations
Preliminary Recommendation 17: Due regard should be paid to the fact that the indicative dose values that trigger emergency measures in Austria are different to those in Slovenia. The calculations and the explanations of the results should account for this.

In relation to this recommendation, the ministry explains that the EIA doses were calculated without taking protective measures into account. The total effective dose equivalent (TEDE) for the whole body and the thyroid, and the soil concentrations of gamma contamination activities from ICRP 103-2007 have been used as the criterion for assessing the level of impact. Regarding emergency measures, Slovenian legislation complies with ICRP 103-2007. Of course, Austria bases its protective measures and impact assessments on its own laws, while the EIA was drawn up in accordance with internationally accepted criteria.

Preliminary Recommendation 18: We recommend that a calculation be made of the transboundary impacts of a severe accident involving containment failure as if this were physically possible, i.e. regardless of the probability of occurrence.

The ministry explains that the representative accident in the EIA Report was selected on the basis of the Krško NPP Safety Analysis Report and of deterministic and probabilistic safety assessments. The reference severe accident was selected as the limiting or envelope scenario presenting the biggest challenge to transboundary impact resulting from a very conservative (almost improbable) scenario involving the loss of all AC power supply, the availability of safety/auxiliary systems, and the loss of operating crew for 24 hours (no action is taken by the operating crew in the first 24 hours). An explanation of the selection of the representative accident is given in Section 6.4 of the EIA Report.
The integrity of the containment can be physically compromised as a result of a major earthquake, the crash of a large aircraft or an extreme internal increase in pressure or temperature. Regarding the fracture analysis, damage to the containment is not likely in the event of a borderline earthquake with a recurrence interval of up to 100,000 years. Based on the analysis of the impact of an aircraft crashing into the Krško NPP containment, loss of the integrity of the containment is not expected; similarly, the envisaged releases would not be greater than those already envisaged in the calculation contained in the EIA Report. The integrity of the containment is ensured, in the event of an increase in internal pressure or temperature, by active engineered safety features in design-extension conditions, the passive autocatalytic recombiner (PAR) and the passive containment filtered venting system (PCFVS). Therefore, leakage from the containment was taken, in the EIA calculation, as release through the PCFVS with additional design-basis leakage at increased pressure. Release category RC6, which is addressed in the Krško NPP probabilistic safety assessments (failure of the containment), envisages a smaller radioactive inventory (source term) in the containment and, consequently, a lower release of radionuclides than envisaged from total core meltdown in the selected representative accident used in the EIA. This means that the highest possible radioactive inventory was addressed (source term).

Response to the opinion of GLOBAL 2000 die Österreichische Umweltschutzorganisation on the environmental impact assessment of the lifetime extension of Krško nuclear power plant, 2022 (Stellungnahme GLOBAL 2000 zu UVP AKW Krško Betriebsverlängerung 2022)

Question 1: Aging management
After 40 years of operation, the Krško reactor is faced with the problem of aging. According to Section 2.16 (p. 127), the status of the reactor is “adequate”. “On the basis of a series of studies and analyses, the Slovenian Nuclear Safety Administration has issued a decision confirming ...” During the period in which the lifetime extension plans were being drawn up, the analysis was already more than ten years old and therefore out of date. The EIA Report claims (Section 2.7.15, p. 87): “All missions (including OSART 2017), as well as the testing carried out by the SNSA, have shown that the aging management programme does comply with international recommendations and regulations for ensuring safety after the start-up of radiation or nuclear facilities.” Global believes that this is not the case.
As part of the Topical Peer Review (TPR) under Article 8e of Directive 2014/87/Euratom, which was conducted in 2017, the peer-review group criticised the scope of the structures, systems and components included in the aging management programme (AMP): The scope of the AMP is not subject to regular review or updated in line with the new IAEA safety standards as required. The aging

management of the reactor pressure vessel also points to deficiencies when set against the safety level that the EU nuclear regulatory authority, which is part of ENSREG, expects for Europe. Regarding the non-destructive evaluation (NDE) of the reactor pressure vessel, the peer-review group raised the criticism that no comprehensive NDE was being conducted on the basic material at the level of the reactor core in order to determine whether there were any defects. The group also criticised the aging management of pipes: The AMP does not routinely include inspections of the safety of pipe penetrations through concrete structures.
Because of the age of the reactor, construction of which began in 1974 and operation in 1982, its technical status should be checked by independent experts and use made of real-life experiences and data from the decommissioning of comparable reactors. This applies in particular to components in the area of the core, such as the reactor pressure vessel and the primary circuit. During normal operations, these are not easily accessible; however, computer modelling of potential aging does not appear to be adequate.

In relation to this comment, the ministry explains, on the basis of the EIA Report, Krško NPP's clarifications and the SNSA decision, that an AMP and TLAAs have been established and updated pursuant to NUREG-1801. The compliance of the AMPs and the TLAAs with IAEA (IGALL) requirements has been examined and confirmed. AMPs are regularly updated at Krško NPP by taking into account new regulatory requirements, foreign and domestic experiences and new R&D findings. Krško NPP has so far implemented 42 AMPs programmes using the GALL approach. IAEA (IGALL) compliance has been examined and confirmed for every programme.
The reactor vessel irradiation control programme controls the effects of aging resulting from a loss of fracture toughness from irradiation and the brittleness of the low-alloy steel material of the reactor pressure vessel. The monitoring methods are in accordance with 10 CFR 50, Appendix H. This programme refers to the requirements for evaluating neutron irradiation, the removal of control capsules, the mechanical testing/evaluation of the sample, and the production of a diagram of the temperature/pressure limits of acceptability for the operation of the reactor vessel. The requirements mentioned in this programme ensure that the reactor vessel's materials meet the requirements regarding the fracture toughness energy of the material under 10 CFR 50, Appendix G, and meet the pressurised thermal shock (PTS) requirements of 10 CFR 50.61. For the period of the lifetime extension, the programme also includes an alternative method of monitoring neutron irradiation (NUREG-1801), which is performed using an ex-vessel neutron dosimetry (EVND) system. Samples are examined, tested and analysed by accredited external laboratories.
Krško NPP also has an in-service inspection programme in place for the non-destructive testing of the reactor vessel and reactor vessel closure head in accordance with ASME XI. For the non-destructive evaluation (NDE) of the basic material of the reactor pressure vessel at the level of the core, Krško NPP is part of the PWROG (Pressurized Water Reactor Owners Group) working group, and implements the latest industrial R&D findings on a continuous basis.
According to all the expert inspections performed so far, the state of the reactor vessel is sufficiently adequate (the pressure boundary safety function is operational) to ensure that Krško NPP is able to operate over the long term.
Tests to check the point at which safety pipelines penetrate concrete structures were included in a specific aging management programme within the framework of the action plan to fulfil the recommendations issued on the basis of the national TPR (ENSREG) report. The Krško NPP containment provides a pressure (safety) boundary using steel containment. Management of the aging of penetrations and welds in the steel containment is addressed in a separate programme that complies with NUREG-1801, XI-M19.
By carrying out regular periodic inspections of structures, systems and components (SSCs), Krško NPP ensures that they are capable of withstanding any design-basis accident even during the period of extended operation (i.e. after more than 40 years of operation). Krško NPP also ensures that aging management processes and preventive measures do not lead to any loss of the original safety margins. This is also confirmed by the inspections conducted by the SNSA, by international inspection missions (TPR, OSART, WANO, IAEA) and by the independent expert institutions involved in all regular outages

of the power plant. TLAAs are also performed for SSCs that are subject to time-limited operating conditions; these are independently confirmed by external inspectors so as to ensure that the design bases and requirements for the analysed SSCs are maintained.

Question 2: Seismic hazard: Krško NPP is the only nuclear power plant in Europe that operates in an active seismic zone. The EIA Report makes reference to several older studies and, on the basis of the most recent analysis of seismic hazard from 2004 (PSHA 2004, horizontal PGA = 0.56 g), comes to the following conclusion: "The set of preliminary conclusions of this multidisciplinary research carried out in the broader area of the location since 2008 [274, 275] produced no indications of the possibility of capable faults or geological structures that could, in the event of an earthquake, permanently deform the surface of the location ('capable faults'), and there were no new findings that could significantly change the existing estimate of seismic hazard at the Krško NPP site [271] and produced between 2002 and 2004 after ten years of research."
This presentation and conclusion is repeated in Section 4.1.11 (Seismic hazard, p. 197f). This conclusion is incorrect.

In relation to these comments, the ministry explains that Section 4.1.11 (Seismic hazard, p. 176) of the EIA Report states that the preliminary results of paleoseismological investigations since 2004 and the updated PSHA (which is under way) have not confirmed the existence of new faults or geological structures in the last ten years that could, in the event of an earthquake, permanently deform the surface of the location ("capable faults"). GEN has nevertheless commissioned a study of the seismic hazard presented by ground displacement. The study, which considered 11 seismic source lines, was completed in 2013. It showed that there was no danger of major permanent ground displacement, while the danger of very minor permanent ground displacement was insignificant (recurrence interval of more than one million years). The relevant section in the EIA Report is therefore justified.

Question 3: The PSHA 2004 study used is questionable in light of several recent studies and publications:
The EU nuclear regulators' peer-review report on stress tests (ENSREG 2012) came to the following conclusions: According to US nuclear regulatory rules and standards, reactor safety is highest at a safe shutdown earthquake (SSE) with a set horizontal ground acceleration (PGA) of 0.3 g. The new analyses of seismic hazard led to an increase in the assumed highest values of horizontal ground acceleration to 0.42 g in 1994 and 0.56 g in 2004, which is nearly twice the original assumption.

On the basis of Krško NPP's statements, the ministry explains that the claim that the seismic hazard analysis from 2004 has been questioned in several recent studies and publications cannot be found in the ENSREG report (2012), nor have those claims been presented for comment.
However, on the basis of Krško NPP's statements the ministry notes that the accelerations have been verified, as field investigations continued after 2004 and have been at their most intensive in the last decade. A project to update the PSHA for the immediate vicinity of Krško NPP is currently under way. As part of this project, a new non-ergodic ground-motion model was developed for the location of the second nuclear power plant block at Krško in 2021. The new non-ergodic ground-motion model takes into account the local characteristics of earthquakes on the basis of the ground-motion measurements that have been provided by ARSO for more than 20 years. This has a positive impact on the results of the PSHA. It has been shown, for the immediate vicinity of Krško NPP, that the PGA and spectral acceleration at higher frequencies and for long recurrence intervals decrease relative to the values determined using the conventional ground-motion model.
Care must be taken when referring to or comparing peak ground accelerations; often the values are not mutually comparable because they can relate to different types of ground and different depths. The PGA sometimes relates to the median value of seismic requirements from a seismic hazard assessment and sometimes to the PGA capacity, which is determined with a higher degree of confidence and with low probability of the limit state being exceeded. Moreover, PGA can relate to a "design" or actual earthquake, or to a spectrum of accelerations. In order to make these relations clearer, we give a longer

explanation below.
The PGA of 0.3 g relates to the level of the foundations of the Krško NPP building, which are 20 m below the surface, while the PGA of 0.56 g (from the Probabilistic Seismic Hazard Analysis/PSHA of 2004) relates to the surface. PGA decreases with depth. Consequently, the claim that the PGA value from the seismic hazard analysis from 2004 is almost twice that of the design PGA value is not accurate.
Krško NPP was designed to withstand earthquakes. The seismic design load of Krško NPP comprises the spectrum of accelerations in accordance with the American RG 1.60 guidance, scaled to a PGA of 0.3 g at the depth of the foundations (approx. 20 m below the surface). As the PGA during an earthquake decreases with depth, as we have already pointed out, the design peak acceleration at the depth of the foundations cannot be directly compared with the PGA at surface derived from the PSHA. In order to be able to compare Krško NPP's seismic design load with the seismic load from the PSHA, due regard must be paid to the uniform hazard spectrum at the level of the foundations, which was determined in the PSHA of 2004. A comparison between the Krško NPP design spectrum and the uniform hazard spectrum for the level of the foundations shows that the spectral acceleration for a frequency of 3.33 Hz from the uniform hazard spectrum (PSHA, 2004) is approximately 12% lower than the corresponding value of the design spectral acceleration for 5% attenuation. Moreover, the seismic analyses of 2013 estimated that the original seismic forces taken into account when Krško NPP was being designed were approximately comparable with the seismic forces on the facility resulting from the RG1.60 seismic load and taking into account a PGA of 0.6 g on the open surface, which roughly corresponds to a PGA with a recurrence interval of 10,000 years (PSHA, 2004). The favourable impact of the interaction between the Krško NPP structure and the ground (which scatters a significant amount of the energy) was also taken into account in this transformation. The calculations from 2013 also showed that the floor spectral accelerations resulting from an earthquake with a PGA of 0.6 g at surface were approximately equal to or less than the original acceleration values for equipment with their own frequencies of between 4 and 16 Hz, which covers a wide range of engineered safety features and equipment at Krško NPP.

Question 4: Seismic events with a PGA greater than 0.8 g are classified as extremely rare at the Krško location, with a recurrence interval 50,000 years or more. However, earthquakes with a PGA of 0.8 g or more present a danger to the reactor core: mechanical damage can interfere with the geometry of the core and lead to the retraction of the control rods. In such a scenario, a partial break cannot be excluded. In this earthquake acceleration zone, neither the injection system in the reactor enclosure nor the low-pressure emergency cooling system would be available. Releases of radioactive material resulting from damage to the reactor core cannot be ruled out.
However, we cannot be certain that the calculated recurrence interval of 50,000 years is correct for strong seismic events with a PGA of 0.8 g or greater.
With earthquakes with a PGA or 0.9 g or more, one cannot rule out structural damage to the spent fuel pool and pipes. Exposure to nuclear fuel is therefore deemed to be probable.
A very powerful earthquake (PGA greater than 0.9 g) causes more or less simultaneous damage to nuclear fuel in the reactor core and in the spent fuel pool. The stress-test report assesses these two events separately.
If the highest ground acceleration value significantly exceeds 1 g, it is highly likely that the early release of radioactivity into the environment will take place.

After studying Krško NPP's comments, the ministry responds as follows: Regarding the comments on the seismic consequences of powerful earthquakes, one should distinguish between a design earthquake and an actual earthquake. A design earthquake is not determined by PGA alone but also by the default elastic spectrum of accelerations, which is smooth and has high spectral accelerations at a wider interval of frequencies. This generally does not occur during a single actual earthquake. This means that spectral accelerations in the event of an earthquake with a PGA of 0.8 g or more will very probably be lower within a wider interval of frequencies than those considered in the Krško NPP seismic hazard analysis. In an actual earthquake with a PGA of 0.8 g or more, the seismic load in terms of spectral accelerations for a wider spectrum of frequencies is very likely to be lower than the seismic load that was considered in the analysis of the safety margins, as the conditional spectrum of accelerations

at a PGA of 0.8 g is considerably lower than the design spectrum of accelerations.
The values that you refer to come from the Slovenian national stress-test report, which was independently reviewed by Slovenian expert institutions authorised by the SNSA, and then reviewed and approved as part of the peer review of all stress tests carried out by ENSREG for the European Commission.
One should also be aware that the above-mentioned seismic capacities mentioned in the report and drawn up as part of the EU stress tests on the basis of ENSREG requirements do not take account of the favourable impact of the additional seismic and nuclear engineered safety features that have been installed at Krško NPP in the last ten years, following the stress tests and as part of the Safety Upgrade Programme. The upgrades covered the construction of new flood-protection systems, the reliability of electricity supply, the cooling of the reactor, the containment and the spent fuel pool, alternative control and plant management systems, and the construction of spent fuel dry storage (currently under construction). This new equipment has been installed in facilities on the main Krško NPP island, although most has been installed in new buildings away from the main island. A new (third) diesel generator has been installed in the new Bunkered Building 1 (BB1) to provide independent supply to the engineered safety features, while additional pumps and alternative redundant cooling water tanks for cooling the reactor and providing support to the steam generators have been installed in Bunkered Building 2 (BB2). These systems have been designed to withstand very powerful earthquakes. The design PGA is 0.6 g for systems on the main island. BB1 has been designed for a 50% higher seismic load than the original seismic criteria for Krško NPP and can withstand a PGA of 0.6 g (this figure rises to 0.78 g for BB2 and the dry storage). In the construction of the new BB1 and BB2 buildings and of the spent fuel dry storage, the safety acceptance criterion in the analysis of seismic vulnerability was also determined using the HCLPF PGA. In comparison with the original seismic design loads incorporated into the Krško NPP design process, the new systems have even greater seismic resilience and, as such, are able to replace the most vulnerable original systems in the event of their failure during an earthquake. If the seismic safety assessments for Krško NPP were to take the new systems into account, the assessment of seismic capacity would be even higher than was shown in the stress-test report.
The impacts of various earthquakes and the adverse events associated with them are taken into account when the core damage frequency (CDF) is being determined. For Krško NPP, this is estimated with respect to the value acceptable under Slovenian legislation and international standards (see "Probabilistic Risk Criteria and Safety Goals: NEA/CSNI/R(2009)16", OECD, Nuclear Energy Agency, Committee on the Safety of Nuclear Installations). Krško NPP's seismic safety is therefore adequate.

<u>Question 5</u>: A new seismic analysis of the location has been required as part of the planning process for the second reactor (Krško 2) at the same site. The SNSA (the Slovenian regulator) raised questions about the possible impact of the Libna tectonic fault, and called for the seismic safety analysis for the existing Krško 1 reactor to be updated. The Institut de Radioprotection et de Sûreté Nucléaire (IRSN), the French technical safety organisation (TSO), sent an open letter calling on the operating company and the regulatory authority (SNSA) to provide further clarifications: The IRSN proposed that the operator provide sufficient local information for a study of the effects of the Libna fault to reduce the uncertainties already established.
The Slovenian experts' study emphasised that the results of the stress test showed, for example, that the effects of peak ground acceleration (PGA) greater than 0.8 g had to be estimated within the framework of the known expected accelerations resulting from an earthquake of medium magnitude and with reference to the seismotectonic conditions in the area. The study concluded that the SNSA's statement that "the recurrence interval for seismic events with a PGA of greater than 0.8 g is deemed to be more 50,000 years" does not accord with the revised PSHA or the SPSA.

After studying Krško NPP's statements, the ministry explains that all the PSHAs carried out so far at Krško NPP have considered the impacts of active faults in the wider surrounding area of the plant. The project to update the PSHA, which is under way and is being financed by GEN, will examine 12 active seismic source lines and several planar seismic sources, followed by four mutually independent seismic

source models. It is assumed that the epicentre of a powerful earthquake could appear anywhere within a wider radius of Krško NPP. The new PSHA, which is being drawn up, examines the potential for an earthquake to be caused by the Libna fault.
Regarding the issue of the Libna fault, the IRSN issued a separate interpretation at the beginning of 2013 that contradicted the interpretations of the other partners (BRGM, GEOZS, ZAG) of the consortium that carried out the first phase of the project to update the PSHA for the immediate vicinity of Krško NPP. Based on the preliminary results produced up to that point, the consortium found that the Libna fault could not, without further evidence, be defined with any certainty as a seismic source that could lead to permanent ground displacement on the surface of the current or future location of Krško NPP. The results of the PSHA for ground displacement, which considered 11 faults, including the Libna fault, showed that there was no danger of major permanent ground displacement, while the danger of very minor permanent ground displacement was negligibly low. The seismic analysis also showed that Krško NPP's structures and systems could withstand significantly greater ground displacement than followed from the Probabilistic Fault Displacement Hazard Analysis for a recurrence interval of 10 million years (Krško NPP, 2013).
According to the PSHA from 2004, the median recurrence interval for seismic events with a PGA greater than 0.8 g is estimated to be approximately 50,000 years. The results of the updated PSHA, which is currently being drawn up, will provisionally be available at the end of 2022, with an independent review following in 2023. Based on the preliminary results of this study, no significant changes in the results are expected in relation to the currently valid PSHA from 2004.
Nevertheless, even today Krško NPP only meets the requirements of the original assumptions based on a PGA of 0.3 g. Only the additional systems, structures and components introduced as part of the safety upgrade process will be planned and implemented in accordance with the design-extension conditions (DEC) typical for a reactor of this design and location. The DEC systems, structures and components will be installed in two newly constructed bunkered buildings.

<u>Question 6</u>: The PGA in design-extension extensions (DEC) is 0.6 g. This value offers almost no safety margin (only 0.04 g) in comparison with the currently determined value for a safe shutdown earthquake (SSE) of 0.56 g. There is no mention of an updated reassessment of seismic risk being carried out at the site. The most recent seismic risk analysis was conducted in 2004. The fact that the seismic hazard at the Krško site is significantly higher than the plant's original design basis of 0.3 g is extremely concerning.

After studying Krško NPP's explanations, the ministry explains that the peak horizontal ground acceleration values are not always mutually comparable, as they can relate to different types of ground and different depths. Moreover, they can also relate to actual or design earthquakes. On the basis of the spectral accelerations, which are more directly connected to the seismic forces than the PGA, it has been estimated that the original seismic forces taken into account when Krško NPP was being designed are roughly comparable to the seismic forces on the facility resulting from a design earthquake with a PGA of 0.6 g on the open surface, which roughly corresponds to a PGA with a recurrence interval of 10,000 years (PSHA, 2004). During the planning of the new facilities, which are away from the main nuclear island, the design PGA was increased by 30%; this was regardless of the fact that the preliminary results of the seismic hazard assessment, taking into account the new non-ergodic ground-motion model, showed that no significant changes were expected from the PSHA carried out in 2004.
The claim that the safety margin is a mere 0.04 g is misleading, and it is a misunderstanding to think that a sufficiently high PGA is the only factor that ensures seismic safety. Seismic safety is also ensured by an appropriate spectral acceleration and by other appropriate safety or design factors within the earthquake-resistant design standards that are taken into account during the design process itself and that increase capacity in PGA terms relative to the design PGA value.

<u>Question 7</u>: The SNSA (Slovenian regulator) claims that in the event of an earthquake with a PGA greater than 0.6 g, the reactor core could be cooled in other ways as well; however, it stresses that this would require additional measures to be carried out in a relatively short period of time. Regarding the

destruction of the nuclear power plant, its surrounding area and infrastructure after an extreme earthquake with a PGA greater than 0.6 g, it seems unrealistic to prevent a meltdown scenario with the means available.
Even if all the planned measures are implemented, the resilience of the facility remains a problem. First, the possible maximum earthquake magnitude is not sufficiently explained. Second, not even an assessment of increased seismic hazard has changed the planning bases (instead, only the additional systems installed as part of the Safety Upgrade Programme will be suitable for the updated PGA of 0.6 g). Third, even though the probable consequences of a powerful earthquake are known, the seismic safety margins are very small.

After studying Krško NPP's explanations, the ministry responds by saying that the claim that the possible maximum magnitude is not sufficiently explained is not true. In the PSHA, the magnitudes are determined in relation to the characteristics of the individual seismic sources and incorporated into the PSHA for the Krško NPP site (PSHA 2004). In the updated hazard analysis, which is in the final stages of implementation, three branches of the logic tree are considered for the maximum magnitude values for each individual seismic source; this ensures that the uncertainty involved in determining the maximum magnitudes is taken into account.
The stress tests carried out in 2011 showed that, on account of the safety factors taken into consideration during the project design process, Krško NPP could shut down safely and maintain long-term cooling operations in the event of an earthquake with a PGA greater than 0.6 g at surface. The ENSREG stress-test report of 2011 estimated that damage to the core was unlikely with earthquakes with a PGA of less than 0.8 g at surface. However, this estimate did not take into account the favourable impact of the new safety equipment installed at the plant in the last ten years in response to the Krško NPP Safety Upgrade Programme (see also the responses to one of the questions above).
As the Krško reactor has only one water supply source, an additional, earthquake-resistant main cooling source was planned independently of the Sava (ultimate heat sink, UHS). (SUP, No 1.3). As the stress-test report states:
"Krško NPP does not have an alternative ultimate heat sink. The installation of a new water line from the Krško HPP was mentioned in the report, but this project was abandoned."
According to the updated national action plan for 2019, the planned installation of the additional cooling source (UHS) has been cancelled. Consequently, only additional cooling using a steam generator cooling system has been introduced: In order to ensure that the reactor core is cooled in the event of an electricity outage and/or failure in the main cooling source (UHS), an additional high-pressure pump for supplying the steam generators was planned in 2015, to be housed in a separate bunkered building with its own water supply (SUP, No. 1.2). The design value of the bunkered building also meets the requirements of the design-extension conditions (DEC), which do not ensure sufficient safety margins.
BB2 (Bunkered Building 2, a reinforced safety structure) is designed to accommodate an alternative safety injection (ASI) system, an alternative auxiliary feedwater (AAF) system and safety power supply to the building. The AUHS is ensured by the construction of BB2 and the installation of the ASI and AAF systems.
The BB2 facilities and systems from the Safety Upgrade Programme, which were built away from the foundations of the main Krško NPP island, were designed for a peak ground acceleration of 0.78 g at the level of the foundations. During the construction of the new facility, the safety acceptance criterion with regard to the analysis of seismic vulnerability was also determined using HCLPF PGA. As has been pointed out on several occasions, additional safety factors are used when designing nuclear facilities so that the likelihood of component failure (including in BB2) is approx. one or two orders of magnitude lower than the likelihood of the occurrence of the design ground acceleration. It should also be pointed out that the design PGA for the BB2 facility and systems exceeds the value
corresponding to a recurrence interval of 10,000 years set out in the PSHA from 2004. According to the preliminary results of the updated PSHA study, which is currently being prepared, the new value of a recurrence interval of 10,000 years is also lower than the design acceleration taken into consideration for BB2.
The impacts of various earthquakes and the adverse events associated with them are taken into account

when the CDF is being determined; for Krško NPP, this is estimated with respect to the value acceptable under Slovenian law. This confirms that Krško NPP's seismic safety is adequate.

Question 8: An updated international investigation into seismic hazard should be carried out and the results incorporated into the EIA Report.

After studying Krško NPP's statements and the SNSA's opinion, the ministry responds by saying that it carries out an EIA procedure on the basis of the information submitted and that it has sufficiently precise information at its disposal to enable it to make a decision. In order to continue to devote sufficient attention to seismic safety in the future, an additional measure has been determined in response to the observation: that Krško NPP must draft an action plan for the third Periodic Safety Review (PSR3*) that includes an update of the PSHA for the Krško NPP site, submit it for approval to the SNSA no later than by the end of 2023 and, on this basis, carry out any additional measures required to increase the nuclear safety of the plant (measure in point II./1.18 of the operative part of this environmental protection consent).

Question 9: Transboundary impacts
According to the EIA Report, design-basis accidents and design-extension conditions can be controlled by a passive filtering system (PCFVS) in such a way that, even in the worst possible case (source term), only very minor releases of radioactive material are expected (Section 2.7.3.2, p. 71):
"However, it is unlikely that there would be direct releases into the environment if the core melted."
Section 6 (p. 384) also envisages very low transboundary impacts, and only in directly neighbouring Croatia, even under the most unfavourable assumptions:
"On the basis of the environmental factors analysed, we can conclude there would be no significant adverse transboundary environmental impacts during normal operation. In the event of a nuclear accident, with the range of scenarios described below (see Section 6.4), significant adverse transboundary environmental impacts might occur. However, the analyses and models below show that the impact would be restricted to the territory of Croatia and have a very limited extent."
Section 6.4 outlines the "expanded design-basis accident of station blackout (SBO)" under the following assumptions:
"The selected accident type is SBO design-extension conditions with no action taken in the first 24 hours (the core is damaged and leaking into the containment sump), followed by measures involving the use of alternative engineered safety features."
According to Section 2.13.5 (p. 123) of the EIA Report, mobile systems are used:
"In the worst possible emergencies, it is possible that the power plant is left without a power supply and without sources of cooling water to cool the reactor and spent fuel elements. For such cases, Krško NPP has mobile equipment that guarantees electricity supply, cooling and process air over a longer time period."
This assumption is possible for the reasons set out in the "Seismic risks" section.
The destruction of infrastructure resulting from a powerful earthquake and the unavailability of the uniform hazard spectrum after a 24-hour SBO is unrealistic.
The operating company estimates that even in this most unfavourable situation, the scenario is one in which the release (source term) of radioactive material is only one sixtieth (!) of one of the releases that occurred at the Japanese Fukushima Daiichi nuclear power plant in 2011:
Under these assumptions, according to Table 140 on page 422 the release of 503.2 terabecquerels of Iodine-131 (I-131) was missing, while according to the most recent analyses and measurements of the super-meltdown at Fukushima, 30 petabecquerels of I-131 were actually released at the destroyed reactor, i.e. 60 times more.
According to the assumptions selected and Table 140 on page 423, the release of 77.5 terabecquerels of Caesium-137 (Cs-137) was missing, while according to the most recent analyses and measurements, 2.5 petabecquerels of Cs-137 were released at the destroyed reactor during the Fukushima meltdown, i.e. more than 32 times the stated amount.
Of course, under an optimistic assumption of very small releases, no transboundary impacts are to be

expected. However, this approach is impermissible from the point of view of an engineer, who always has to account for the "actual worst case".
The next summary on page 437 is therefore extremely flippant and should be amended:
"Based on the results of the study, we conclude that in a design-basis accident involving a loss of coolant (LB LOCA) and a beyond-design-basis accident (DEC-B), which also represent the worst accident scenario, there would be no major transboundary impacts on the environment or on human health and property."
Proper treatment of the worst-case scenario must, of course, consider realistic (and real) assumptions regarding the radioactive inventory (source term), which must be submitted subsequently.

Regarding these statements and those of Krško NPP, the ministry responds by saying that the representative accident in the EIA Report was selected on the basis of the Krško NPP Safety Analysis Report, deterministic and probabilistic safety assessments, and internationally recognised nuclear safety standards, in line with industrial and regulatory practice. The reference severe accident (DEC-B) was selected as the limiting or "envelope" scenario presenting the biggest challenge to transboundary impact resulting from a very conservative (almost improbable) scenario involving the loss of all AC power supply, the loss of safety/auxiliary systems, the loss of operating crew for 24 hours (no action is taken by operating crew in the first 24 hours), and radioactive releases through the systems and the passive containment filtered venting system (PCFVS), with additional design-basis leakage from the increase in pressure. An explanation of the selection of the representative accident is given in Section 6.4 of the EIA Report.
This accident scenario was chosen because of the expected complete meltdown of the core and the most rapid and most conservative release of radioactivity in the containment. This means that the EIA addressed the highest possible radioactive inventory (source term). The purpose of the PCFVS is to protect the integrity of the containment in the event of an increase in pressure caused by a severe accident, to filter the atmosphere of the containment in the event of any release, and to protect the environment and the population against radioactive aerosols in the atmosphere and from gaseous radioactive iodine and its organic substances. The system is passive and has been entirely designed in accordance with the requirements of the design-extension conditions (including earthquake-related conditions). Moreover, the analysis considers the release of radioactivity from containment leakage before and after the PCFVS is activated. Therefore, in summary, the most conservative assumption was used: that of complete damage to the core together with the conservative containment leakage and the use of a passive, conservatively designed filter system for protecting the containment.
Following the Fukushima accident, Krško NPP carried out a series of analyses of design-extension conditions. The analyses addressed the combinations of accidents, based on which an additional upgrade of the nuclear power plant was required (DEC). The safety upgrades were carried out as part of the national post-Fukushima action plan following the EU stress tests, and took place as part of the Safety Upgrade Programme described in Section 2.7.12 of the EIA Report. The new additional systems installed as part of the SUP ensure that Krško NPP will manage beyond-design-basis accidents using the extended range of equipment and upgrades. Safety upgrades were carried out in the areas of seismic hazard, flood protection, mitigation of the effects of fire, and the provision of additional sources of supply in the case of emergency situations or the loss of power supply, etc. (EIA Report, Section 2.8). The Krško NPP SUP has led to a reduction in risk in the last few years. All safety upgrades are reflected in the Krško NPP safety analyses and in the PSA model, which shows a significant reduction in the core damage frequency (EIA Report, Section 2.8).
In light of the above, the analysis of the reference severe accident in the EIA Report suitably addresses the worst possible scenario, with due regard paid to the real (and current) assumptions regarding the radioactive inventory (source term).

Question 10: Emissions of ionising radiation in normal operation
According to Section 4.4.6.1 (p. 245), 3.45 terabecquerels of tritium (H-3) and 19.8 petabecquerels of carbon (C-14) were released into the atmosphere in 2020. According to Section 4.4.6.2 (p. 251-3), an average of 11.3 terabecquerels of tritium (H-3) was released in the 2010–2020 period and an average

of 1.7 gigabecquerels of carbon (C-14) was released in liquid emissions of radioactivity between 2013 and 2019. According to Section 4.4.6.4 (p. 255), 5.6 terabecquerels of radioactive liquid tritium (H-3) were released in August 2019 alone. Nevertheless, the following appears in the conclusion regarding emissions of ionising radiation in Section 4.4.7.6 (p. 277): “The authors of the report (87) state that all types of exposure of the population are negligible in relation to naturally occurring radiation, limit doses and the permitted limits.”

This does not correspond to the findings of the “Epidemiological study of childhood cancer in the vicinity of nuclear power plants (KiKK study)”, which is not addressed in this context. The KiKK study analysed the areas surrounding 16 German nuclear power plants for the 1980–2003 period (a total of 22 reactors). A total of 1,592 cases involving children under the age of five and 4,735 control cases from the same regions were described at the time of diagnosis, with cancer occurring significantly more frequently (+60%) in the vicinity of (five kilometres from) nuclear power plants, particularly leukaemia (+100%). One possible interpretation for these empirically proved higher rates of cancer is the peak in the release of radioactive tritium (H-3) and carbon (C-14) when the reactor pressure vessel is opened during the replacement of fuel elements, which can lead to embryos and foetuses being marked with high concentrations of radioactivity.

The discussion of the possible effects of releases of radioactive tritium (H-3) and carbon (C-14) from Krško nuclear power plant and of the effects that can be expected from these releases, particularly on children and adolescents in the vicinity of the reactor in light of the German KiKK study, should be delivered subsequently.

In relation to these comments and after studying Krško NPP’s statements and the positive opinion produced by the Ministry of Health in the EIA procedure, the ministry estimates that significant impacts on the health of the population are not likely under the conditions of normal operation assessed in the KiKK study, and points out the following in relation to the KiKK (BfS) leukaemia study.

Incidence of leukaemia in children

Leukaemia is the most common form of cancer in childhood. It accounts for between 25% and 30% of all newly detected cancers among the under-15s worldwide. The mechanisms that cause leukaemia among children are still poorly understood. Figures from European cancer registers indicate that the incidence rate of leukaemia among children grew on average by 0.7% a year between 1970 and 1999. In the last 20 years, this has risen to 1% a year, mainly in wealthier countries. Slovenia has a long history of gathering of data on cancer cases. The Cancer Registry of Slovenia (SLORA/CRS) has been maintained at the Ljubljana Institute of Oncology since 1950, making it one of the oldest population registries for cancer in Europe. For more than 60 years it has gathered and annually published data on the incidence, prevalence and survival rate of cancer patients. Its website provides data from 1961 on.

The CRS records data on the incidence of all types of cancer by sex, age and region. Krško nuclear power plant is located in the Spodnjeposavska (Lower Posavska) region. According to CRS figures for 1980–2018, the Spodnjeposavska region (marked in turquoise in the graph) does not stand out in terms of the number of new cases of leukaemia among children and adolescents (0–19 years) in comparison with other Slovenian regions (source: http://www.slora.si/stevilo-novih-bolnikov).

Figures from the World Health Organization on the average incidence of leukaemia among children aged under 14 in the countries of the European region in 2000 does not show a link between nuclear power plants and the incidence of childhood leukaemia in these countries. As we know, Italy has no nuclear power plants, but still had the highest age-standardised incidence rate (ASIR) of leukaemia among the under-14s (number of patients per million inhabitants) among the selected European countries in 2000. Source:https://www.euro.who.int/__data/assets/pdf_file/0005/97016/4.1.-Incidence-of childhoodleukaemia-EDITED_layouted.pdf

Because of the small number of cases (between 5 and 18 new cases per year according to data from the National Institute of Public Health, published on 22 October 2020 at www. kazalci.arso.gov.si.), we are unable to identify a characteristic trend in incidences of childhood leukaemia in Slovenia in the 1998–2017 period.

In 2006 the Municipality of Brežice and the Agency for Radwaste Management (ARAO) commissioned

a report from Ljubljana Institute of Oncology (www.onko-i.si) ("Incidence of cancer in the Municipality of Brežice in comparison with the rest of Slovenia", which was a geographical analysis of the incidence of cancer in the Municipality of Brežice based on data from the CRS).
Data was collected for a standardised incidence ratio in the 12 statistical regions of Slovenia in three consecutive periods: period one 1970-1983, period two 1984–1993, and period three 1994–2003 (both sexes together).
The report states that the factors so far known as causing leukaemia are ionising radiation and certain substances at the workplace, while studies are being made of the impact of some viral infections.
The data excludes chronic lymphocytic leukaemia, which typically does not affect children, as the analysis reports. Across the whole of Slovenia, the risk rose in the third period and was significantly higher than in the first period. There were no statistically significant region-by-region differences in the risk of developing leukaemia. Compared to Slovenia as a whole, the risk in the Spodnjeposavska region was average in all three periods. In the most recent period the risk has increased in Eastern Slovenia as well, although it was not possible to detect any specific areas in which there was a particularly higher risk of leukaemia. The Municipality of Brežice is average in terms of the size of the risk. The incidence for the Spodnjeposavska region in the three periods referred to above is:
0.85–0.97 for the first period 1970–1983
0.71–0.84 for the second period 1984–1993
0.98–1.11 for the third period 1994–2003
The nationwide figures for people falling ill with leukaemia were 57 in 1970, 82 in 1983 and 122 in 2003 (75 men and 47 women). In the third period, the statistical regions with the highest incidence (1.12 and over) were Goriška, Obalno-Kraška, Jugovzhodna Slovenija and Zasavska.

BfS study
This study (Epidemiologische Studie zu Kinderkrebs in der Umgebung von Kernkraftwerken – KiKK-Studie), which advances a hypothesis that proximity to a nuclear power plant has a harmful impact on health, was commissioned by the German Federal Office for Radiation Protection (Bundesamt für Strahlenschutz, BfS). In its most recent announcement on 13 October 2021, (www.BfS.de), the Office states the following position on the study:
"... There is currently no plausible explanation for the observed effect, which shows a largely consistent pattern with minor fluctuations over the 24-year period studied. It could be a combination of different causes. The interaction of the various factors and the underlying mechanisms of childhood leukaemia are therefore the focus of current research."
It also published a notice on its website on 11 November 2016 in relation to the findings of a group of international experts:
"Identifying the causes of childhood leukaemia
A large number of factors are thought to cause childhood leukaemia, including infections and pesticides, low doses of radioactivity and low-frequency magnetic fields from the power grid. Despite the different approaches and initial findings, there is still a need for research, as we know too little about the causes of the disease.
At the invitation of the BfS, paediatricians, radiation protection experts, epidemiologists, geneticists and scientists from other disciplines will exchange their research results and the current state of knowledge in their respective disciplines in Munich from 14 to 16 November 2016. The aim is to create new starting points for research into the causes and to further develop research strategies.
For the fifth time, the BfS workshop brings together international experts who are working on the causes of childhood leukaemia. The BfS initiative is based on the one hand on studies that show a possible connection between low-frequency magnetic fields from the power grid and the risk of leukaemia in children. On the other hand, the discussions refer to the KiKK study: A 2007 study showed that children under five living near a nuclear power plant had a significantly increased risk of leukaemia. In both cases, there were no scientifically reliable explanations for the causes of the disease."

Epidemiological research in the USA, UK and Switzerland
A number of detailed studies have been made of the hypothesis advanced by the BfS study regarding

nuclear power plants. None of them have confirmed a correlation between leukaemia and proximity to a nuclear power plant. This finding is explained in more detail in the following two articles:

- "Childhood Cancer Incidence in Proximity to Nuclear Power Plants in Illinois", November 2012, a publication of the Illinois Department of Public Health, Division of Epidemiologic Studies, Springfield, Illinois, November 2012
- "Nuclear power plants cleared of leukaemia link", Daniel Cressy, Nature (May, 2011);

"Investigation of cancer clusters should turn to non-radiation causes, say British researchers". Research into leukaemia incidence has also been undertaken in Switzerland. The paper below describes this issue in broad terms:

- "Nuclear power plants and childhood leukaemia: Lessons from the past and future directions", Claudia E. Kuehni, Ben D. Spycher, Institute of Social and Preventive Medicine (ISPM), University of Bern, Switzerland; Swiss Med Wkly. 2014;144:w13912

C-14 measurements in the vicinity of Krško NPP

Another of the shortcomings of the BfS study is that it does not acknowledge or address actual measurements of potential contaminants, which present a hypothetical problem. Carbon C-14 was the substance most heavily highlighted in the study.

For a number of years, measurements have been carried out in the vicinity of Krško NPP that can show the order of magnitude of concentrations in nature or the changes to the natural concentrations of C-14 from releases. Very roughly speaking, the increase in the immediate vicinity of the facilities or at the perimeter fence is, on average, higher than the natural values for CO_2 by a factor of two during the period of nuclear refuelling, while dilution in the atmosphere is significantly greater at a distance of more than one kilometre; therefore, there cannot be more significant deviations from naturally occurring C-14 values. We can also model CO_2 emissions into the atmosphere more accurately using the Lagrange "in-cell" model, and take C-14 measurements at the ventilation outlets into consideration. More detailed monitoring of C-14 during refuelling was reported in 2008 ("Verification of the dispersion model by airborne carbon C-14", Breznik et al.; INIS-A-RC—900 online inis.iaea.org)

In relation to measurements in the environment, papers and internal reports are regularly published by internationally recognised experts from the Ruđer Bošković Institute in Zagreb. The initial results of two cases available online (inis.iaea.org) are illustrative: "Activity of ^{14}C in the atmosphere and vegetation in the vicinity of Krško nuclear power plant 2006–2010", I. Krajcar Bronić, B. Obelić et al.; and "Six years of the systematic monitoring of ^{14}C in the atmosphere and vegetation in the vicinity of Krško nuclear power plant (Krško NPP)".

Slightly elevated values are reported in plants in the course of sampling after refuelling relative to the reference or normal value of C-14 in carbon, which is up to around 104 pMC ("percent Modern Carbon"). According to the definition, 100 pMC corresponds to 226 Bq/kgC and, in the case of CO_2 in the air, natural activity in the air is 46 mBq/m^3. Only after refuelling were the values in plants at the Krško NPP perimeter around 120 pMC. At a distance of 1 km, the values were 110 pMC. In a year without refuelling, the C-14 values in plants at a distance of 1 km were similar to those at a distance of around 10 km, i.e. 104 pMC.

The calculated doses under the applicable scientific assumptions in the hypothetical case of the consumption of large quantities of these plants are negligible. Even inhaling air throughout the year does not lead to any noteworthy increase in the individual's dose at the Krško NPP perimeter.

Monitoring of unbound and organically bound tritium via atmospheric exposure pathways

The concentration of naturally occurring tritium in rainwater is approximately 1 Bq/l, which causes the natural presence of tritium in food and living organisms via moisture in the air and via water. Tritium is a constituent of water (HTO). The possibility of organically bound tritium (OBT) affecting living organisms has been highlighted in recent years. Measurement methods enable us to trace the presence of tritium in the environment in an extremely precise way. For example, in 2021 the IRB Zagreb laboratory conducted periodic special sampling of apples and corn in the immediate vicinity (the sampling was commissioned by Krško NPP) and found OBT in both materials. Only at one point in the immediate vicinity of the facility (by the perimeter fence) was the measurement four times higher than the wider

surroundings, while at other places the difference was lower.
In that case, the difference in the tritium measurement right by the buildings of the plant was the result of the continuous ventilation of the premises (at a discharge height of around 40 m above the ground). The majority of the ventilation filters release steam. Because the atmospheric releases are diluted, concentration decreases rapidly with distance. The annual reports on the monitoring of the surrounding area contain statistical data on the dispersion coefficients.
Krško NPP determines the dose from the inhalation of H-3 at a distance of 500 m from the reactor on a monthly basis, following continuous sampling and laboratory measurements carried out by the Jožef Stefan Institute in Ljubljana. The annual value of an individual's internal dose at this distance is, together with the impact of other radionuclides (including C-14), no more than 1 or 2 microSv (conservative ground discharge assumption applied). This is a negligible amount and one that does not increase cancer risk.
In addition to the large number of H-3 measurements performed in the Sava, in boreholes and at drinking water pumping stations, H-3 measurements of precipitation and sediments are also carried out at the following locations:

- Stara Vas, continuous monthly sample, collected every 31 days, 12 measurements a year;
- Brege, continuous monthly sample, collected every 31 days, 12 measurements a year;
- Dobova, continuous monthly sample, collected every 31 days, 12 measurements a year.

Regarding the estimate of the impact of OBT on the health of the population, the calculation shows us that its contribution to the dose after the consumption, for example, of around 100 kg of apples is completely negligible. The effective dose or total contribution of all forms of tritium (unbound and organically bound) is 0.05 µSv ($5.0E^{-5}$ mSv) from the consumption of water and food at Brege, and around 0.1 µSv ($1E^{-4}$ mSv) from the consumption of water from the Sava (JSI estimates for 2021).
Tritium does not accumulate or build up in living organisms (see "An updated review on tritium in the environment", Eyrolle Frédérique et al., Institut de Radioprotection et de Sûreté Nucléaire (IRSN), November 2017, Journal of Environmental Radioactivity). Its radiotoxicity remains less significant than that of other naturally occurring or typical artificial radionuclides.
The impact of tritium in the case of heavy water (CANDU) reactors can be much more significant for the population because they produce much more tritium than light water reactors. In the case of future fusion reactors as well, tritium could appear in greater quantities or have an impact on the surrounding area in the event of an accident.

Final disposal
Forty years after the Krško reactor began operating, the issue of the final disposal of high-level radioactive waste remains completely unresolved. According to Section 4.4.11.3 (p. 292), a total of 1,553 spent fuel elements with highly radioactive isotopes will have been produced by the end of the regular operating period in 2023. This rises to 2,281 spent fuel elements if the operating period is extended by another 20 years. According to p. 293:
"The owners have also opted for a joint guarantee for the final storage of ABE [spent fuel]. The joint repository is to be built in Slovenia or Croatia." [emphasis added]
It is also explained elsewhere (Section 6.3.5, p. 389) that there is no concrete plan for the final disposal of high-level radioactive waste:
"When this report was being drafted, the exact location of the storage facility was unknown."
In addition, the (delayed) completion of the spent fuel dry storage by 2023 will not be used for the complete relocation of 1,323 fuel elements (from the end of 2020), even though the EIA itself clearly acknowledges the risk of continuing to store spent fuel in the wet storage facility (Section 2.7.12, p. 84):
"Alongside the reactor core, the spent fuel pool at Krško constitutes the most significant potential source of radiological hazard for the surrounding area in the event of a nuclear accident."
5. A concrete plan for the long-term final disposal of high-level radioactive waste must be submitted before approval for the lifetime extension of Krško NPP is granted. The plan must involve not only a siting and public participation plan, but also a financing plan as provided in Directive EU 2011/70. As the currently available funds of EUR 0.2 million are way too low (the costs for the repository in Finland

are EUR 5 billion), a decision must be taken to increase the fees paid into the Slovenian nuclear waste fund. In addition to this, the plan to relocate spent fuel elements must be adjusted so that as many fuel elements as possible are transferred to dry storage as soon as possible, in order to reduce the risk, rather than only some of the fuel elements being moved initially for cost reasons.

In relation to these statements, the ministry explains that under the Act Ratifying the Treaty between the Government of the Republic of Slovenia and the Government of the Republic of Croatia on the Regulation of Status and Other Legal Relations Regarding Investment in and the Exploitation and Decommissioning of Krško Nuclear Power Plant (Official Gazette of RS [Mednarodne pogodbe], No. 5/03, hereinafter: Intergovernmental Treaty), the Intergovernmental Commission tasked with monitoring the Treaty and performing other tasks in accordance with the Treaty (hereinafter: Intergovernmental Commission) approved the Third Revision of the Krško NPP Decommissioning Programme and the Programme for the Disposal of Radioactive Waste (RW) and Spent Fuel (SF) from Krško NPP on 14 July 2020. Every five years at least, periodic revisions of the programme are carried out with the aim of updating the reference disposal concept in line with the latest technical solutions and information. Under the third and fourth paragraphs of Article 10 of the Intergovernmental Treaty, the Krško NPP Decommissioning Programme and the Programme for the Disposal of RW and SF from Krško NPP are the two relevant documents that contain an estimate of the funds required to carry out the activities that the programmes deem to be necessary. In accordance with the provisions of the Intergovernmental Treaty, costs are funded by regular payments into two special funds: “Sklad NEK” in Slovenia and the “Fond za financiranje razgradnje i zbrinjavanja radioaktivnog otpada i istrošenoga nuklearnog goriva NEK” in Croatia. Based on the adopted programmes, the Slovenian government set a new amount of the contribution to be paid into the Krško NPP Fund by GEN energija. Since September 2020, the amount of that contribution has been EUR 0.0048 for every received kWh of electricity generated by Krško NPP. That figure rose to EUR 0.012 on 1 January 2022. Every year, HEP d.o.o. pays EUR 14.25 million into the Croatian Fond NEK in accordance with a Croatian government decree.

Krško NPP is planning to relocate spent fuel elements from wet to dry storage as a risk-reduction measure. As far as planning the relocation timetable is concerned, it will rely on its own experience and the timetables of similar storage facilities. Safety and the use of a highly qualified technical workforce will be key to the process; and while speed of relocation of the spent fuel is important, it does not take precedence over other criteria. Krško NPP has adjusted the timetable to make it optimal.

Completion of SF dry storage is planned for the end of 2022, while the relocation of 592 fuel elements from the spent fuel pool to dry storage will take place in the first half of 2023. When the dates of the envisaged campaigns of relocation to dry storage were being planned, consideration was given to the factors of technical feasibility, radiation and nuclear safety, and cost-effectiveness. The date of the campaigns and the number of fuel elements to be relocated have been acknowledged as optimal.

Krško NPP will continue to review the timetable of the relocation of spent fuel from the spent fuel pool to dry storage, and adjust it as required to minimise the risks associated with spent fuel.

Alternatives

According to the EIA Report, extending the operational lifetime of the Krško reactor for another 20 years is “the most favourable alternative of all the technologies” (Section 3.1, p. 148):

Energy, system, environmental protection and economic studies have shown that the lifetime extension of Krško NPP constitutes the most favourable alternative of all the technologies suitable for the generation of electricity in base-load mode and matured for commercial use by 2023.

The Krško reactor is a year-round generator of electricity in base-load mode (Section 2.1, p. 55): “In accordance with its operating characteristics, Krško NPP operates in base-load mode throughout the year.”

This statement on the “year-round” load capacity of the base load runs contrary to the effects of the climate crisis and the changed operational management resulting from the heating of the Sava, as the EIA Report itself mentions (Section 4.1.4.2, p. 186): “The average monthly temperature of the water that enters the HPP chain (into the Vrhovo Basin) has increased by between 1.5 and 2°C in the summer months over recent decades, while the highest temperatures in the same period have also increased

by between 3 and 4°C. This means a significantly higher ‘natural temperature background’ for Krško NPP operation.”
In the tables showing the average daily and monthly temperatures of the Sava, which are printed at Krško, it is already 27.5°C. According to Section 4.4.4.1 (p. 229), over a few days in 2020 full use was made the of highest permitted temperature increase of 3°C, even in summer months with a “higher temperature background”.
According to Section 5.6.1 (p. 328), reactor power should be reduced “if the temperature difference ΔT cannot be maintained below 3°C even when the cooling towers are in operation”. The average temperature increase cannot be maintained below 3°C even when the cooling towers are in operation. According to Table 115 (p. 332) in the same section, because of the advancing climate crisis the “availability of water (drought)” is contributing to the “future vulnerability of electricity generation” from Krško NPP. Also emphasised on p. 334
“It is also a fact that the intensity of climate change has increased in recent years. The temperature of the Sava River rose from an average of 10.9°C in the 1984–1993 period to an average of 12.6°C in the 2011–2020 period.”
According to Table 121 (p. 337), the number of days on which the cooling tower is expected to operate is set to rise from the current average of 122 days a year to an average of 138.9 days a year and, in years with low Sava flow rates, to up to 229.3 days a year (or two thirds of the year). This will have a negative impact on electricity generation in the reactor because of the consumption of electricity by the cooling towers. The targeted reduction of power in order to be able to meet the authorised parameters is an even stronger measure. Page 339 contains this statement:
“One can conclude from the table (Table 123) that even though it is not possible to rule out the need to lower capacity because of climate change, the likelihood, given the climate change projections currently available, is relatively low.” And on p. 340: “Climate change could only rarely cause the occurrence of such situations, on average 1–2 days a year in 2043.” If an unfavourable year occurs (2019 projection into the future), the number of days on which power has to be reduced could be up to ten times higher.”
In other words, even according to the modelling available to the operator, the reactor will have to undergo unplanned power reduction on up to 20 days, which contradicts the statement on the reliable year-round operation of the base load.
Moreover, consideration is not given to the fact that according to the Ordinance on the emission of substances and heat from the drainage of effluent from pollution sources, the maximum permitted temperature of river water is 30°C (this value will probably be exceeded during the planned lifetime extension of the reactor because of the current climate crisis, meaning that it will not be possible to ensure the continuous base load of the reactor, as has happened with comparable nuclear power plants in France and elsewhere because of the climate crisis, particularly in the summer months).
Alternative technologies for the proposed lifetime extension of Krško NPP are not presented in relation to the state of the art and the costs, as the next example from Section 3.2.2 (p. 150) shows: Here it is calculated that 655 wind turbines with a nominal power of 2.3 MW would be required to provide the equivalent amount of electricity from the Krško reactor.
This does not correspond to the state of the art in 2022, where wind turbines have been installed with a power of 4.2 MW and more. Assuming systems with 4.2 MW, an energy yield of 10–12 GWh/a at 3,000 hours of full load would require only 242 wind turbines a year with a total investment cost of EUR 1.6 billion.
While the undoubtedly possible negative impacts of renewable energy sources from the environmental point of view are given full consideration in the EIA Report, the negative effects and the possible lifetime extension of Krško NPP are shown in a much more positive light. Section 3.2.3 (p. 153) contains a table that shows in detail the “possible negative effects” of renewable energy sources, including “solar energy” and the “creation of dangerous pollutants during dismantling”.
The study by the Energy Economics group at Vienna University of Technology came to this conclusion based on the current technical data on the available technologies and on the current costs of electricity generation.
“A more detailed review of potentials in Croatia and Slovenia shows that the domestic potentials of renewables do perhaps suffice to compensate for the shortfall in supply arising from the early exit from

coal and nuclear energy."
"The strong use of renewable energy sources as envisaged in the just transition scenarios will lead to a fall in electricity prices on the wholesale market in the coming years, which is a result of the proactive gradual abandonment of electricity supply using fossil fuels in Slovenia and Croatia and across the whole of the European continent. Variable renewable sources such as hydroenergy, wind power and solar photovoltaics have lower operating costs, which will lead to a fall in wholesale prices."
6. Scenarios containing realistic assumptions regarding the technical availability and effectiveness of all alternative technologies must be presented. Some of the studies and assumptions presented in the EIA Report are out of date and clearly give precedence to nuclear technologies without properly considering the risks and limitations of availability in light of the advancing climate crisis.

In relation to these comments, the ministry explains that full consideration has been given to climate change and that both the EIA Report and the ministry in the operative part have ensured that all the listed measures for reducing impact on waters set out in points II/1.1 to II/1.17 of the operative part of this environmental protection consent will be carried out.
The ministry explains that Slovenia's 2021 Integrated National Energy and Climate Plan (NECP) and Croatia's 2020 Integrated National Energy and Climate Plan were drawn up and presented to the European Commission in accordance with Regulation (EU) 2018/1999 of 11 December 2018 on the Governance of the Energy Union and Climate Action. All scenarios of future energy use and supply defined in the national energy and climate plans are based on the lifetime extension of Krško NPP in order to enable the energy and climate policy targets to be met. The analyses carried out as the basis for the National Energy and Climate Plans have shown that increasing the use of renewable and non-carbon resources and increasing energy efficiency are not in themselves sufficient to enable the targets to be met if we take the estimated electricity needs and the increased requirements for reducing greenhouse gas emissions into account.
A study titled "Energy, systemic, economic and ecological aspects of the extension of the operational lifetime of Krško NPP", which was drawn up by Elektroinštitut Milan Vidmar and the Faculty of Electrical Engineering at the University of Zagreb, showed that Krško NPP would be irreplaceable during the period of the proposed lifetime extension. Without Krško NPP, both countries will be reliant on electricity imports, where and if available. EU Member States' national energy and climate plans show a net energy deficit, meaning that electricity imports will not always be available and that reducing consumption will be the only alternative in crisis situations. This runs contrary to the first dimension of the energy Union: "Energy security, solidarity and trust – diversifying European energy sources and ensuring energy security through solidarity and cooperation between Member States". Extending Krško NPP operation to 2043 is the starting point on the path to decarbonisation and long-term energy independence. It will not be possible for either country to maintain short-term energy security without Krško NPP. Due to the planned increase in electrification of traffic (use of electric vehicles), heating (use of heat pumps), and the electrification and phasing out the use of fossil fuels in other sectors, both countries will require an ever-increasing share of stable energy in the form of electricity. According to estimates, the electricity deficit will continue to rise in Slovenia (for several years now, Slovenia has been importing electricity to cover about 20% of its consumption). By 2030, Slovenia will have a deficit of at least 1 TWh/year of electricity if Krško NPP continues to operate, regardless of development of technology, significantly more efficient consumption of electricity and the intensive introduction of new renewable energy sources. The gradual reduction in the use of fossil fuels therefore further highlights the role of nuclear energy, which is a seasonally stable, low-carbon source of energy. Current and projected developments do not show that we are yet at the point where current electricity production capacities can be met entirely by energy from renewables while satisfying the need, today and in the future, for energy supply that is reliable, secure, environmentally sound and cost-effective. The need to work within spatial restrictions and preserve natural and other assets hinders the development of the new renewable energy sources that could otherwise replace Krško NPP in the next 20 years. Based on the analysed scenarios, the energy balance sensitivity analyses and the projected required power, the lifetime extension of Krško NPP is shown to be the most favourable solution from the technical, environmental and economic standpoints. Events in recent months, which have seen a steep rise in fuel and electricity

prices, are further confirmation of the urgency of maintaining production at Krško NPP, as it guarantees affordable and sufficient supply of the electricity that industry and commerce so desperately need. If the operational lifetime of Krško NPP is not extended, Slovenia and Croatia will no longer be able to meet the requirements of the strategies and commitments referred to above. Moreover, it will endanger the stability and reliability of operation of the electricity system, which could lead to slower progress towards climate neutrality.

The overheating of the Sava River is prevented by means of a number of measures, including a combined cooling system and the activation of the cooling towers. In 2008 Krško NPP expanded its cooling capacity with the construction of a third block of cooling towers, leading to a total cooling capacity of 627.8 MW. The upgrading of the cooling towers in 2008 increased cooling capacity by 36%, This has reduced the likelihood of situations in which the plant is required to reduce power in response to a possible exceeding of the 3°C level. Section 5.6.1 of the EIA Report gives an estimate of the days in which the need could arise for the plant's power to be reduced. As the likelihood of such events is extremely small, additional measures are not required (Table 123) – indeed, plant power has not had to be reduced on a single occasion since the cooling towers were upgraded in 2008. The cooling towers can disperse 49.5% of the power plant's total waste heat, which means it has large reserve capacity for heat removal. Between 2010 and 2020, the average temperature of the Sava at the point of full mixing rarely exceeded 27°C in one day (four times in July 2015, once in August 2017 and four times in August 2018), but it never exceeded 28°C. The projected trend in the rise of the average temperature in the summer months is between 0.3 and 0.4°C per decade for the area of the Lower Sava ("Estimate of climate change in Slovenia up to the end of the 21st century". Synthesis report – Part One, ARSO, November 2018). In relation to the measurements contained in the study titled "Energy buildings along and on the Sava – Analysis of river temperatures in the Lower Sava in July and August 2019 and the verification of previous studies" (Revision A, IBE, April 2020), the reservoir of the Brežice hydropower plant has an additional cooling effect on the water.

The alternative to lifetime extension is presented in Section 3 of the EIA Report. The Espoo Convention requires an assessment to be made of the possible alternatives to a proposed activity, while the EIA Directive requires reasonable alternatives to be examined. Possible (i.e. reasonable) alternatives must be capable of satisfactorily achieving the objectives of the proposed activity, and must also be feasible in terms of the technical, economic, political and other relevant criteria. It must be realistic to realise the alternatives at the time the decision on the project is taken. Constructing a power plant or plants (including those that use renewables in combination with other sources) to replace production at Krško NPP is currently not a realistic proposition. In addition, the UNECE Good Practice Recommendations on the Application of the Convention to Nuclear Energy-Related Activities, Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention), explain that alternative means of energy production are national issues of the party of origin and are therefore more properly addressed at the strategic level, as they are in the Integrated National Energy and Climate Plan.

The conclusions of a study produced by Vienna University of Technology, which sets out the options for the future use of renewables for energy purposes, highlight the natural conditions, such as solar radiation and the presence of wind, in Slovenia and Croatia. However, the ministry notes that it does not take into account the vulnerability of the area, i.e. any other equally important circumstances and legal restrictions, such as: the Biodiversity Strategy and Slovenia's great biodiversity, the European ecological Natura 2000 network, valuable natural features, protection of waters and the aspects of population and health, as well as the fact that Slovenia has a large share of sensitive areas, such as the Karst and the Alps, are all factors that must be taken into account when analysing vulnerability and suitability for a specific renewable source, which Slovenia is doing within the framework of the European Commission project "RES_ Renewable Energy Sources in Slovenia 2023", where the actual real and feasible potential will be calculated.

Response to the opinion of Mag. Johanna Nekowitsch Wiener Plattform Atomkraftfrei, Meiselstraße 52/19, 1140 Vienna

Question 1: Owing to its age (it began to be constructed in 1974 and came into operation in 1982), the current technical status of the reactor should be examined by independent international experts. This should be done not only with computer models but also on the basis of relevant experiences and data from the decommissioning of comparable reactors.

After studying Krško NPP's comments, the ministry responds by saying that an Aging Management Programme has been established and updated, and time-limited aging analyses (TLAA) produced and updated on the basis of NUREG-1801. The compliance of the AMPs and the TLAAs with IAEA (IGALL) requirements has been examined and confirmed. AMPs are regularly updated at Krško NPP by taking into account new regulatory requirements, foreign and domestic experiences and new R&D findings. Krško NPP has so far implemented 42 AMPs programmes using the GALL approach. IAEA (IGALL) compliance has been examined and confirmed for every programme.
The reactor vessel irradiation control programme controls the effects of aging resulting from a loss of fracture toughness from irradiation and the brittleness of the low-alloy steel material of the reactor pressure vessel. The monitoring methods are in accordance with 10 CFR 50, Appendix H. This programme refers to the requirements for evaluating neutron irradiation, the removal of control capsules, the mechanical testing/evaluation of the sample, and the production of a diagram of the temperature/pressure limits of acceptability for the operation of the reactor vessel. The requirements mentioned in this programme ensure that the reactor vessel's materials meet the requirements regarding the fracture toughness energy of the material under 10 CFR 50, Appendix G, and meet the pressurised thermal shock (PTS) requirements of 10 CFR 50.61. For the period of the lifetime extension, the programme also includes an alternative method of monitoring neutron irradiation (NUREG-1801), which is performed using an ex-vessel neutron dosimetry (EVND) system. Samples are examined, tested and analysed by accredited external laboratories.
Krško NPP also has an in-service inspection programme in place for the non-destructive testing of the reactor vessel and reactor vessel closure head in accordance with ASME XI. For the non-destructive evaluation (NDE) of the basic material of the reactor pressure vessel at the level of the core, Krško NPP is part of the PWROG (Pressurized Water Reactor Owners Group) working group, and implements the latest industrial R&D findings on a continuous basis.
According to all the expert inspections performed so far, the state of the reactor vessel is sufficiently adequate (the pressure boundary safety function is operational) to ensure that Krško NPP is able to operate over the long term.
Tests to check the point at which safety pipelines penetrate concrete structures were included in a specific aging management programme within the framework of the action plan to fulfil the recommendations issued on the basis of the national TPR (ENSREG) report. The Krško NPP containment provides a pressure (safety) boundary using steel containment. Management of the aging of penetrations and welds in the steel containment is addressed in a separate programme that complies with NUREG-1801, XI-M19.
By carrying out regular periodic inspections of structures, systems and components (SSCs), Krško NPP ensures that they are capable of withstanding any design-basis accident even during the period of extended operation (i.e. after more than 40 years of operation). Krško NPP also ensures that aging management processes and preventive measures do not lead to any loss of the original safety margins. This is also confirmed by the inspections conducted by the SNSA, by international inspection missions (TPR, OSART, WANO, IAEA) and by the independent expert institutions involved in all regular outages of the power plant. TLAAs are also performed for SSCs that are subject to time-limited operating conditions; these are independently confirmed by external inspectors so as to ensure that the design bases and requirements for the analysed SSCs are maintained.

Question 2: The data presented on seismic hazard is very out of date. Scientifically up-to-date international studies should be carried out and the results incorporated into the EIA Report.

The ministry responds by saying that the EIA Report (Section 4.1.11, Seismic hazard, p. 176) states that the preliminary results of paleoseismological investigations since 2004 and the updated PSHA (which is under way) have not confirmed the existence of new faults or geological structures in the last ten years that could, in the event of an earthquake, permanently deform the surface of the location ("capable faults"). Nevertheless, an additional study of the seismic hazard presented by ground displacement was commissioned. The study, which considered 11 seismic source lines, was completed in 2013. It showed that there was no danger of major permanent ground displacement, while the danger of very minor permanent ground displacement was insignificant (recurrence interval of more than one million years).

Field research also continued after 2004 and has been at its most intensive in the last decade.

A project to update the PSHA for the immediate vicinity of Krško NPP is currently under way. As part of this project, a new non-ergodic ground-motion model was developed for the location of the second nuclear power plant block at Krško in 2021. The new non-ergodic ground-motion model takes into account the local characteristics of earthquakes on the basis of the ground-motion measurements that have been provided by ARSO for more than 20 years. This has a positive impact on the results of the PSHA. It has been shown, for the immediate vicinity of Krško NPP, that the PGA and spectral acceleration at higher frequencies and for long recurrence intervals decrease relative to the values determined using the conventional ground-motion model.

A project is currently under way to update the Probabilistic Seismic Hazard Analysis in the wider surroundings of Krško NPP. The project began just over ten years ago with field research. The preliminary study covers 12 seismic source lines within a 200 km radius of the plant. In addition to seismic source lines, it also considers seismic sources that could arise in specific areas. A new non-ergodic ground-motion model has also been developed for the location.

Krško NPP was designed to withstand earthquakes. The seismic design load of Krško NPP comprises the spectrum of accelerations in accordance with the American RG 1.60 guidance, scaled to a PGA of 0.3 g at the depth of the foundations (approx. 20 m below the surface). As the PGA during an earthquake decreases with depth, as we have already pointed out, the design peak acceleration at the depth of the foundations cannot be directly compared with the PGA at surface derived from the PSHA. In order to be able to compare Krško NPP's seismic design load with the seismic load from the PSHA, due regard must be paid to the uniform hazard spectrum at the level of the foundations, which was determined in the PSHA of 2004. A comparison between the Krško NPP design spectrum and the uniform hazard spectrum for the level of the foundations shows that the spectral acceleration for a frequency of 3.33 Hz from the uniform hazard spectrum (PSHA, 2004) is approximately 12% lower than the corresponding value of the design spectral acceleration for 5% attenuation. Moreover, the seismic analyses of 2013 estimated that the original seismic forces taken into account when Krško NPP was being designed were approximately comparable with the seismic forces on the facility resulting from the RG1.60 seismic load and taking into account a PGA of 0.6 g on the open surface, which roughly corresponds to a PGA with a recurrence interval of 10,000 years (PSHA, 2004). The favourable impact of the interaction between the Krško NPP structure and the ground (which scatters a significant amount of the energy) was also taken into account in this transformation. The calculations from 2013 also showed that the floor spectral accelerations resulting from an earthquake with a PGA of 0.6 g at surface were approximately equal to or less than the original acceleration values for equipment with their own frequencies of between 4 and 16 Hz, which covers a wide range of engineered safety features and equipment at Krško NPP.

The stress tests carried out in 2011 showed that, on account of the safety factors taken into consideration during the project design process, Krško NPP could shut down safely and maintain long-term cooling operations in the event of an earthquake with a PGA greater than 0.6 g at surface. The ENSREG stress-test report of 2011 estimated that damage to the core was unlikely with earthquakes with a PGA of less than 0.8 g at surface. However, this estimate did not take into account the favourable impact of the new safety equipment installed at the plant in the last ten years in response to the Krško NPP Safety Upgrade Programme (see also the responses to one of the questions above). BB2 (Bunkered Building 2, a reinforced safety structure) is designed to accommodate an alternative safety injection (ASI) system, an alternative auxiliary feedwater (AAF) system and safety power supply to the building. The AUHS is ensured by the construction of BB2 and the installation of the ASI and AAF systems. The BB2 facilities and systems from the Safety Upgrade Programme, which were built away from the foundations of the main Krško NPP island, were designed for a peak ground acceleration of 0.78 g at the level of the foundations. During the construction of the new facility, the safety acceptance

criterion with regard to the analysis of seismic vulnerability was also determined using HCLPF PGA. As has been pointed out on several occasions, additional safety factors are used when designing nuclear facilities so that the likelihood of component failure (including in BB2) is approx. one or two orders of magnitude lower than the likelihood of the occurrence of the design ground acceleration. It should also be pointed out that the design PGA for BB2 and its systems exceeds the value corresponding to a recurrence interval of 10,000 years set out in the PSHA from 2004. According to the preliminary results of the updated PSHA study, which is currently being prepared, the new value of a recurrence interval of 10,000 years is also lower than the design acceleration taken into consideration for BB2.
The impacts of various earthquakes and the adverse events associated with them are taken into account when the core damage frequency (CDF) is being determined; for Krško NPP it is estimated at a value that is acceptable under Slovenian law. This confirms that Krško NPP's seismic safety is adequate.

Question 3: The assumptions in the report regarding the consequences of a super break or meltdown are too optimistic. The decision on whether to extend operation of the plant should be based on real data from real accidents (e.g. Fukushima).

After studying Krško NPP's responses, the ministry explains that the representative accident in the EIA Report was selected on the basis of the Krško NPP Safety Analysis Report, deterministic and probabilistic safety assessments, and internationally recognised nuclear safety standards, in line with industrial and regulatory practice. The reference severe accident (DEC-B) was selected as the limiting or envelope scenario presenting the biggest challenge to transboundary impact resulting from a very conservative (almost improbable) scenario involving the loss of all AC power supply, the loss of safety/auxiliary systems, the loss of operating crew for 24 hours (no action is taken by operating crew in the first 24 hours), and radioactive releases through the systems and the passive containment filtered venting system (PCFVS), with additional design-basis leakage from the increase in pressure. An explanation of the selection of the representative accident is given in Section 6.4 of the EIA Report.
This accident scenario was chosen because of the expected complete meltdown of the core and the most rapid and most conservative release of radioactivity in the containment. This means that the EIA addressed the highest possible radioactive inventory (source term). The purpose of the PCFVS is to protect the integrity of the containment in the event of an increase in pressure caused by a severe accident, to filter the atmosphere of the containment in the event of any release, and to protect the environment and the population against radioactive aerosols in the atmosphere and from gaseous radioactive iodine and its organic substances. The system is passive and has been entirely designed in accordance with the requirements of the design-extension conditions (including earthquake-related conditions). Moreover, the analysis considers the release of radioactivity from containment leakage before and after the PCFVS is activated. Therefore, in summary, the most conservative assumption was used: that of complete damage to the core together with the conservative containment leakage and the use of a passive, conservatively designed filter system for protecting the containment.
Following the Fukushima accident, Krško NPP carried out a series of analyses of design-extension conditions. The analyses addressed the combinations of accidents, based on which an additional upgrade of the nuclear power plant was required (DEC). The safety upgrades were carried out as part of the national post-Fukushima action plan following the EU stress tests, and took place as part of the Safety Upgrade Programme described in Section 2.7.12 of the EIA Report. The new additional systems installed as part of the SUP ensure that Krško NPP will manage beyond-design-basis accidents using the extended range of equipment and upgrades. Safety upgrades were carried out in the areas of seismic hazard, flood protection, mitigation of the effects of fire, and the provision of additional sources of supply in the case of emergency situations or the loss of power supply, etc. (EIA Report, Section 2.8).
The Krško NPP SUP has led to a reduction in risk in the last few years. All safety upgrades are reflected in the Krško NPP safety analyses and in the PSA model, which shows a significant reduction in the core damage frequency (EIA Report, Section 2.8).
It is not possible to compare accidents in entirely different types of nuclear plant, nor can a comparison be made without taking the cause of the accident into account. The Fukushima accident arose as a result of a failure to take account of the risk presented by external hazards.

The safety upgrade process at Krško NPP involved a systematic approach to improving the safety of the plant on the basis of WENRA and other recommendations. The safety upgrade process incorporated deterministic and probabilistic analyses and international recommendations for improving nuclear safety. All external risks were reviewed in accordance with a variety of international standards, and the plant was found to have no systematic deficiencies.
In light of the above, the analysis of the reference severe accident in the EIA Report suitably addresses the worst possible scenario, with due regard paid to the real (and current) assumptions regarding the radioactive inventory (source term).

Question 4: The report minimises the impact of radioactive releases from Krško NPP on human health. We know from the epidemiological study of childhood cancer in the vicinity of nuclear power plants (the KiKK study) that high emissions of radioactive tritium and radioactive carbon during normal plant operation leads to an increase of 60% in cancer incidence and 100% in leukaemia incidence.

The response has already been provided on pp. 111–114 [124-127] of the Grounds for this environmental protection consent.

Question 5: There is no specific plan for the permanent disposal of high-level radioactive waste from Krško nuclear power plant – this plan must be supplied. Spent fuel must be transferred as quickly as possible from the spent reactor fuel pool to a safer dry storage location – the timetable presented is too slow.

The ministry believes that the timetable is adequate and in line with the environmental protection consent, as the most important thing is to ensure that transfer to dry storage is carried out safely. Under the Act Ratifying the Treaty between the Government of the Republic of Slovenia and the Government of the Republic of Croatia on the Regulation of Status and Other Legal Relations Regarding Investment in and the Exploitation and Decommissioning of Krško Nuclear Power Plant (Official Gazette of RS [Mednarodne pogodbe], No. 5/03, hereinafter: Intergovernmental Treaty), the Intergovernmental Commission tasked with monitoring the Treaty and performing other tasks in accordance with the Treaty (hereinafter: Intergovernmental Commission) approved the Third Revision of the Krško NPP Decommissioning Programme and the Programme for the Disposal of Radioactive Waste (RW) and Spent Fuel (SF) from Krško NPP on 14 July 2020. Every five years at least, periodic revisions of the programme are carried out with the aim of updating the reference disposal concept in line with the latest technical solutions and information. Under the third and fourth paragraphs of Article 10 of the Intergovernmental Treaty, the Krško NPP Decommissioning Programme and the Programme for the Disposal of RW and SF from Krško NPP are the two relevant documents that contain an estimate of the funds required to carry out the activities that the programmes deem to be necessary. In accordance with the provisions of the Intergovernmental Treaty, costs are funded by regular payments into two special funds: “Sklad NEK” in Slovenia and the “Fond za financiranje razgradnje i zbrinjavanja radioaktivnog otpada i istrošenoga nuklearnog goriva NEK” in Croatia. Based on the adopted programmes, the Slovenian government set a new amount of the contribution to be paid into the Krško NPP Fund by GEN energija. Since September 2020, the amount of that contribution has been EUR 0.0048 for every received kWh of electricity generated by Krško NPP. That figure rose to EUR 0.012 on 1 January 2022. Every year, HEP d.o.o. pays EUR 14.25 million into the Croatian Fond NEK in accordance with a Croatian government decree.
Krško NPP is planning to relocate spent fuel elements from wet to dry storage as a risk-reduction measure. As far as planning the relocation timetable is concerned, it will rely on its own experience and the timetables of similar storage facilities. Safety and the use of a highly qualified technical workforce will be key to the process; and while speed of relocation of the spent fuel is important, it does not take precedence over other criteria. Krško NPP has adjusted the timetable to make it optimal.
Completion of SF dry storage is planned for the end of 2022, while the relocation of 592 fuel elements from the spent fuel pool to dry storage will take place in the first half of 2023. When the dates of the envisaged campaigns of relocation to dry storage were being planned, consideration was given to the

factors of technical feasibility, radiation and nuclear safety, and cost-effectiveness. The date of the campaigns and the number of fuel elements to be relocated have been acknowledged as optimal.
Krško NPP will continue to review the timetable of the relocation of spent fuel from the spent fuel pool to dry storage, and adjust it as required to minimise the risks associated with spent fuel.

Question 6: Alternative scenarios with realistic data on sustainable energy, such as wind and solar, should be addressed, as should the energy-saving possibilities. The assumptions underlying the EIA Report are out of date. Moreover, nuclear technology is obviously given precedence without adequate attention being given to the advancing climate crisis and its consequences: a fall in water levels and rising temperatures in rivers, which are used to cool nuclear plants, means that production from nuclear plants will have to be reduced.

After studying Krško NPP's comments, the ministry takes the position that the project framework is provided by Slovenia's 2021 Integrated National Energy and Climate Plan (NECP) and Croatia's 2020 Integrated National Energy and Climate Plan, which were drawn up and presented to the European Commission in accordance with Regulation (EU) 2018/1999 of 11 December 2018 on the Governance of the Energy Union and Climate Action. All scenarios of future energy use and supply defined in the national energy and climate plans are based on the lifetime extension of Krško NPP in order to enable the energy and climate policy targets to be met. The analyses carried out as the basis for the National Energy and Climate Plans have shown that increasing the use of renewable and non-carbon resources and increasing energy efficiency are not in themselves sufficient to enable the targets to be met if we take the estimated electricity needs and the increased requirements for reducing greenhouse gas emissions into account.
A study titled "Energy, systemic, economic and ecological aspects of the extension of the operational lifetime of Krško NPP", which was drawn up by Elektroinštitut Milan Vidmar and the Faculty of Electrical Engineering at the University of Zagreb, showed that Krško NPP would be irreplaceable during the period of the proposed lifetime extension. Without Krško NPP, both countries will be reliant on electricity imports, where and if available. EU Member States' national energy and climate plans show a net energy deficit, meaning that electricity imports will not always be available and that reducing consumption will be the only alternative in crisis situations. This runs contrary to the first dimension of the energy Union: "Energy security, solidarity and trust – diversifying European energy sources and ensuring energy security through solidarity and cooperation between Member States". Extending Krško NPP operation to 2043 is the starting point on the path to decarbonisation and long-term energy independence. It will not be possible for either country to maintain short-term energy security without Krško NPP. Due to the planned increase in electrification of traffic (use of electric vehicles), heating (use of heat pumps), and the electrification and phasing out the use of fossil fuels in other sectors, both countries will require an ever-increasing share of stable energy in the form of electricity. According to estimates, the electricity deficit will continue to rise in Slovenia (for several years now, Slovenia has been importing electricity to cover about 20% of its consumption). By 2030, Slovenia will have a deficit of at least 1 TWh/year of electricity if Krško NPP continues to operate, regardless of development of technology, significantly more efficient consumption of electricity and the intensive introduction of new renewable energy sources. The gradual reduction in the use of fossil fuels therefore further highlights the role of nuclear energy, which is a seasonally stable, low-carbon source of energy. Current and projected developments do not show that we are yet at the point where current electricity production capacities can be met entirely by energy from renewables while satisfying the need, today and in the future, for energy supply that is reliable, secure, environmentally sound and cost-effective. The need to work within spatial restrictions and preserve natural and other assets hinders the development of the new renewable energy sources that could otherwise replace Krško NPP in the next 20 years. Based on the analysed scenarios, the energy balance sensitivity analyses and the projected required power, the lifetime extension of Krško NPP is shown to be the most favourable solution from the technical, environmental and economic standpoints. Events in recent months, which have seen a steep rise in fuel and electricity prices, are further confirmation of the urgency of maintaining production at Krško NPP, as it guarantees affordable and sufficient supply of the electricity that industry and commerce so desperately need. If the

operational lifetime of Krško NPP is not extended, Slovenia and Croatia will no longer be able to meet the requirements of the strategies and commitments referred to above. Moreover, it will endanger the stability and reliability of operation of the electricity system, which could lead to slower progress towards climate neutrality.

The overheating of the Sava River is prevented by means of a number of measures, including a combined cooling system and the activation of the cooling towers. In 2008 Krško NPP expanded its cooling capacity with the construction of a third block of cooling towers, leading to a total cooling capacity of 627.8 MW. The upgrading of the cooling towers in 2008 increased cooling capacity by 36%, This has reduced the likelihood of situations in which the plant is required to reduce power in response to a possible exceeding of the 3°C level. Section 5.6.1 of the EIA Report gives an estimate of the days in which the need could arise for the plant's power to be reduced. As the likelihood of such events is extremely small, additional measures are not required (Table 123) – indeed, plant power has not had to be reduced on a single occasion since the cooling towers were upgraded in 2008. The cooling towers can disperse 49.5% of the power plant's total waste heat, which means it has large reserve capacity for heat removal. Between 2010 and 2020, the average temperature of the Sava at the point of full mixing rarely exceeded 27°C in one day (four times in July 2015, once in August 2017 and four times in August 2018), but it never exceeded 28°C. The projected trend in the rise of the average temperature in the summer months is between 0.3 and 0.4°C per decade for the area of the Lower Sava ("Estimate of climate change in Slovenia up to the end of the 21st century". Synthesis report – Part One, ARSO, November 2018). In relation to the measurements contained in the study titled "Energy buildings along and on the Sava – Analysis of river temperatures in the Lower Sava in July and August 2019 and the verification of previous studies" (Revision A, IBE, April 2020), the reservoir of the Brežice hydropower plant has an additional cooling effect on the water.

The alternative to lifetime extension is presented in Section 3 of the EIA Report. The Espoo Convention requires an assessment to be made of the possible alternatives to a proposed activity, while the EIA Directive requires reasonable alternatives to be examined. Possible (i.e. reasonable) alternatives must be capable of satisfactorily achieving the objectives of the proposed activity, and must also be feasible in terms of the technical, economic, political and other relevant criteria. It must be realistic to realise the alternatives at the time the decision on the project is taken. Constructing a power plant or plants (including those that use renewables in combination with other sources) to replace production at Krško NPP is currently not a realistic proposition. In addition, the UNECE Good Practice Recommendations on the Application of the Convention to Nuclear Energy-Related Activities, Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention), explain that alternative means of energy production are national issues of the party of origin and are therefore more properly addressed at the political and strategic level, as they are in the Integrated National Energy and Climate Plan.

The conclusions of a study produced by Vienna University of Technology, which sets out the options for the future use of renewables for energy purposes, highlight the natural conditions, such as solar radiation and the presence of wind, in Slovenia and Croatia. Unfortunately, they do not take into account any other equally important factors for the survival of mankind and other species on our planet in the light of climate change.

The new EU Strategy for Biodiversity 2030 requires Member States to redouble their efforts to preserve biodiversity and to protect 30% of their land and sea areas (10% under strict protection conditions) by 2030. The Convention on Biodiversity (CBD), which is the global framework for biodiversity, will have similar coverage requirements after 2020. This means that the network in the EU will have to be expanded over the next decade, by approximately 4% on land and by 19% on sea.

A great deal of Slovenia's surface area comprises Natura 2000 areas, other protected areas and areas of restricted use. While this means that there are fewer opportunities for renewable energy sources, they are being developed because of the need to replace coal-fired thermal power stations.

Response to the Opinion in relation to the environmental impact assessment for the 2022 project to extend the lifetime of Krško NPP, Dalibor Strasky (STELLUNGNAHME im Rahmen des Umweltverträglichkeits- prüfung für das Projekt KKW Krško Betriebsverlängerung 2022)

Question 1: Aging

The documents state at several points that:

- “The spatial position or location of Krško NPP will not change;
- the dimensions and design of Krško NPP, including the technology, will not change;
- the capacity and mode of operation of Krško NPP will not change.

The planned project includes a continuation of Krško NPP operations with the existing operating characteristics after 2023 with the construction of new buildings (buildings that would improve the physical characteristics of Krško NPP are not planned).”

- The authors of the EIA Report proceed from a simple premise: that the lifetime extension means only an extension of the previous state of affairs, that the plant will not change, either in structural, nuclear safety/technical or operating terms, and that, since there have so far not been any more serious problems, the plant will remain as it has been into the future. However, this way of thinking is fundamentally wrong, as the facility will undergo considerable change. The plant was planned and designed to operate for 40 years. Aging changes the properties of the materials and, with it, nuclear safety. This is not a positive thing. The aging of the materials in the reactor pressure vessel is of fundamental importance because the operational lifetime of a plant that is in an area of seismic hazard is being extended to 60 years. The irradiation programme (preliminary samples) meets the requirements of ASTM E185. The last irradiation capsule was removed in 2012, which brought an end to the programme. The results of the first capsule with advance samples showed that the metal weld samples in particular were between two and five times more brittle than would have been expected under the instructions contained in US NRC Reg. Guide 1.99 Rev. 2, although the levels of Cu and P both in the basic material (0.07% by weight for Cu, 0.01% by weight for P) and in the metal of the weld (0.02% by weight for Cu, 0.007% by weight for P) were not too high. Ex-vessel neutron dosimetry (EVND) is used to check the neutron dose, which is analytically the result of certain systems diagrams for a period of 60 years. During the most recent full repeat inspection of the RPV in 2010, signs similar to cracking (which must be reported) were detected. These were evaluated in accordance with the ASME criteria and found to be acceptable. Generally speaking, when the indications established previously (2001/2004) were checked, a growth in cracking was not recorded.[74] In response to primary water stress corrosion cracking (PWSCC) in the components that contain alloy 600/82/182, the closure head of the reactor pressure vessel was replaced (replacement completed in 2012), even though cracks had not been found. The new cover does not contain alloy 600/82/182. The SNSA found that instances of the unplanned unavailability of facilities increased in 2020, which it attributes to the degradation of the facility and inadequate maintenance programmes.

After studying the information provided by Krško NPP, the ministry responds by saying that the plant monitors the aging of the reactor vessel in a number of ways. Analyses include measurements of samples, inspections of the reactor vessel and of welds and time-limited aging analyses (TLAA). All reactor vessel samples were within the ASME limits of acceptability and US NRC Reg. Guide 1.99 Rev. 2. No cracks have been recorded in the course of the ultrasound inspections of the Krško NPP reactor vessel carried out up to now. All the indications on the reactor vessel welds are volumetric, of the metallurgical inclusion type, are within the limits of acceptability, and are unchanged in terms of size and orientation. The reactor vessel welds at Krško NPP were inspected in 2021 by the Tecnatom company, which found no indication of cracking in the welds. All the recorded ultrasound indications were acceptable in accordance with the requirements of “ASME Section XI, 2007 Edition with 2008 Addenda”. Krško NPP monitors all deviations at the plant via a Corrective Programme. The large number of corrective requirements cannot therefore be attributed to the aging of the facility, but mainly to the numerous other activities that take place at the plant, including the installation of additional new engineered safety features as part of the Safety Upgrade Programme.

Question 2: Seismic safety
Krško NPP's original design was based on analyses of seismic hazard in the 1964–1968 and 1971–1975 periods. Accordingly, a safe shutdown earthquake (SSE) with a PGAh (peak horizontal ground acceleration) of 0.30 g was determined as the construction basis for the highest level of safety of the system.
In the latest studies, the site hazard has successively fallen to PGA = 0.42 g and increased to PGA =0.56 g. The latest international practice is to determine the hazard potential of active seismic faults using paleoseismological methods. No such data exists for Krško.

After studying information provided by Krško NPP, the ministry states that it is not true that no paleoseismological studies have been produced for the site of the plant. The first seismology-related geological, geomechanical, hydrological, geophysical and engineering studies were carried out in the 1970s. A design PGA of 0.3 g at the level of the foundations was determined in response to these studies. A seismotectonic model was produced in 1994 as part of the first Probabilistic Seismic Hazard Analysis (PSHA) at the Krško NPP site. A research programme was subsequently initiated and led, in 2004, to a PSHA for the Krško NPP site. This updated the seismotectonic model from 1994. According to the results of the analysis of 2004, PGA at surface is 0.56 g with a recurrence interval of 10,000 years. The PGA values given above are not directly comparable. The original design spectral acceleration with a PGA of 0.3 g relates to the level of the foundations of the Krško NPP building (approx. 20 m below the surface), while the PGA of 0.56 g relates to the open surface. As PGA decreases with depth, a direct comparison between these PGAs cannot be made. Seismic analyses of the ground and analyses of the interaction between the structure and the ground were therefore performed. They took into account a design spectral PGA on the open surface of 0.6 g (this roughly corresponds to a PGA for a recurrence interval of 10,000 years, PSHA 2004). These analyses showed that the seismic impacts on the structure and equipment of Krško NPP were approximately the same as they were when the plant was being designed.
A project is currently under way to update the PSHA in the immediate vicinity of Krško NPP, and began with field studies just over ten years ago. The analysis covers 12 seismic source lines within a 200 km radius of the plant. In addition to seismic source lines, it is also considering planar seismic sources. A new non-ergodic ground-motion model for the vicinity of the Krško NPP site was approved by an international peer-review panel in 2021. This model takes into account the local characteristics of earthquakes on the basis of the ground-motion measurements that have been provided by ARSO for more than 20 years. The new PSHA will be completed at the end of 2022 and an independent review carried out in 2023. Based on the preliminary results, and taking the impact of the new non-ergodic ground-motion model into account, no significant changes from the results of the currently valid study of seismic hazard from 2004 are expected.

Question 3: Krško NPP concept
Westinghouse developed the concept of the pressurised water reactor (the Krško type) in the 1950s. In conceptual terms, it is a solution rarely used in Europe: a pressurised water reactor with two coolant loops. Although the solution reduces the risk of leakages in the primary circuit of the plant, it complicates the thermohydraulic situation in the reactor core and makes it more difficult to control a LOCA.
Like all other second-generation nuclear power plants currently in operation, Krško NPP was originally designed without plans being drawn up as to how it might respond to a severe accident.
The severe accidents that have occurred so far (Three Mile Island in 1979, Chernobyl in 1986 and, most recently, Fukushima in 2011) clearly indicate this shortcoming in the design and planning process. The upgrades and the precautionary measures that have been adopted at Krško in relation to the provision of additional cooling water and energy stocks, as well as the on-site simulator that "trains" staff to deal with beyond-design-basis accidents, are unable to compensate for this shortcoming.

The ministry has studied Krško NPP's definitions and replies that it is not possible to compare accidents in entirely different types of nuclear plant, nor can a comparison be made without taking the cause of the accident into account. The ministry believes that while accidents are very rare, their consequences

are wide-ranging.
The TMI-2 accident in 1979 occurred because of a failure to take account of the findings of the WASH-1400 study (Reactor Safety Study, 1975).
The accident at Chernobyl arose because a test of the plant's own power supply was carried out, safety systems were turned off, there were problems with procedures and the reactor did not function properly at low power (RBMK-type reactor).
The Fukushima accident arose as a result of a failure to take account of the risk presented by external hazards.
The safety upgrade process at Krško NPP involved a systematic approach to improving the safety of the plant on the basis of WENRA and other recommendations. The safety upgrade process incorporated deterministic and probabilistic analyses and international recommendations for improving nuclear safety. Tests may not be carried out at Krško NPP if they do not comply with the plant's procedures, safety analyses, technical specifications or regulatory guidelines/requirements. All external risks were reviewed in accordance with a variety of international standards, and the plant was found to have no systematic deficiencies.

Question 4: The most recent analyses of a severe accident with the available calculation codes for the "upgraded" Krško nuclear power plant did not yield a clear result regarding the appropriate SAM strategy.

The ministry has studied Krško NPP's definitions and replies that analyses using the MAAP 5.03 model were performed as part of the PSR2 action plan. All the important scenarios that lead to severe accidents were calculated. We should stress that the PWROG SAMG (Pressurized Water Reactor Owners Group Severe Accident Mitigation Guidelines)
has also been validated on the Krško NPP simulator, which has been updated with the MAAP 5.03 model. Krško NPP has therefore made a significant contribution to improving the international SAMG, and the adequacy of its SAMG strategies has been confirmed.
As with the Fukushima reactor blocks, the spent fuel storage pool is located outside the containment area. This and the storage pool are not designed with severe accident management in mind.
Krško NPP upgraded the SAMG in relation to accident management in the spent fuel pool (SFP) after the generic PWROG SAMG had been updated. In addition, Krško NPP installed alternative SFP cooling, a spray system and a flap on the spent fuel building as part of the Safety Upgrade Programme.
However, the authors of the EIA Report believe that Krško NPP "stands at the forefront of European power plants".

Question 5: Page 39 of the report: "In the framework of the EU stress tests conducted by the European Commission following the Fukushima accident in March 2011, Krško NPP was the only nuclear power plant in Europe that received no recommendations, which placed it first among European power plants." In addition to the fact that there could be a variety of reasons for this absence of recommendations, one should point out that the purpose of the stress tests was not to compare the nuclear power plants that were inspected during those tests.

The purpose of the European stress tests was to inspect European power plants with regard to their ability to withstand external risks. While the inspection was not originally meant as a means of comparing power plants, the results of the inspection were very indicative, given that Krško NPP did not receive a single recommendation regarding improvements that had to be made.
Question 6: Energy policy
The lifetime extension of the plant is presented in the documents as unavoidably necessary, as the country would, in the opposite case, be forced to import the shortfall in electricity or generate it in new power plants, with the construction of new power plants being assessed as unrealistic. However, this explanation raises the following questions:
• It was known, not later than by the time Krško NPP was being planned, that it would operate for "only" 40 years. Preparation of an energy plan containing the "no Krško NPP" variant took 40 years.

How did the competent ministries, offices and institutions use these 40 years? What does the “no Krško NPP” energy plan look like? What measures have been adopted to ensure that the Slovenian energy industry would be able to supply the Slovenian population with energy even without Krško nuclear power plant?

- How can you guarantee that Slovenian politicians will not use the same arguments for continuing Krško NPP operation after another 20 years have passed from now?
- How has the Slovenian energy industry prepared itself for a situation in which Krško NPP suffers an accident and the power plant is unable to restart?

In the documents, the “no-action alternative” (decommissioning of the plant in 2023) is only compared and dealt with in relation to fossil fuel alternatives. While it is understandable that these alternatives are unacceptable in terms of climate protection and Slovenia’s climate policy commitments, it is surprising that no discussions at all are taking place on energy-saving measures in this context. It is clear that Slovenian political circles are persisting with extended operation of Krško NPP at any cost.

After studying Krško NPP’s materials and responses, the ministry explains that the competent authorities have used the last 40 years to carry out safety reviews, safety upgrades and investments in Krško NPP so that it is in good condition in 2022, that it has been updated, that a dry storage facility for high-level radioactive waste has been built, that a start has been made on a low- and intermediate-level waste building and that conditions have been put in place to enable a decision to be made to extend the plant’s operational lifetime for 20 years.
The alternative to lifetime extension is presented in Section 3 of the EIA Report. The Espoo Convention requires an assessment to be made of the possible alternatives to a proposed activity, while the EIA Directive requires reasonable alternatives to be examined. Possible (i.e. reasonable) alternatives must be capable of satisfactorily achieving the objectives of the proposed activity, and must also be feasible in terms of the technical, economic, political and other relevant criteria. It must be realistic to realise the alternatives at the time the decision on the project is taken. Constructing a power plant or plants (including those that use renewables in combination with other sources) to replace production at Krško NPP is currently not a realistic proposition. moreover, the case-law of the European court states that alternatives may be sought within a specific energy source. Alternative methods of generating electricity are national issues determined by national programmes.
A study titled “Energy, systemic, economic and ecological aspects of the extension of the operational lifetime of Krško NPP”, which was drawn up by Elektroinštitut Milan Vidmar and the Faculty of Electrical Engineering at the University of Zagreb, showed that Krško NPP would be irreplaceable during the period of the proposed lifetime extension. Without Krško NPP, two countries, Slovenia and Croatia, would be reliant on electricity imports, where and if available. EU Member States’ national energy and climate plans show a net energy deficit, meaning that electricity imports will not always be available and that reducing consumption will be the only alternative in crisis situations. This runs contrary to the first dimension of the energy Union: “Energy security, solidarity and trust – diversifying European energy sources and ensuring energy security through solidarity and cooperation between Member States”. Extending Krško NPP operation to 2043 is the starting point on the path to decarbonisation and long-term energy independence. It will not be possible for either country to maintain short-term energy security without Krško NPP. This becomes even more urgent in terms of future energy use, as electricity is the predominant form of energy in industry, transport and services, and a major source of energy in households. The gradual reduction in the use of fossil fuels therefore further highlights the role of nuclear energy, which is a seasonally stable, low-carbon source of energy. Current and projected developments do not show that we are yet at the point where current electricity production capacities can be met entirely by energy from renewables while satisfying the need, today and in the future, for energy supply that is reliable, secure, environmentally sound and cost-effective. The need to work within spatial restrictions and preserve natural and other assets hinders the development of the new renewable energy sources that could otherwise replace Krško NPP in the next 20 years. Based on the analysed scenarios, the energy balance sensitivity analyses and the projected required power, the lifetime extension of Krško NPP is shown to be the most favourable solution from the technical, environmental and economic standpoints. Events in recent months, which have seen a steep rise in fuel and electricity

prices, are further confirmation of the urgency of maintaining production at Krško NPP, as it guarantees affordable and sufficient supply of the electricity that industry and commerce so desperately need. If the operational lifetime of Krško NPP is not extended, Slovenia and Croatia will no longer be able to meet the requirements of the strategies and commitments referred to above. Moreover, it will endanger the stability and reliability of operation of the electricity system, which could lead to slower progress towards climate neutrality.
The EIA procedure is being performed for an extension of Krško NPP's operational lifetime from 40 to 60 years, i.e. to 2043. Under the Resolution on the National Programme for Radioactive Waste and Spent Fuel Management 2016–2025 and the Programme for the Decommissioning of Krško NPP and the Disposal of Radioactive Waste and Spent Fuel, Krško NPP will be decommissioned after it ceases to operate in 2043. The decommissioning itself is divided into several phases. The decommissioning approach that has been selected will start with the preparation of plans and all the necessary documents two years prior to the end of the lifetime extension of the plant (i.e. in 2041).
An accident that renders a power plant permanently non-operational could happen to any power plant, not only a nuclear one. The owners of the plant are investing the necessary funds in various safety upgrades in accordance with global practice so as to minimise the possibility of such accidents occurring. One of the basic safety principles established by the IAEA and transposed into Slovenian legislation is the accident prevention principle. Every practical effort to prevent and mitigate accidents must be made. To ensure that the likelihood of an accident with harmful consequences is extremely low, measures have to be taken that include preventing damage or abnormal situations that could lead to a loss of control, and preventing the escalation of such damage or abnormal situations should they arise. "Defence in depth" is the main means of preventing accidents and mitigating their consequences, and is carried out mainly through a combination of a large number of parallel and independent safety levels that are meant to be terminated before they can cause harmful effects on people and the environment. Krško NPP devoted considerable attention to nuclear safety when the reactor was being planned and the plant designed. Engineered safety features have been designed to provide safety functions in all operational states, even in the event of the failure of specific equipment. Since the operation of engineered safety features in the event of a defect, a failure or a highly unlikely accident at a nuclear power plant is paramount, all engineered safety features are redundant. Thanks to Krško NPP's prudent and targeted safety upgrades in recent decades, and particularly the implementation of the Safety Upgrade Programme, the safety level continues to improve. The modernisation of safety solutions at Krško NPP includes the best available technological solutions and follows international practice. This applies in particular to the reliable cooling of the core in order to ensure the integrity of the containment, the management of severe accidents and the cooling of spent fuel. Krško nuclear power plant operates in a stable, reliable and safe manner.

Approval and implementation of the plan for the lifetime extension is not a recommended course of action. In terms of concept, Krško NPP is a second-generation plant developed in the 1950s, meaning that it no longer meets today's nuclear safety requirements. The measures taken to retrofit and upgrade may alleviate this shortcoming, but cannot eliminate it altogether. While some important components of the plant have been replaced, the reactor pressure vessel, the material of which has become more brittle than expected, cannot (for obvious reasons) be replaced. The risk of an earthquake at the site must be taken as the most likely trigger for a defect or accident. The contemporary approach is to determine the hazard potential of active seismic faults using paleoseismological methods. No such data exists for Krško.

Response to the joint opinion submitted by: Wiener Umweltanwaltschaft, e.h. Mag. Dr. Andrea Schnattinger; Tiroler Umweltanwaltschaft, e.h. Mag. Walter Tschon; Salzburger Umweltanwaltschaft, e.h. Mag. Dipl.-Ing. Dr Gishild Schaufler; Stmk. Umweltanwaltschaft, e.h. HR MMag.a Ute Pöllinger; NÖ Umweltanwaltschaft, e.h. Mag. Thomas Hansmann; ÖO Umweltanwaltschaft, e.h. DI Dr Martin Donat; Für die Bgld. Umweltanwaltschaft, e.h. DI Dr Michael Graf; Kärntner Umweltanwaltschaft, e.h. Mag. Rudolf Auernig; Für die Naturschutzanwaltschaft Vorarlberg, e.h. DIin Katharina Lins,

Question 1: The introductory description of the project states that Krško NPP does not directly emit greenhouse gases during operation and can therefore be regarded as an energy source that emits low levels of greenhouse gases. According to the IPPC report (2014), greenhouse gas emissions from nuclear energy fluctuate between 3.7 and 110 g/kWh. Greenhouse gases are emitted by nuclear power plants, particularly during uranium extraction and the production of fuel, as well as in the processes of storage, final disposal and power plant construction. Because the system already exists, these last points do not merit consideration. Consequently, given that the power plant is to continue to operate for an additional 20 years, an assessment of the development of greenhouse gas emissions should be made in light of the growing energy needs in relation to uranium extraction. Moreover, reference should be made to the greenhouse gas quantities that would be produced were the most favourable form of electricity production in terms of greenhouse gases to be used.

After studying Krško NPP's explanations, the ministry responds by saying that, under the "Technical assessment of nuclear energy with respect to the 'do no significant harm' criteria of Regulation (EU) 2020/852 ('Taxonomy Regulation')" (JRC Science for Policy report, 2021), greenhouse gas emissions are deemed to be produced across the entire lifespan of a nuclear power plant (construction, operation and decommissioning). They are therefore produced in a process that extends from the extraction and exploitation of ore, enrichment of the ore, and the final disposal of the ore or disposal of the waste. For example, lifecycle greenhouse gas emissions for the existing French nuclear reactor fleet in 2010 was assessed to be 5.29 gCO_2-eq / kWh, where the uranium ore grades were higher than 0.1%.
According to uranium ore production figures, the mean production uranium ore grade in 2009 was 0.12% uranium oxides (U_3O_8). In the lifecycle analysis for nuclear electricity generation, the estimated level of greenhouse gas emissions for the mining and milling stage was 1.3 gCO_2-eq/kWh for an assumed ore grade of 0.15% (U_3O_8). However, an assumed ore grade of 0.01% (U_3O_8) results in significantly higher greenhouse gas emissions at the mining and milling stage, increasing the lifecycle greenhouse gas emissions by about 26 gCO_2-eq / kWh. A lower ore grade such as this results in correspondingly larger greenhouse gas emissions. Based on predicted nuclear power annual growth rates of 1.9%, resources are projected to remain above a grade of 0.01% (U_3O_8) for the next 50 years.
The Regulation on the establishment of a framework to facilitate sustainable investment has established that nuclear technology contributes significantly to reducing greenhouse gas emissions and achieving the targets of the Paris Agreement. From the wider nuclear technology framework, it can, together with renewable energy sources, contribute to future climate change mitigation. Nuclear energy is the main source of low-carbon electricity. In terms of emission quantities, it is close to hydro energy and is, at the same time, a reliable source of energy, as the "Lifecycle Greenhouse Gas Emissions of Various Electricity Generation Sources" analysis shows (source: "Technical assessment of nuclear energy with respect to the 'do no significant harm' criteria of Regulation (EU) 2020/852 ('Taxonomy Regulation')", JRC Science for Policy Report, 2021).
According to the above, lifecycle greenhouse gas emissions from nuclear electricity generation are within the 100 gCO_2-eq/kWh emissions intensity threshold proposed by the Technical Expert Group on Sustainable Finance (TEG) for electricity generation, and will remain so for at least the next 50 years, thereby satisfying the TEG definition for a substantial contribution to climate change mitigation.
In addition, the quantities of absolute and relative greenhouse gas emissions for 2023–2043 are shown in the EIA (Table 110, Section 5.5.1. and Figure 17). Comparisons of emissions from other energy sources are also shown.
One can therefore conclude that Krško NPP will continue to contribute to climate change mitigation if its operational lifetime is extended.

Question 2: The present documentation states that discharges of cooling water into the Sava cannot cause a rise in the temperature of more than 3 Kelvins after they are mixed with the river water. A reference is made, in relation to this regulation, to the possibility of using cooling towers. It should be pointed out that, as a result of climate change, an accelerated rise in the temperature of the Sava can be expected. If the water temperature exceeds 30°C, we can assume a problematic reduction in the amount of oxygen available to aquatic life in the river. Together with an air temperature of around 35°C, the effectiveness of the cooling towers as the last cooling body falls rapidly. We can assume that the highest water temperatures in the Sava are in correlation with the highest air temperatures that appear at the location. In this context, the question arises as to whether there is an upper temperature limit for the Sava beyond which the discharge of cooling water from Krško NPP becomes completely prohibited. If not, the limit should be defined in order to protect the river's ecosystem. The assessment of the project should also take into account whether and how the lack of cooling options, which causes shutdowns (e.g. in nuclear power plants in France, which have already been more affected by climate change), affects the environmental balance of the project.

The ministry responds by saying that Krško NPP regularly monitors the temperature of the water to ensure that the Sava does not rise more than 3°C above its natural temperature. The maximum difference between the temperature of the Sava before the sampling location for cooling water and its temperature after the cooling water is mixed with the river water may not exceed a daily average of 3°C (3°K). This requirement is consistently adhered to, something that Krško NPP also confirms by year-round measurements of the temperature of the Sava (monitoring).

The temperature of the waste cooling water from the CW system at the discharge into the Sava (M2 measuring point) may not, as a daily average, exceed 43°C, while the temperature of the waste cooling water from the cooling towers at the discharge into the Sava (M3 measuring point) may not, as a daily average from the start of October to the beginning of April, exceed 30°C (or 43°C from the start of May to the end of September).

The overheating of the Sava River is prevented by means of a number of measures, including a combined cooling system and the activation of the cooling towers. If the combined cooling system is insufficient to meet these conditions, the plant is required to reduce its power accordingly. In 2008 Krško NPP extended its cooling capacity with the construction of a third block of cooling towers (four cells added to the existing six). The total cooling capacity is now 627.8 MW. The upgrading of the cooling towers in 2008 increased cooling capacity by 36%, reducing the likelihood of situations in which the plant was required to reduce power in response the 3°C level possibly being exceeded. Section 5.6.1 of the EIA gives an estimate of the days in which the need could arise for the plant's power to be reduced. As the likelihood of such events is extremely small, additional measures are not required (Table 123) – indeed, plant power has not had to be reduced on a single occasion since the cooling towers were upgraded in 2008. The cooling towers can disperse 49.5% of the power plant's total waste heat, which means it has large reserve capacity for heat removal.

Between 2010 and 2020, the average temperature of the Sava at the point of full mixing rarely exceeded 27°C in one day (four times in July 2015, once in August 2017 and four times in August 2018), but it never exceeded 28°C. The projected trend in the rise of the average temperature in the summer months is between 0.3 and 0.4°C per decade for the area of the Lower Sava ("Estimate of climate change in Slovenia up to the end of the 21st century". Synthesis report – Part One, ARSO, November 2018). In relation to the measurements contained in the study titled "Energy buildings along and on the Sava – Analysis of river temperatures in the Lower Sava in July and August 2019 and the verification of previous studies" (Revision A, IBE, April 2020), the reservoir of the Brežice hydropower plant has an additional cooling effect on the water. We therefore predict that, with the continuation of the restriction on Krško NPP causing an increase in the temperature of the Sava of more than 3°C (3°K), there will be no problematic reduction in the amount of oxygen available to aquatic life in the river.

Question 3: This documentation states that its design-basis flood (probability 10-4/year) is at a height of 155.35 m above sea-level. Measurements from 1926 to 2000 were used to calculate the design-basis flood. The lowest entrances and openings of the plant are located at 155.5 m a.s.l., and the assumed highest flood-water level is 155.61 m a.s.l. This should be combined with the most unfavourable meteorological and hydrological conditions. At the same time, a flood with 1.7 times the flow rate is provided as an additional assumption. According to available information, this has a probability of 10-6/year (the order of magnitude is not defined). The available documents do not offer any opportunity to check the assumptions. It is surprising that the design-basis flood envisages, as a consequence, the collapse of the dams. This consideration is missing for the case of the probable maximum flood (PMF) associated with much more extreme meteorological and hydrological conditions. Regarding the assessment of the flood safety of the plant, the question arises as to whether damage to the dams is taken into account in time correlation with flood events at the dams (tidal wave) in the upper course of the plant, and of the extent to which the impact of storms at the site on the highest water levels during floods are taken into account. To evaluate whether the proper PMF has been selected, the most important parameters at least should be indicated. It would also be desirable if there were an indication of the probability of occurrence. It should be pointed out that the use of data from after 2000 would expand the database by more than a quarter and, at the same time, enable us to expect a better assessment of the parameters of the hydrological framework resulting from the acceleration of climate change.

After studying Krško NPP's comments, the ministry responds by saying that Krško NPP's flood protection is multi-layered. The plant is protected against floods by embankments that overflow at 11,130 m^3/s (USAR 2.4.10). This corresponds to a frequency of less than $1E^{-06}$/year (additional statistical processing of the figure, USAR 2.4-6B). Floods capable of overflowing the embankments have been defined, with a high degree of reliability, as extremely unlikely (Gumbel extreme values distribution). PMFs amount to 7,081 m^3/s and represent the most unfavourable combination of extreme precipitation (probable maximum precipitation, or PMP, ANS-2.8 standard) and the melting of snow in the entire area of flow into the Sava. Moreover, consideration has also been given to fluctuations in the water level in the reservoir of the Brežice HPP, the most unfavourable wind levels and the appearance of surge waves in the reservoir. In the case of PMF, water fluctuations and the most unfavourable appearance of surge waves, the water level would reach 156.82 m (USAR 2.4.3.6), i.e. still 0.28 m below the safety level (level of buildings along the Sava 157.1 m E-004404, MECL-ESW-01).

PMP that triggers PMF is assumed across the whole area of the flow into the Sava (i.e. around 40% of the entire surface area of Slovenia). PMP represents around twice the quantity of precipitation than the highest measured value. At the same time, the default is a 100-year snowpack that melts as a result of this precipitation. This combination of events has been defined, with a high degree of reliability, as extremely unlikely.

Barriers are also installed at the entrances into the facility (155.5 m) when the level of the Sava is close to or at an elevation of 155.5 m and/or extremely high river flow rates of over 4,500 m^3/s are predicted. These barriers protect the power plant from any potential collapse of the embankments in the event of a simultaneous seismic event involving PMF. The barriers are seismically designed for a PGA of 0.6 g. This ensures a very high level of flood protection for various simultaneous combinations of extreme events. The plant is therefore extremely well protected against floods.

The power plants on the Sava are of the "run-of-river" type, i.e. they are hydropower plants in which there is little or no water storage. These power plants would have all their spillways completely open and be submerged if PMF occurred, meaning that they would not retain any water. The worst possible combination of flood water (25-year flood) is taken into account, where the barriers at the hydropower plants are still partly closed and the maximum amount of water has accumulated. It is assumed that they would be breached in sequence or at the same time (two different scenarios). Under the most unfavourable combination, the flow rate at Krško NPP would reach 3,700 m^3/s, which would mean that the water level would be 154.93 m. Assuming the simultaneous appearance of surge waves, the maximum water level would reach 155.34 m. The collapse of the barriers on the Sava would therefore not present an additional risk to Krško NPP. At higher flow rates, the barriers at these plants would be entirely washed away and their collapse would no longer make a considerable contribution to flood water quantities.

The risk analyses for Krško NPP will be updated as required as part of the third Periodic Safety Review

(PSR3).

Question 4: Krško NPP is located in an active seismic zone. The expected ground accelerations are significantly higher than they are for comparable systems in Europe. The location on the Sava line and the southern edge of the Alps can be regarded as unfavourable in terms of seismic hazard. A high design ground acceleration of 0.3 g was assumed even when the system was being planned. This roughly corresponds to an earthquake with a recurrence interval of 475 years, i.e. an event with a high likelihood of occurrence during an operational lifespan of 60 years. With ground acceleration of this magnitude at the level of the floor slabs, it should still be possible to disconnect the system safely. A ground acceleration of 0.6 g was applied to new buildings at the site; this also applied to flood protection. According to the information available, the spent fuel dry storage should be designed for 0.78 g. According to estimates, the integrity of the reactor core is ensured up to 0.8 g, with early large discharges expected to occur from 1 g. At the location, 0.56 g with a recurrence interval of 10^{-4} years and 0.8 g at more than 5 x 10^{-4} years are expected. Given the unfavourable framework conditions, a more comprehensible description of the resilience of the relevant components of the plant to seismic events, particularly an assessment of the integrity of the reactor core and the containment system, would be desirable. The question is also raised as to the hydrological conditions under which the integrity of the flood protection can be assumed for ground acceleration of up to 0.6 g.

After studying the expert positions taken by Krško NPP in the comment, the ministry responds by saying that above comparisons between seismic load and the data from the seismic hazard map for Slovenia are not appropriate; because of the different methodologies applied, the national map cannot be directly compared to the results of the Probabilistic Seismic Hazard Analysis for the location under consideration (in this case, Krško NPP). The seismic design load of Krško NPP comprises the spectrum of accelerations in accordance with the American RG 1.60 guidance, scaled to a PGA of 0.3 g at the depth of the foundations (approx. 20 m below the surface). On the basis of the spectral accelerations, which are more directly connected to the design seismic forces than the PGA, it has been estimated that the original seismic forces taken into account when Krško NPP was being designed are roughly comparable to the seismic forces on the facility resulting from a design spectrum with a PGA of 0.6 g on the open surface, which roughly corresponds to a PGA with a recurrence interval of 10,000 years (PSHA, 2004). The design PGA was 0.6 g for new systems on the main island and 0.78 g for new facilities away from the main island, including the spent fuel dry storage. The flood protection for Krško NPP facilities has also been designed for a design PGA of 0.6 g at surface. The flood protection embankments along the Sava were designed for a design acceleration of 0.3 g. The seismic responses and consequences in the event of an earthquake with a PGA greater than 0.8 g at surface are described in detail in the national stress-test report (SNSA, 2011). The stress-test report estimated that damage to the core was unlikely with earthquakes with a PGA of less than 0.8 g at surface. However, this estimate did not take into account the favourable impact of the new safety equipment installed at the plant in the last ten years in response to the Krško NPP Safety Upgrade Programme.

Question 5: The scenarios produced for design-basis and beyond-design-basis accidents are ultimately based on the existing integrity of the containment system and low leakage rates. In order to assess the transboundary impact, it would be useful to address events with early large discharges, such as incidents involving an open containment.

The ministry gives the following clarification: An accident involving the loss of all power (station blackout, SBO), with no action taken in the first 24 hours and with discharges from the PCFVS, was chosen as the BDBA. This sequence has an initial probability of the order of 4e-7/year. If combined with delayed mitigation, the probability is an additional two orders of magnitude lower. This scenario was chosen because it involved complete meltdown of the core and the most rapid and most conservative release of radioactivity in the containment.

Question 6: The undersigned demand that all safety measures be adopted and that insurance coverage be provided for at least the financial damage that could arise, judging from past severe beyond-design-basis accidents at nuclear power plants, from the operation of the nuclear power plant in Slovenia. Precautionary measures for coverage should, in our opinion, be carried out by the operator, as a reduction in liability or even partial assumption by the state would constitute ineligible aid under Article 107 of the TFEU.

After studying Krško NPP's specialist technical material, the ministry responds by saying that, pursuant to the Convention on Third Party Liability in the Field of Nuclear Energy (Paris Convention), the Vienna Convention on Civil Liability for Nuclear Damage, the Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention and the Slovenian Nuclear Damage Liability Act, the user of the nuclear facility (i.e. Krško NPP) is liable for any nuclear damage caused by a nuclear accident. The user (Krško NPP) has adequate insurance to cover these liabilities.

Question 7: Opinion of the Austrian Federal State of Carinthia (Stellungnahme für das Bundesland Kärnten)

Question 7A: Krško is located in one of the most seismically hazardous areas in Europe. Construction on Krško NPP began in 1975 and was completed in 1981. The plant began operating in 1983. The first seismic plan for Krško NPP was based on analyses of seismic hazard in the 1964–1968 and 1971–1975 periods. Accordingly, the construction basis for the highest level of safety of the system is the safe shutdown earthquake (SSE) with a value of PGAh = 0.30 g (PGAh: peak horizontal ground acceleration - peak ground acceleration).

In the latest studies, the site hazard has successively fallen to PGA = 0.42 g and increased to PGA =0.56 g. The latest international practice is to determine the hazard potential of active seismic faults using paleoseismological methods. No such data exists for Krško.

The present EIA Report from October 2021, supplemented on 8 November 2021 and 10 January 2022, refers to an analysis of seismic safety from November 2004 and a stress-test report from December 2011. This leads one to conclude that:

- no new edition of the Krško NPP stress-test report has been produced;
- the assessment of the potential for seismic hazard at the Krško site has not been updated.

It is therefore recommended that BMK ask Slovenia, at Austria's (and Carinthia's) request and as part of the transboundary assessment of environmental impact, to:

- update the assessment of the potential for seismic hazard at the Krško site;
- obtain an update of the design earthquake in accordance with the ENSREG proposal.

The new design earthquake values should be incorporated into the current transboundary procedure.

After studying information provided by Krško NPP, the ministry states that it is not true that no paleoseismological studies have been produced for the site of the plant. The first seismology-related geological, geomechanical, hydrological, geophysical and engineering studies were carried out in the 1970s. A design-basis PGA of 0.3 g at the level of the foundations was selected in response to these studies. A seismotectonic model was produced in 1994 as part of the first Probabilistic Seismic Hazard Analysis (PSHA) at the Krško NPP site. A research programme was subsequently initiated and led, in 2004, to a PSHA for the Krško NPP site. This updated the seismotectonic model from 1994. According to the results of the PSHA from 2004, the PGA at surface is 0.56 g with a recurrence interval of 10,000 years.

The original design spectral acceleration with a PGA of 0.3 g relates to the level of the foundations of the Krško NPP building (approx. 20 m below the surface), while the PGA of 0.56 g relates to the open surface. As PGA decreases with depth, a direct comparison between these PGAs cannot be made. Seismic analyses of the ground and analyses of the interaction between the structure and the ground, which were carried out with a design spectral PGA on the open surface of 0.6 g in mind (this roughly corresponds to a PGA for a recurrence interval of 10,000 years, PSHA 2004), showed that the seismic impacts on the structure and equipment of Krško NPP were approximately the same as they were when the plant was being designed. It is worth pointing out that all modifications and all equipment have been qualified, in line with the ENSREG recommendations, for the new floor seismic spectra, which were

determined in 2013 and constitute the envelopes of the original and the new floor spectra, which were calculated with due regard to the design seismic spectrum, scaled to a PGA of 0.6 g on the open surface at the Krško NPP site.
A project is currently under way to update the PSHA for the immediate vicinity of Krško NPP, and began with field studies just over ten years ago. The analysis covers 12 seismic source lines within a 200 km radius of the plant. In addition to seismic source lines, it is also considering planar seismic sources. A new non-ergodic ground-motion model for the site was approved by an international peer-review panel in 2021. This model takes into account the local characteristics of earthquakes on the basis of the ground-motion measurements that have been provided by ARSO for more than 20 years. The new seismic hazard analysis will be updated at the end of 2022 and an independent review carried out in 2023. Based on the preliminary results of the seismic hazard analysis using the new non-ergodic ground-motion model, it is clear from the opinion produced by the Faculty of Civil Engineering and Geodesy that the final results of the analysis are not expected to deviate significantly from the results of the seismic study from 2004. Additional justification was sent to Austria in writing as: Appendix 1 – Overview of the non-ergodic ground motion model for Krško and preliminary PSHA results for the mean return period of 10,000 years, Rev.0. Under Slovenian legislation and EU practice, Krško NPP will, after the new PSHA analysis (which will be subject to an independent review and to approval by the SNSA) is completed, use it as the input data for updating the Krško NPP seismic PSA model, which is carried out once a year.
Regarding the possible changes to the results of the seismic hazard analysis, one must realise a sufficiently high PGA is not the only factor that ensures seismic safety. Seismic safety is also ensured by an appropriate spectral acceleration and by other safety or design factors within the earthquake-resistant design standards that are taken into account during the design process itself and that increase capacity in PGA terms relative to the design PGA value. The stress tests carried out in 2011 showed that, on account of the safety factors taken into consideration during the Krško NPP project design process, it was highly likely that the plant would be able to stop safely and maintain long-term cooling operations in the event of an earthquake with a PGA of up to 0.8 g at surface. The likelihood that Krško NPP's systems and components will fail to operate is therefore one or two orders of magnitude lower than the likelihood of the occurrence of the PGA. Here it is important for the assessments of the likelihood of failure to take into account the conservative engineering assumptions when the limit situations are being defined. Certain other margins, for example the favourable impact of the conditional spectrum of accelerations, have so far not been taken into account when determining seismic safety.

Question 7B: Because of Krško NPP's age (it has been in operation for around 40 years), materials have aged or seen a decline in their quality, thereby progressively reducing the functionality and reliability of structures, systems and components (SSCs) with a longer service period. This unavoidably leads to a breakdown of the original safety margins and to the greater likelihood of damage, especially in situations of particular stress.
In the best case, measures such as additional inspections or tests, which are often introduced as a replacement for operations to eliminate detected deviations, only enable us to observe the progress of the damage and not remedy the loss of safety.

The ministry responds by saying that by carrying out regular periodic inspections of structures, systems and components (SSCs), Krško NPP ensures that they are capable of withstanding any design-basis accident even during the period of extended operation (i.e. after more than 40 years of operation). Krško NPP also ensures that aging management processes and preventive measures do not lead to any loss of the original safety margins. This is also confirmed by the inspections conducted by the SNSA, by international inspection missions (TPR, OSART, WANO, IAEA) and by the independent expert institutions involved in all regular outages of the power plant. Time-limited aging analyses (TLAA) are also performed for SSCs that are subject to time-limited operating conditions. These are independently confirmed by external inspectors and prove that the design bases and requirements for the analysed SSCs will be maintained.
Safety margins are guaranteed throughout the entire operation of the plant and have never been put at

risk.

The ministry also explains that the EIA merely states that Krško NPP is not a Seveso plant but a nuclear plant, and that an EIA is being carried out.

Reponses to the comments submitted by: Albena Simeonova, Foundation for Environment and Agriculture, Nikopol, Vasil Levski str N2, Bulgaria; Monika Wittingerová, Jihočeské matky, z.s., Karla Buriana 3, 370 01 České Budějovice, Czech Republic; Marcin Harembski, Stowarzyszenie Ekologiczno-Kulturalne "Wspólna Ziemia" (Association Common Earth), Parszczenica 7/2, 89-607 Konarzyny, Poland; Dr Paul Dorfman, Nuclear Consulting Group, http://www.nuclearconsult.com/; Niels Henrik Hooge, NOAH Friends of the Earth Denmark, Nørrebrogade 39, 1. tv., DK-2200 Copenhagen

Question 1: Alternatives
The EIA Report omits important information on whether the lifetime extension is even necessary for satisfying electricity needs in Slovenia and Croatia. A new study by Vienna University of Technology concluded that more than 50% of Slovenian electricity demand could be covered by photovoltaics and on-shore wind energy as soon as 2030, and that the electricity needs of Slovenia and Croatia could be fully met by renewable energy sources by 2050.
The Espoo Convention and the EIA Directive both require an assessment to be made of alternatives to a proposed activity. We ask that the EIA Report present alternative energy scenarios, i.e. those that do not include extension of the operational lifetime of a 40-year-old nuclear power plant. As a response to the climate crisis, energy efficiency and energy-saving measures must be the most important options for alternative scenarios, while any new electricity generation must be based on renewable energy sources, the costs of which are continually coming down.

The ministry points out that Slovenia's 2021 Integrated National Energy and Climate Plan (NECP) and Croatia's 2020 Integrated National Energy and Climate Plan were drawn up and presented to the European Commission in accordance with Regulation (EU) 2018/1999 of 11 December 2018 on the Governance of the Energy Union and Climate Action. The Integrated National Energy and Climate Plans drawn up by both countries set out the objectives, policies and measures for five dimensions of the Energy Union up to 2030 (with an outlook to 2040), and cover, among other things: decarbonisation (greenhouse gas emissions) and renewable energy sources, energy efficiency and energy security. All scenarios of future energy use and supply defined in the Integrated National Energy and Climate Plans are based on extending Krško NPP's operational lifetime in order to enable the energy and climate policy targets to be met. The analyses that formed the basis for the National Energy and Climate Plans have shown that increasing the use of renewable and low-carbon-emission sources and increasing energy efficiency are not in themselves sufficient to enable the targets to be met if we take estimated electricity consumption and the increased requirements to reducing greenhouse gas emissions into account.
A study titled "Energy, systemic, economic and ecological aspects of the extension of the operational lifetime of Krško NPP", which was drawn up by Elektroinštitut Milan Vidmar and the Faculty of Electrical Engineering at the University of Zagreb, addressed the "no-action alternative" and showed that Krško NPP would be irreplaceable during the period of the proposed lifetime extension. If the lifetime of Krško NPP is not extended, both countries will be reliant on electricity imports, where and if available. EU Member States' national energy and climate plans show a net energy deficit, meaning that electricity imports will not always be available when needed and that reducing consumption will be the only alternative in crisis situations. This is not in line with the first dimension of the Energy Union: "Security, solidarity and trust - diversifying Europe's sources of energy and ensuring energy security through solidarity and cooperation between EU countries". Operating Krško NPP until 2043 is a first step towards decarbonisation and long-term energy independence. It will not be possible for either country to maintain short-term energy security without Krško NPP. Current developments and their forecasts do not indicate a sufficient technological breakthrough capable of replacing Krško NPP's current generation capacity with renewable energy sources while meeting the current and future required criteria of reliability, safety, environmental sustainability and economic viability. The requirement to preserve spatial features and

natural and other assets makes it difficult to introduce new renewable energy sources capable of replacing Krško NPP in the next 20 years. Based on the scenarios and sensitivity analyses of energy balances and electricity demand, it is clear that extending Krško NPP's operational lifetime is the most technically, environmentally and economically advantageous solution. Events in recent months, which have seen a steep rise in fuel and electricity prices, are further confirmation of the urgency of maintaining production at Krško NPP, as it guarantees affordable and sufficient supply of the electricity that industry and commerce so desperately need. If Krško NPP's operational lifetime is not extended, the stability and reliability of the electricity systems of Slovenia and Croatia will be at risk, which could slow its progress towards climate neutrality.

The conclusions of a study produced by Vienna University of Technology, which sets out the options for the future use of renewables for energy purposes, highlight the natural conditions, such as solar radiation and the presence of wind, in Slovenia and Croatia. Unfortunately, they do not take into account any other equally important factors. The new EU Strategy for Biodiversity 2030 requires Member States to redouble their efforts to preserve biodiversity and to protect 30% of their land and sea areas (10% under strict protection conditions) by 2030. The Convention on Biodiversity (CBD), which is the global framework for biodiversity, will have similar coverage requirements after 2020. This means that the network in the EU will have to be expanded over the next decade, by approximately 4% on land and by 19% on sea.

Slovenia and Croatia are, in European terms, two countries with an above-average percentage of land area given over to protected and Natura 2000 areas (and an above-average number of such areas). Slovenia has 2,260 protected areas covering 40.4% of the land surface and 2.48% of the marine surface of the country. For comparison, Austria's 1,584 protected areas cover 28.06% of the surface of the country, which is close to the average for EU countries (25.9% land and 11.1% sea).

Background documents have been produced for the use of wind energy in Slovenia. They conclude that: Slovenia has fairly limited wind power potentials. Average wind speeds are relatively low, while the small number of areas suitable for wind power largely coincide with extensive and multi-layered areas of protected and endangered areas; these are seen as exclusionary or limiting criteria for the siting of wind farms. When the minimum distance between a wind turbine and a settlement is taken into account, the number of potentially suitable locations falls still further because of Slovenia's highly dispersed settlement pattern.

The alternative to lifetime extension is presented in Section 3 of the EIA Report. The Espoo Convention requires an assessment to be made of the possible alternatives to a proposed activity, while the EIA Directive requires reasonable alternatives to be examined. Possible (i.e. reasonable) alternatives must be capable of satisfactorily achieving the objectives of the proposed activity, and must also be feasible in terms of the technical, economic, political and other relevant criteria. It must be realistic to realise the alternatives at the time the decision on the project is taken. Constructing a power plant or plants (including those that use renewables in combination with other sources) to replace production at Krško NPP is currently not a realistic proposition. In addition, the UNECE Good Practice Recommendations on the Application of the Convention to Nuclear Energy-Related Activities, Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention), explain that alternative means of energy production are national issues of the party of origin and are therefore more properly addressed at the political and strategic level, as they are in the Integrated National Energy and Climate Plan.

Question 2: Risk of severe accidents

One very important question in the transboundary context is: Could an accident happen at the old nuclear power plant that would have significant impacts on the surrounding areas and on other countries as well?

The ministry notes that Section 6.4 of the EIA Report outlines the transboundary impacts from an emergency/accident at Krško NPP. This section presents the results of dose calculations at certain distances for design-basis (DB) and beyond-design-basis (BDB) accidents at Krško NPP. The assumed reference BDB event has used a very conservative (unlikely) scenario and provides an envelope for any impact of an accident on the environment.

Question 3: Active seismic zone
Krško lies in an active seismic zone. Krško NPP was originally designed to withstand a PGA of 0.3 g. This was increased to 0.56 g on account of several Probabilistic Seismic Hazard Analyses (PSHA) conducted up to 2014. New structures, systems and components (SSCs) have been designed to withstand 0.6 g or even 0.78 g. No proof has been provided that old SSCs can also withstand higher PGAs.
New studies show that the seismic hazard was underestimated in the PSHAs of 2004 and 2014. Historical earthquakes could exceed 0.56 g. We are demanding the use of a new PSHA drawn up using the latest methods (new methods for determining seismic hazard have been introduced in the last few years). This must be done before a decision on lifetime extension is made.

On the basis of information supplied by Krško NPP, the ministry notes that while the plant does indeed lie in an active seismic zone, it has been designed and updated so that it is earthquake-resistant. The seismic design load of Krško NPP comprises the spectrum of accelerations in accordance with the American RG 1.60 guidance, scaled to a PGA of 0.3 g at the depth of the foundations (approx. 20 m below the surface). As the PGA during an earthquake decreases with depth, as we have already pointed out, the design peak acceleration at the depth of the foundations cannot be directly compared with the PGA at surface derived from the PSHA. In order to be able to compare Krško NPP’s seismic design load with the seismic load from the PSHA, due regard must be paid to the uniform hazard spectrum at the level of the foundations, which was determined in the PSHA of 2004. A comparison between the Krško NPP design spectrum and the uniform hazard spectrum for the level of the foundations shows that the spectral acceleration for a frequency of 3.33 Hz from the uniform hazard spectrum (PSHA, 2004) is approximately 12% lower than the corresponding value of the original design spectral acceleration for 5% attenuation. Moreover, the seismic analyses of the main Krško NPP island (2013) estimated that the original seismic forces taken into account when Krško NPP was being designed were approximately comparable with the seismic forces on the facility resulting from the RG1.60 seismic load and taking into account a PGA of 0.6 g on the open surface, which roughly corresponds to a PGA with a recurrence interval of 10,000 years (0.56 g for a recurrence interval of 10,000 years – PSHA, 2004). The calculations showed that the floor spectral accelerations resulting from an earthquake with a PGA of 0.6 g at surface were less than the acceleration values for equipment with their own frequencies of between 4 and 16 Hz, which covers a wide range of engineered safety features and equipment at Krško NPP.
Seismic safety cannot be discussed solely on the basis of the seismic hazard at the site. It should be noted that additional safety factors were taken into account during the planning phase. These safety factors and uncertainties have been evaluated as part of the seismic analysis of brittleness and the seismic probabilistic safety assessment of the plant. The analysis of seismic brittleness, which was carried out in 2004 and subsequently, proved that the original SSCs could withstand much higher PGAs than those for which they were originally designed. On the basis of seismic brittleness assessments, it is estimated that there is a high probability that the plant can withstand a PGA greater than 0.6 g. The stress tests, which did not take into account the new DEC systems because they had not yet been installed, showed that the PGA at which core damage becomes probable is 0.8 g or more.
It should be stressed at this juncture that Krško NPP’s seismic capacities are taken from the Slovenian national stress-test report, which was independently reviewed by institutions authorised by the SNSA and then examined and approved within the framework of the international review of all stress tests conducted for the European Commission by ENSREG.
One should also be aware that the above-mentioned seismic capacities mentioned in the report and drawn up as part of the EU stress tests do not take account of the favourable impact of the additional seismic and nuclear engineered safety features that have been planned and installed at Krško NPP as part of the Safety Upgrade Programme. Some of this new equipment has been installed in facilities on the main Krško NPP island, although most has been installed in new buildings away from the main island. A new (third) diesel generator has been installed in the new Bunkered Building 1 (BB1) to provide independent supply to the engineered safety features, while additional pumps and alternative redundant

cooling water tanks have been installed in Bunkered Building 2 (BB2). As stated above, these systems have been designed to withstand very powerful earthquakes. In comparison with the original seismic design loads incorporated into the Krško NPP design process, the new systems have even greater seismic resilience and, as such, are able to replace the most vulnerable original systems in the event of their failure during an earthquake. If the seismic safety assessments for Krško NPP were to take the new systems into account, the assessment of seismic capacity would be even higher than was shown in the stress-test report.
No earthquake with a PGA close to 0.56 g, which is mentioned in the above statements, has occurred in the wider Krško area since the plant began operating. The most powerful earthquake in the immediate vicinity of Krško NPP took place in 1917 in the town of Brežice. According to data from the time, the magnitude of the earthquake was estimated to be 5.7 and the depth of earthquake epicentre was 13 km. The intensity of the earthquake was estimated to be 8 on the European Macroseismic Scale (EMS, source: http://www.arso.gov.si/potresi/potresna%20aktivnost/potres1917.html). The earthquake of 1917 was a typical earthquake of the type expected in the wider Krško NPP area. Earthquakes with an EMS intensity level of 8 can cause considerable or severe damage to classically constructed buildings, but do not present an extreme seismic hazard to massive reinforced-concrete buildings and robust systems such as nuclear power plants.
Slovenian law and EU practice require seismic hazard (and other hazards) to be periodically reassessed using the very latest methods. A new seismic hazard analysis is currently also being drafted for the potential second unit at the Krško site. According to the preliminary results, and taking the newly developed non-ergodic ground-motion model into account, significant differences in seismic hazard from the PSHA from 2004 are not expected.

Question 4: Extreme weather events
Extreme weather events are among the consequences of climate change. It is not clear whether Krško nuclear power plant is sufficiently robust to resist the increasingly extreme weather events or combinations of effects, such as earthquakes that cause floods. We request that the WENRA regulations from 2020 be applied to the determination of the planning bases for safety measures to protect against these hazards.

After studying Krško NPP's statements, the ministry responds by saying that special adaptation measures and safety upgrades have been carried out to improve Krško NPP's resilience and safety in the face of the coming climate challenges and extreme weather events. The potential impacts of climate change and new findings regarding the likely trends in external events are addressed in the Periodic Safety Reviews, which contain a reassessment of protection against external hazards and an analysis of the impact of extreme weather events on safety.
As described in Section 2.7.9 of the EIA Report, Krško NPP has compiled a technical report titled "Identifying external hazards", which provides an overview of external hazards in accordance with the requirements and guidelines of WENRA Issue T: Natural Hazards, Guidance Document and EPRI– Identification of External Hazards for Analysis. Krško NPP has developed a systematic approach to the regular updating of information on all significant specific threats to the plant, including by applying procedures to uncover possible new threats and regularly updating information on known threats. The external hazards report defines 104 external events. Krško NPP has also considered all combinations of hazards in accordance with the explanations set out in WENRA RHWG, Issue T: Natural Hazards Head Document, Guidance for the WENRA Safety Reference Levels for Natural Hazards introduced as lesson learned from TEPCO Fukushima Daiichi accident. The combinations of external events assessed included earthquake and fire, earthquake and external flooding, earthquake and extreme drought, and extreme combinations of long-lasting external events. A review of external hazards showed that all such hazards had been given due consideration in the plant's analyses and procedures, and that Krško NPP was robust, able to cope with extreme weather events and also able to withstand combinations of external hazards. The results of the assessment have been reviewed and approved by the SNSA. The EU stress tests have also shown that Krško NPP has a robust design that withstands extreme weather events and external hazards, and that it is well-prepared for such events. The extensive overview of

external hazards that could affect Krško NPP and produced as part of the EU stress tests included: floods, strong winds, intensive 24-hour rainfall, extreme cold, extreme heat, hailstorms, frost, heavy snowfall and cyclonic storms. Extreme weather events and combinations of risks were the (planning) basis underpinning the Safety Upgrade Programme described and presented in the EIA Report, which introduced additional DEC engineered safety features to further improve protection of the plant.
The WENRA Safety Reference Levels, which have been incorporated into Slovenian law, are binding, i.e. WENRA Safety Reference Levels for Existing Reactors, September 2014. The WENRA SRL for Existing Reactors 2020 are being examined in the course of the third Periodic Safety Review, which is currently under way. According to the preliminary results of the independent review, Krško NPP complies with the WENRA SRL for Existing Reactors 2020.

Question 5: Aging
The aging of an old nuclear power plant is a serious problem. Both the first Topical Peer Review on Aging Management in 2017/2018 and the IAEA pre-SALTO mission showed up deficiencies in aging management. The original design has become outdated, which is a problem not even the extensive post-Fukushima Safety Upgrade Programmes have been able to eliminate.

After studying information from Krško NPP and the SNSA's opinion, the ministry responds by saying that Krško NPP has a comprehensive Aging Management Programme (AMP) in place for monitoring the aging of all passive structures and components (reactor vessel, concrete, underground pipes, steel structures, electrical cables, etc.). The aging of active components is monitored by means of an effective preventive maintenance programme. The aging of active components is controlled through the monitoring of maintenance efficiency in accordance with the requirements set out in Maintenance Rule 10 CFR 50.65, Reliability Centred Maintenance INPO API 913, and Environmental Qualification Programmes 10 CFR 50.49, as well as with US regulations and standards. Activities relating to the replacement of equipment are included in the long-term plan of investments and maintenance activities. Inspections, controls and other aging-related activities are currently carried out via a system of work orders and preventive maintenance. The following existing programmes at the plant are essential for the management of the aging of active components: maintenance programmes, equipment qualification programmes, programmes of checks during operation, control programmes and aquatic chemistry programmes.
The AMP comprises various Krško NPP programmes, procedures and activities that ensure that all the allotted functions of SSCs managed under the AMP are identified and adequately checked for the effects of aging. The findings are used to determine measures that enable the SSCs to perform their allotted functions until the end of Krško NPP's operational lifetime and also in the event that its operational lifetime is extended. The Krško NPP AMP has been designed in compliance with the NUREG-1801 – Generic Aging Lessons Learned (GALL) Report. It ensures comprehensive supervision of the aging of the plant, including mechanical, electrical and structural SSCs (in relation to which it systematically identifies aging mechanisms and their effects on SSCs important to safety), identification of the possible consequences of aging and the determination of measures to maintain the performance and reliability of SSCs.
Krško NPP received the following assessments in the ENSREG First Topical Peer Review on Aging Management: one good practice, four good performances and four areas for improvement. As the ENSREG First Topical Peer Review Updated National Action Plan on the Krško NPP Ageing Management Programme (May 2021) makes clear, all the problems identified have been resolved or are being addressed in accordance with the action plan and the regulatory requirements.
The Krško NPP AMP was reviewed and evaluated by the IAEA pre-SALTO (Safety Aspects of Long Term Operation) mission. The pre-SALTO mission carried out a thorough review of AMPs and their implementation on the basis of IAEA standards and international best practice. The pre-SALTO mission found that the plant was in good condition, although there were some areas that required improvement to reach the level of the IAEA safety standards and international best practice. The mission resulted in 9 good performances and 14 issues resulting in a suggestion or recommendation for improvement. An action plan was set up to resolve the problems identified and is currently being implemented. The AMP

is also being comprehensively and systematically assessed within the context of the third Periodic Safety Review (PSR3), which is currently under way. The Krško NPP AMP is an ongoing programme with an in-built capacity for improvements based on in-house and external operating experience and the results of worldwide research and development.

<u>Question 6:</u> Risk of terrorist attack
As difficulties with materials and design increase, so does the risk of terrorist attacks. Power plants designed more than 50 years ago are not in a fit state to withstand the effects of the current threat.

The ministry responds by saying that the documentation shows that Krško NPP has redundant engineered safety features that are physically separate from each other. As part of the Safety Upgrade Programme, Krško NPP installed additional engineered safety features in two bunkered buildings that are physically separate and adequately distanced from the plant's main island, where the reactor is located in a double-shell containment. This ensures that the plant's operation can be safely halted in the event of a large commercial airliner crashing into it. Krško NPP is also protected against other types of terrorist attack or commando raid. However, owing to the sensitive nature of physical protection and security at Krško NPP, information on protection against the downing of an aircraft, terrorist attacks and commando raids is classified.

<u>Question 7</u>: Risk of severe accidents
The EIA Report calculated the design-extension condition using the assumption that the containment would remain unaffected. However, this accident is not the worst accident that could happen. While a severe accident that leads to failure of the containment is highly unlikely, the risk of an accident of that kind cannot be overlooked.

On the basis of Krško NPP's comments, the ministry explains the results of the flexRISK research project showed that an accident at Krško involving containment bypass could release up to 69 petabecquerels (PBq) of Caesium-137 and 539 PBq of Iodine-131.

<u>Question 8</u>: In the event of a severe accident at Krško, highly radioactive contamination could affect every country in Europe in adverse weather conditions. The EIA Report should also include calculations for an accident with the highest radioactive inventory (highest source term), the risk of which is not zero, and dispersion calculations for the whole of Europe.

After studying Krško NPP's comments and the opinion supplied by the SNSA, the ministry explains that the representative accident in the EIA Report was selected on the basis of the Krško NPP Safety Analysis Report, the PSA and internationally recognised nuclear safety standards, in line with industrial and regulatory practice. The identification criteria applied to determine the most important severe accident sequences comply with the US NRC instructions. The accident scenario was determined on the basis of the likelihood that it would lead to significant adverse transboundary impacts. The scenarios and results presented in the EIA Report have been reviewed by the SNSA.
The EIA Report analysed radiological releases from a reactor core accident in the case of a design-basis accident and a representative severe accident (DEC-B or BDBA) (EIA Report, Section 6.4). According to the plant's Safety Analysis Report, from the point of view of radiological release the limiting fault accident is a large-break LOCA. No other design-basis accident causes a major release of radioactivity into the environment. This also includes the accident class involving containment bypass, as represented by steam generator tube rupture (SGTR). The activity of the primary coolant in line with the technical specifications and the measures undertaken at the plant in accordance with abnormal operating procedures (AOP) and emergency operating procedures (EOP) reduces the radiological consequences of this event.
A radiological release in the case of any possible severe accident (DEC-B or BDBA) was analysed using station blackout (SBO) with no action taken in the first 24 hours (the assumption is that operators will not take any action in the first 24 hours), with release through the passive containment filtered venting

system (PCFVS) as the reference case. This sequence was chosen because of the expected complete meltdown of the core and the most rapid and most conservative release of radioactivity within the containment. The PCFVS was installed to protect the integrity of the containment in the event of an increase in pressure during a severe accident, and to filter the atmosphere of the containment in the event of any release. This protects the environment and the surrounding population from radioactive aerosols in the air and from gaseous radioactive iodine and its organic compounds. The system is passive and fully designed in accordance with DEC requirements (including seismic). The release of radioactivity after a severe accident can be attributed to it. Moreover, the analysis considers the release of radioactivity from containment leakage before and after the PCFVS is activated. To summarise, the most conservative complete core damage is assumed, together with a conservative leakage from the containment and the use of containment protection with a passive, conservatively designed system of filtered venting channels. The difference between our radioactive inventory (source term) and that used in flexRISK is the result of the explicit calculation of the capacity of the containment in our case and the release of almost all the available radioactive material in their case. Our position is that the source of the accident has been prepared in accordance with the requirements of the EIA Report.

In the EIA Report (Section 6.4), the dispersion calculations for the selected accidents were carried out for distances of up to 200 km from Krško NPP. The calculated doses for releases into the atmosphere in the accidents studied have shown that a DBA and DEC-B are not expected to have major impacts beyond of a radius of 10 km from the plant. The effects are considerably less at distances of up to 200 km, as the calculations clearly show. As the effects are further reduced at distances over 200 km, greater distances were not specifically addressed.

The authors of the final flexRISK report (Flexible Tools for Assessment of Nuclear Risk in Europe Final Report (2013)) discussed the shortcomings of their work and pointed out the limitations and uncertainties of the data used in the project. The project made use of available generic data, such as generic accident scenarios and radioactive inventories (source term), as well as available probabilistic safety assessments (PSA) that are not directly comparable. The authors themselves state that a comprehensive PSA would be required for each nuclear power plant, along with the use of appropriate computer codes and models.

Krško NPP has carried out a series of upgrades in the areas of seismic hazard, flood protection, mitigation of the effects of fire, and the provision of additional sources of supply in the event of emergency situations or failure of the external power supply, etc. (EIA Report, Section 2.8). The Krško NPP SUP has led to a reduction in risk in the last few years. All safety upgrades are reflected in the Krško NPP safety analyses and in the PSA model, which shows a significant reduction in the core damage frequency (EIA Report, Section 2.8). We cannot take the flexRISK assessments, which are based on generic data and do not take into account possible safety improvements carried out at Krško NPP, as representative.

Spent fuel and radioactive waste

Question 9: The safe disposal of radioactive waste and spent fuel is a problem that has not been resolved anywhere in the world, particularly as regards final disposal technologies, which are typically unsuccessful – see Asse (Germany) or WIPP (USA). Expecting safety to continue almost forever is, given today's knowledge and technical capacities, an illusion.

Proof of the safe disposal of the additional nuclear waste generated in the course of the lifetime extension has not been provided. Krško NPP still does not have an interim spent fuel storage facility, as the dry storage is still under construction. In the meantime, spent fuel has to be stored in the spent fuel pool. There is currently no concrete plan for final storage. Slovenia and Croatia, who are the owners of Krško NPP and are jointly responsible for nuclear waste management, are instead pinning their hopes on a multinational repository. A national repository in Slovenia or Croatia would begin operating in 2063, although the other date mentioned in the EIA Report (2093, almost at the end of the century) appears more realistic. Moreover, the plan is to use the Swedish KBS-3 method for the final disposal of spent fuel, where no account seems to be taken of the fact that the latest research findings show that copper can corrode even in oxygen-free environments. As a result of other corrosion mechanisms and mechanisms that could cause stress to copper canisters, it is not possible to ensure the integrity of those canisters over the long term. For the final disposal of HLW resulting from operation and the possible extension of Krško NPP's operational lifetime, the Slovenian authorities are consciously advocating an untested technology that has been subject to criticism.

The ministry agrees that the issue of the long-term disposal of HLW remains unresolved and that delays have arisen in the attempts to resolve it. At the same time, however, it notes that a long-term solution must be found as quickly as possible, either for the current HLW quantities or for the increased quantities resulting from a further 20 years of operation.
At the same time, the ministry notes that considerable progress has been made in the spent fuel dry storage project, for which an EIA has been produced and a building permit acquired, and the facility is in the final phase of construction. The first campaign of transfer of spent fuel to dry storage will take place in the first half of 2023.
The disposal of spent fuel will take place in accordance with the Programme for the Disposal of Radioactive Waste and Spent Fuel, which was prepared in accordance with the provisions of the Treaty between the Government of the Republic of Slovenia and the Government of the Republic of Croatia on the Regulation of Status and Other Legal Relations Regarding Investment in and the Exploitation and Decommissioning of Krško Nuclear Power Plant (Intergovernmental Treaty). Periodic reviews of the disposal programme are carried out at least every five years in order to update the disposal reference concept in line with new technical solutions and information. Spent fuel from Krško NPP will be deposited for the long term in a spent fuel repository at an as-yet-undetermined location in Slovenia or Croatia (or, if possible, in a regional or multinational repository).
In order to develop a final solution and a reference disposal scenario, both sides are starting to develop a geological disposal concept and collect data on specific geological formations. Their revisions to the disposal programme reflect the international progress being made with various disposal concepts and the ongoing development of regional and multinational geological repositories.
Regarding the Swedish KBS-3 disposal technology, research into and the development of different deep geological disposal concepts will be monitored and the options assessed in the light of scientific progress before any final decision on the disposal concept is taken.
A licensed, state-of-the-art solution will be chosen, as was the case with the spent fuel dry storage, for which the tried-and-tested HOLTEC technology was selected. Because of the existing spent fuel and radioactive waste, the quantity of spent fuel resulting from the extension of Krško NPP's operational lifetime does not qualitatively change the situation that needs to be addressed.

Question 10: One significant shortcoming of this EIA procedure is the lack of alternative solutions to the extension of the operational lifetime of an old nuclear power plant, which presents an entirely avoidable risk to large parts of Europe. We are therefore demanding the closure of the nuclear power plant at Krško.

The ministry notes that the alternative to lifetime extension is presented in Section 3 of the EIA Report. The EIA has been prepared in accordance with the Slovenian Decree on the method of drafting and on the content of the report on the effects of planned activities affecting the environment (Official Gazette of RS, Nos. 36/09, 40/17 and 44/22 [ZVO- 2]), which complies with Directive 2011/92/EU of 13 December 2011 (EIA Directive) and Directive 2014/52/EU of 16 April 2014 amending Directive 2011/92/EU. The alternative to lifetime extension is presented in Section 3 of the EIA Report. The EIA procedure is being conducted in accordance with the requirements of the Espoo Convention and Slovenian national law governing EIA procedures. The ministry cannot grant the request to close Krško NPP as it is in possession of positive opinions, including one from the SNSA on the safety aspects, which is in this case is very important.

Comments submitted by: Obmann Gottfried Brandner, Verein Lebensraum Waldviertel

Question 1: Alternatives
The EIA Report omits important information on whether the lifetime extension is even necessary for satisfying electricity needs in Slovenia and Croatia. A new study by Vienna University of Technology

concluded that more than 50% of Slovenian demand for electricity could be covered by photovoltaics and on-shore wind energy as soon as 2030, and that the electricity needs of Slovenia and Croatia could be fully met by renewable energy sources by 2050.
The Espoo Convention and the EIA Directive both require an assessment to be made of alternatives to a proposed activity. We ask that the EIA Report present alternative energy scenarios, i.e. those that do not include extension of the operational lifetime of a 40-year-old nuclear power plant. As a response to the climate crisis, energy efficiency and energy-saving measures must be the most important options for alternative scenarios, while any new electricity generation must be based on renewable energy sources, the costs of which are continually coming down.

In relation to these comments, the ministry points out that Slovenia's 2021 Integrated National Energy and Climate Plan (NECP) and Croatia's 2020 Integrated National Energy and Climate Plan were drawn up and presented to the European Commission in accordance with Regulation (EU) 2018/1999 of 11 December 2018 on the Governance of the Energy Union and Climate Action. The Integrated National Energy and Climate Plans drawn up by both countries set out the objectives, policies and measures for five dimensions of the Energy Union up to 2030 (with an outlook to 2040), and cover, among other things: decarbonisation (greenhouse gas emissions) and renewable energy sources, energy efficiency and energy security. All scenarios of future energy use and supply defined in the Integrated National Energy and Climate Plans are based on extending Krško NPP's operational lifetime in order to enable the energy and climate policy targets to be met. The analyses that formed the basis for the National Energy and Climate Plans have shown that increasing the use of renewable and low-carbon-emission sources and increasing energy efficiency are not in themselves sufficient to enable the targets to be met if we take estimated electricity consumption and the increased requirements to reducing greenhouse gas emissions into account.
A study titled "Energy, systemic, economic and ecological aspects of the extension of the operational lifetime of Krško NPP", which was drawn up by Elektroinštitut Milan Vidmar and the Faculty of Electrical Engineering at the University of Zagreb, showed that Krško NPP would be irreplaceable during the period of the proposed lifetime extension. If the lifetime of Krško NPP is not extended, both countries will be reliant on electricity imports, where and if available. EU Member States' national energy and climate plans show a net energy deficit, meaning that electricity imports will not always be available when needed and that reducing consumption will be the only alternative in crisis situations. This is not in line with the first dimension of the Energy Union: "Security, solidarity and trust - diversifying Europe's sources of energy and ensuring energy security through solidarity and cooperation between EU countries". Operating Krško NPP until 2043 is a first step towards decarbonisation and long-term energy independence. It will not be possible for either country to maintain short-term energy security without Krško NPP. The situation is even worse for future energy use, as electricity is considered the predominant form of energy in the economy (industry, transport, services) and for most of the population's energy consumption. Current developments and their forecasts do not indicate a sufficient technological breakthrough capable of replacing Krško NPP's current generation capacity with renewable energy sources while meeting the current and future required criteria of reliability, safety, environmental sustainability and economic viability. The requirement to preserve spatial features and natural and other assets makes it difficult to introduce new renewable energy sources capable of replacing Krško NPP in the next 20 years. Based on the scenarios and sensitivity analyses of energy balances and electricity demand, it is clear that extending Krško NPP's operational lifetime is the most technically, environmentally and economically advantageous solution. Events in recent months, which have seen a steep rise in fuel and electricity prices, are further confirmation of the urgency of maintaining production at Krško NPP, as it guarantees affordable and sufficient supply of the electricity that industry and commerce so desperately need. If Krško NPP's operational lifetime is not extended, the stability and reliability of the electricity systems of Slovenia and Croatia will be at risk, which could slow its progress towards climate neutrality.
The conclusions of a study produced by Vienna University of Technology, which sets out the options for the future use of renewables for energy purposes, highlight the natural conditions, such as solar radiation and the presence of wind, in Slovenia and Croatia. Unfortunately, they do not take into account

any other equally important factors. The new EU Strategy for Biodiversity 2030 requires Member States to redouble their efforts to preserve biodiversity and to protect 30% of their land and sea areas (10% under strict protection conditions) by 2030. The Convention on Biodiversity (CBD), which is the global framework for biodiversity, will have similar coverage requirements after 2020. This means that the network in the EU will have to be expanded over the next decade, by approximately 4% on land and by 19% on sea.

Slovenia and Croatia are, in European terms, two countries with an above-average percentage of land area given over to protected and Natura 2000 areas (and an above-average number of such areas). Slovenia has 2,260 protected areas covering 40.4% of the land surface and 2.48% of the marine surface of the country. Croatia has 1,192 protected areas covering 38.02% of the land surface and 9.28% of the marine surface of the country. For comparison, Austria's 1,584 protected areas cover 28.06% of the surface of the country, which is close to the average for EU countries (25.9% land and 11.1% sea).

Background documents have been produced for the use of wind energy in Slovenia. They conclude that: Slovenia has fairly limited wind power potentials. Average wind speeds are relatively low, while the small number of areas suitable for wind power largely coincide with extensive and multi-layered areas of protected and endangered areas; these are seen as exclusionary or limiting criteria for the siting of wind farms. When the minimum distance between a wind turbine and a settlement is taken into account, the number of potentially suitable locations falls still further because of Slovenia's highly dispersed settlement pattern.

However, the ministry stresses that renewable energy sources must be developed regardless of the lifetime extension and that, according to ECJ case-law, one source of energy is not an alternative to another and that alternatives must be analysed within a single source. Therefore, in this case, Alternative 1 is extending operational lifetime and Alternative 2 is not-extending operational lifetime, as it involves the existing Krško NPP facility.

The alternative to lifetime extension is presented in Section 3 of the EIA Report. The EIA Directive requires reasonable alternatives to be examined. Possible (i.e. reasonable) alternatives must be capable of satisfactorily achieving the objectives of the proposed activity, and must also be feasible in terms of the technical, economic and other relevant criteria. It must be realistic to realise the alternatives at the time the decision on the project is taken. Constructing a power plant or plants (including those that use renewables in combination with other sources) to replace production at Krško NPP is currently not a realistic proposition. In addition, the UNECE Good Practice Recommendations on the Application of the Convention to Nuclear Energy-Related Activities, Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention), explain that alternative means of energy production are national issues of the party of origin and are therefore more properly addressed at the political and strategic level, as they are in the Integrated National Energy and Climate Plan.

<u>Question 2</u>: Risk of severe accidents

One very important question in the transboundary context is: Could an accident happen at the old nuclear power plant that would have significant impacts on the surrounding areas and on other countries as well?

The ministry responds by saying that Section 6.4 of the EIA Report outlines the transboundary impacts from an emergency/accident at Krško NPP. This section presents the results of dose calculations at certain distances for design-basis (DB) and beyond-design-basis (BDB) accidents at Krško NPP. The assumed reference BDB event has used a very conservative (unlikely) scenario and provides an envelope for any impact of an accident on the environment.

<u>Question 3</u>: Active seismic zone

Krško lies in an active seismic zone. Krško NPP was originally designed to withstand a PGA of 0.3 g. This was increased to 0.56 g on account of several Probabilistic Seismic Hazard Analyses (PSHA) conducted up to 2014. New structures, systems and components (SSCs) have been designed to withstand 0.6 g or even 0.78 g. No proof has been provided that old SSCs can also withstand higher PGAs.

New studies show that the seismic hazard was underestimated in the PSHAs of 2004 and 2014. Historical earthquakes could exceed 0.56 g. We are demanding the use of a new PSHA drawn up using the latest methods (new methods for determining seismic hazard have been introduced in the last few years). This must be done before a decision on lifetime extension is made.

The ministry notes that Krško NPP is earthquake-resistant as a result of earthquake-proof construction that formed part of the original Krško NPP design and the safety upgrades that take seismic safety into consideration. The seismic design load of Krško NPP comprises the spectrum of accelerations in accordance with the American RG 1.60 guidance, scaled to a PGA of 0.3 g at the depth of the foundations (approx. 20 m below the surface). As the PGA during an earthquake decreases with depth, as we have already pointed out, the design peak acceleration at the depth of the foundations cannot be directly compared with the PGA at surface derived from the PSHA. In order to be able to compare Krško NPP's seismic design load with the seismic load from the PSHA, due regard must be paid to the uniform hazard spectrum at the level of the foundations, which was determined in the PSHA of 2004. A comparison between the Krško NPP design spectrum and the uniform hazard spectrum for the level of the foundations shows that the spectral acceleration for a frequency of 3.33 Hz from the uniform hazard spectrum (PSHA, 2004) is approximately 12% lower than the corresponding value of the original design spectral acceleration for 5% attenuation. Moreover, the seismic analyses of the main Krško NPP island (2013) estimated that the original seismic forces taken into account when Krško NPP was being designed were approximately comparable with the seismic forces on the facility resulting from the RG1.60 seismic load and taking into account a PGA of 0.6 g on the open surface, which roughly corresponds to a PGA with a recurrence interval of 10,000 years (0.56 g for a recurrence interval of 10,000 years – PSHA, 2004). The calculations showed that the floor spectral accelerations resulting from an earthquake with a PGA of 0.6 g at surface were less than the acceleration values for equipment with their own frequencies of between 4 and 16 Hz, which covers a wide range of engineered safety features and equipment at Krško NPP.

Seismic safety cannot be discussed solely on the basis of the seismic hazard at the site. It should be noted that additional safety factors were taken into account during the planning phase. These safety factors and uncertainties have been evaluated as part of the seismic analysis of brittleness and the seismic probabilistic safety assessment of the plant. The analysis of seismic brittleness, which was carried out in 2004 and subsequently, proved that the original SSCs could withstand much higher PGAs than those for which they were originally designed. On the basis of seismic brittleness assessments, it is estimated that there is a high probability that the plant can withstand a PGA greater than 0.6 g. The stress tests, which did not take into account the new DEC systems because they had not yet been installed, showed that the PGA at which core damage becomes probable is 0.8 g or more.

It should be stressed at this juncture that Krško NPP's seismic capacities are taken from the Slovenian national stress-test report, which was independently reviewed by institutions authorised by the SNSA and then examined and approved within the framework of the international review of all stress tests conducted for the European Commission by ENSREG.

One should also be aware that the above-mentioned seismic capacities mentioned in the report and drawn up as part of the EU stress tests do not take account of the favourable impact of the additional seismic and nuclear engineered safety features that have been planned and installed at Krško NPP as part of the Safety Upgrade Programme. Some of this new equipment has been installed in facilities on the main Krško NPP island, although most has been installed in new buildings away from the main island. A new (third) diesel generator has been installed in the new Bunkered Building 1 (BB1) to provide independent supply to the engineered safety features, while additional pumps and alternative redundant cooling water tanks have been installed in Bunkered Building 2 (BB2). As stated above, these systems have been designed to withstand very powerful earthquakes. In comparison with the original seismic design loads incorporated into the Krško NPP design process, the new systems have even greater seismic resilience and, as such, are able to replace the most vulnerable original systems in the event of their failure during an earthquake. If the seismic safety assessments for Krško NPP were to take the new systems into account, the assessment of seismic capacity would be even higher than was shown in the stress-test report.

No earthquake with a PGA close to 0.56 g, which is mentioned in the above statements, has occurred in the wider Krško area since the plant began operating. The most powerful earthquake in the immediate vicinity of Krško NPP took place in 1917 in the town of Brežice. According to data from the time, the magnitude of the earthquake was estimated to be 5.7 and the depth of earthquake epicentre was 13 km. The intensity of the earthquake was estimated to be 8 on the European Macroseismic Scale (EMS, source: http://www.arso.gov.si/potresi/potresna%20aktivnost/potres1917.html). The earthquake of 1917 was a typical earthquake of the type expected in the wider Krško NPP area. Earthquakes with an EMS intensity level of 8 can cause considerable or severe damage to classically constructed buildings, but do not present an extreme seismic hazard to massive reinforced-concrete buildings and robust systems such as nuclear power plants.
Slovenian law and EU practice require seismic hazard (and other hazards) to be periodically reassessed using the very latest methods. A new seismic hazard analysis is currently also being drafted for the potential second unit at the Krško site. According to the preliminary results, and taking the newly developed non-ergodic ground-motion model into account, significant differences in seismic hazard from the PSHA from 2004 are not expected.

Question 4: Extreme weather events
Extreme weather events are among the consequences of climate change. It is not clear whether Krško nuclear power plant is sufficiently robust to resist the increasingly extreme weather events or combinations of effects, such as earthquakes that cause floods. We request that the WENRA regulations from 2020 be applied to the determination of the planning bases for safety measures to protect against these hazards.

The ministry responds by saying that special adaptation measures and safety upgrades have been carried out to improve Krško NPP's resilience and safety in the face of the coming climate challenges and extreme weather events. The potential impacts of climate change and new findings regarding the likely trends in external events are addressed in the Periodic Safety Reviews, which contain a reassessment of protection against external hazards and an analysis of the impact of extreme weather events on safety.
As described in Section 2.7.9 of the EIA Report, Krško NPP has compiled a technical report titled "Identifying external hazards", which provides an overview of external hazards in accordance with the requirements and guidelines of WENRA Issue T: Natural Hazards, Guidance Document and EPRI– Identification of External Hazards for Analysis. Krško NPP has developed a systematic approach to the regular updating of information on all significant specific threats to the plant, including by applying procedures to uncover possible new threats and regularly updating information on known threats. The external hazards report defines 104 external events. Krško NPP has also considered all combinations of hazards in accordance with the explanations set out in WENRA RHWG, Issue T: Natural Hazards Head Document, Guidance for the WENRA Safety Reference Levels for Natural Hazards introduced as lesson learned from TEPCO Fukushima Daiichi accident. The combinations of external events assessed included earthquake and fire, earthquake and external flooding, earthquake and extreme drought, and extreme combinations of long-lasting external events. A review of external hazards showed that all such hazards had been given due consideration in the plant's analyses and procedures, and that Krško NPP was robust, able to cope with extreme weather events and also able to withstand combinations of external hazards. The results of the assessment have been reviewed and approved by the SNSA. The EU stress tests have also shown that Krško NPP has a robust design that withstands extreme weather events and external hazards, and that it is well-prepared for such events. The extensive overview of external hazards that could affect Krško NPP and produced as part of the EU stress tests included: floods, strong winds, intensive 24-hour rainfall, extreme cold, extreme heat, hailstorms, frost, heavy snowfall and cyclonic storms. Extreme weather events and combinations of risks were the (planning) basis underpinning the Safety Upgrade Programme described and presented in the EIA Report, which introduced additional DEC engineered safety features to further improve protection of the plant.
The WENRA Safety Reference Levels, which have been incorporated into Slovenian law, are binding, i.e. WENRA Safety Reference Levels for Existing Reactors, September 2014. The WENRA SRL for

Existing Reactors 2020 are being examined in the course of the third Periodic Safety Review, which is currently under way. According to the preliminary results of the independent review, Krško NPP complies with the WENRA SRL for Existing Reactors 2020.

Question 5: Aging
The aging of an old nuclear power plant is a serious problem. Both the first Topical Peer Review on Aging Management in 2017/2018 and the IAEA pre-SALTO mission showed up deficiencies in aging management. The original design has become outdated, which is a problem not even the extensive post-Fukushima Safety Upgrade Programmes have been able to eliminate.

The ministry responds by saying that Krško NPP has a comprehensive Aging Management Programme (AMP) in place for monitoring the aging of all passive structures and components (reactor vessel, concrete, underground pipes, steel structures, electrical cables, etc.). The aging of active components is monitored by means of an effective preventive maintenance programme. The aging of active components is controlled through the monitoring of maintenance efficiency in accordance with the requirements set out in Maintenance Rule 10 CFR 50.65, Reliability Centred Maintenance INPO API 913, and Environmental Qualification Programmes 10 CFR 50.49, as well as with US regulations and standards. Activities relating to the replacement of equipment are included in the long-term plan of investments and maintenance activities. Inspections, controls and other aging-related activities are currently carried out via a system of work orders and preventive maintenance. The following existing programmes at the plant are essential for the management of the aging of active components: maintenance programmes, equipment qualification programmes, programmes of checks during operation, control programmes and aquatic chemistry programmes.
The AMP comprises various Krško NPP programmes, procedures and activities that ensure that all the allotted functions of SSCs managed under the AMP are identified and adequately checked for the effects of aging. The findings are used to determine measures that enable the SSCs to perform their allotted functions until the end of Krško NPP's operational lifetime and also in the event that its operational lifetime is extended. The Krško NPP AMP has been designed in compliance with the NUREG-1801 – Generic Aging Lessons Learned (GALL) Report. It ensures comprehensive supervision of the aging of the plant, including mechanical, electrical and structural SSCs (in relation to which it systematically identifies aging mechanisms and their effects on SSCs important to safety), identification of the possible consequences of aging and the determination of measures to maintain the performance and reliability of SSCs.
Krško NPP received the following assessments in the ENSREG First Topical Peer Review on Aging Management: one good practice, four good performances and four areas for improvement. As the ENSREG First Topical Peer Review Updated National Action Plan on the Krško NPP Ageing Management Programme (May 2021) makes clear, all the problems identified have been resolved or are being addressed in accordance with the action plan and the regulatory requirements.
The Krško NPP AMP was reviewed and evaluated by the IAEA pre-SALTO (Safety Aspects of Long Term Operation) mission. The pre-SALTO mission carried out a thorough review of AMPs and their implementation on the basis of IAEA standards and international best practice. The pre-SALTO mission found that the plant was in good condition, although there were some areas that required improvement to reach the level of the IAEA safety standards and international best practice. The mission resulted in 9 good performances and 14 issues resulting in a suggestion or recommendation for improvement. An action plan was set up to resolve the problems identified and is currently being implemented. The AMP is also being comprehensively and systematically assessed within the context of the third Periodic Safety Review (PSR3), which is currently under way. The Krško NPP AMP is an ongoing programme with an in-built capacity for improvements based on in-house and external operating experience and the results of worldwide research and development.

Question 6: Risk of terrorist attack
As difficulties with materials and design increase, so does the risk of terrorist attacks. Power plants designed more than 50 years ago are not in a fit state to withstand the effects of the current threat.

In response to these statements, the ministry points out that Krško NPP has redundant engineered safety features that are physically separate from each other. As part of the Safety Upgrade Programme, Krško NPP installed additional engineered safety features in two bunkered buildings that are physically separate and adequately distanced from the plant's main island, where the reactor is located in a double-shell containment. This ensures that the plant's operation can be safely halted in the event of a large commercial airliner crashing into it. Krško NPP is also protected against other types of terrorist attack or commando raid. However, owing to the sensitive nature of physical protection and security at Krško NPP, information on protection against the downing of an aircraft, terrorist attacks and commando raids is classified.

Question 7: Risk of severe accidents
The EIA Report calculated the design-extension condition using the assumption that the containment would remain unaffected. However, this accident is not the worst accident that could happen. While a severe accident that leads to failure of the containment is highly unlikely, the risk of an accident of that kind cannot be overlooked. The results of the flexRISK research project showed that an accident at Krško involving containment bypass could release up to 69 petabecquerels (PBq) of Caesium-137 and 539 PBq of Iodine-131. In the event of a severe accident at Krško, highly radioactive contamination could affect every country in Europe in adverse weather conditions.
The EIA Report should also include calculations for an accident with the highest radioactive inventory (highest source term), the risk of which is not zero, and dispersion calculations for the whole of Europe.

After studying Krško NPP's comments and materials, the ministry responds by saying that the representative accident in the EIA Report was selected on the basis of the Krško NPP Safety Analysis Report, the PSA and internationally recognised nuclear safety standards, in line with industrial and regulatory practice. The identification criteria applied to determine the most important severe accident sequences comply with the US NRC instructions. The accident scenario was determined on the basis of the likelihood that it would lead to significant adverse transboundary impacts. The scenarios and results presented in the EIA Report have been reviewed by the SNSA.
The EIA Report analysed radiological releases from a reactor core accident in the case of a design-basis accident and a representative severe accident (DEC-B or BDBA) (EIA Report, Section 6.4). According to the plant's Safety Analysis Report, from the point of view of radiological release the limiting fault accident is a large-break LOCA. No other design-basis accident causes a major release of radioactivity into the environment. This also includes the accident class involving containment bypass, as represented by steam generator tube rupture (SGTR). The activity of the primary coolant in line with the technical specifications and the measures undertaken at the plant in accordance with abnormal operating procedures (AOP) and emergency operating procedures (EOP) reduces the radiological consequences of this event.
A radiological release in the case of any possible severe accident (DEC-B or BDBA) was analysed using station blackout (SBO) with no action taken in the first 24 hours (the assumption is that operators will not take any action in the first 24 hours), with release through the passive containment filtered venting system (PCFVS) as the reference case. This sequence was chosen because of the expected complete meltdown of the core and the most rapid and most conservative release of radioactivity within the containment. The PCFVS was installed to protect the integrity of the containment in the event of an increase in pressure during a severe accident, and to filter the atmosphere of the containment in the event of any release. This protects the environment and the surrounding population from radioactive aerosols in the air and from gaseous radioactive iodine and its organic compounds. The system is passive and fully designed in accordance with DEC requirements (including seismic). The release of radioactivity after a severe accident can be attributed to it. Moreover, the analysis considers the release of radioactivity from containment leakage before and after the PCFVS is activated. To summarise, the most conservative complete core damage is assumed, together with a conservative leakage from the containment and the use of containment protection with a passive, conservatively designed system of filtered venting channels. The difference between our radioactive inventory (source term) and that used

in flexRISK is the result of the explicit calculation of the capacity of the containment in our case and the release of almost all the available radioactive material in their case. Our position is that the source of the accident has been prepared in accordance with the requirements of the EIA Report.
In the EIA Report (Section 6.4), the dispersion calculations for the selected accidents were carried out for distances of up to 200 km from Krško NPP. The calculated doses for releases into the atmosphere in the accidents studied have shown that a DBA and DEC-B are not expected to have major impacts beyond of a radius of 10 km from the plant. The effects are considerably less at distances of up to 200 km, as the calculations clearly show. As the effects are further reduced at distances over 200 km, greater distances were not specifically addressed.
The authors of the final flexRISK report (Flexible Tools for Assessment of Nuclear Risk in Europe Final Report (2013)) discussed the shortcomings of their work and pointed out the limitations and uncertainties of the data used in the project. The project made use of available generic data, such as generic accident scenarios and radioactive inventories (source term), as well as available probabilistic safety assessments (PSA) that are not directly comparable. The authors themselves state that a comprehensive PSA would be required for each nuclear power plant, along with the use of appropriate computer codes and models.
Krško NPP has carried out a series of upgrades in the areas of seismic hazard, flood protection, mitigation of the effects of fire, and the provision of additional sources of supply in the event of emergency situations or failure of the external power supply, etc. (EIA Report, Section 2.8). The Krško NPP SUP has led to a reduction in risk in the last few years. All safety upgrades are reflected in the Krško NPP safety analyses and in the PSA model, which shows a significant reduction in the core damage frequency (EIA Report, Section 2.8). We cannot take the flexRISK assessments, which are based on generic data and do not take into account possible safety improvements carried out at Krško NPP, as representative.

<u>Question 8</u>: Spent fuel and radioactive waste
The safe disposal of radioactive waste and spent fuel is a problem that has not been resolved anywhere in the world, particularly as regards final disposal technologies, which are typically unsuccessful – see Asse (Germany) or WIPP (USA). Expecting safety to continue almost forever is, given today's knowledge and technical capacities, an illusion.
Proof of the safe disposal of the additional nuclear waste generated in the course of the lifetime extension has not been provided. Krško NPP still does not have an interim spent fuel storage facility, as the dry storage is still under construction. In the meantime, spent fuel has to be stored in the spent fuel pool. There is currently no concrete plan for final storage. Slovenia and Croatia, who are the owners of Krško NPP and are jointly responsible for nuclear waste management, are instead pinning their hopes on a multinational repository. A national repository in Slovenia or Croatia would begin operating in 2063, although the other date mentioned in the EIA Report (2093, almost at the end of the century) appears more realistic. Moreover, the plan is to use the Swedish KBS-3 method for the final disposal of spent fuel, where no account seems to be taken of the fact that the latest research findings show that copper can corrode even in oxygen-free environments. As a result of other corrosion mechanisms and mechanisms that could cause stress to copper canisters, it is not possible to ensure the integrity of those canisters over the long term. For the final disposal of HLW resulting from operation and the possible extension of Krško NPP's operational lifetime, the Slovenian authorities are consciously advocating an untested technology that has been subject to criticism.

The ministry responds by saying that an EIA was produced for the spent fuel dry storage and a building permit acquired, and that construction of the facility is in full swing. The first campaign of transfer of spent fuel to dry storage will take place in the first half of 2023. The disposal of spent fuel will take place in accordance with the Programme for the Disposal of Radioactive Waste and Spent Fuel, which was prepared in accordance with the provisions of the Treaty between the Government of the Republic of Slovenia and the Government of the Republic of Croatia on the Regulation of Status and Other Legal Relations Regarding Investment in and the Exploitation and Decommissioning of Krško Nuclear Power Plant (Intergovernmental Treaty). Periodic reviews of the disposal programme are carried out at least

every five years in order to update the disposal reference concept in line with new technical solutions and information. Spent fuel from Krško NPP will be deposited in a spent fuel repository at an as-yet-undetermined location in Slovenia or Croatia (or, if possible, in a regional or multinational repository).
In order to develop a final solution and a reference disposal scenario, both sides are starting to develop a geological disposal concept and collect data on specific geological formations. Their revisions to the disposal programme reflect the international progress being made with various disposal concepts and the ongoing development of regional and multinational geological repositories.
Regarding the Swedish KBS-3 disposal technology, research into and the development of different deep geological disposal concepts will be monitored and the options assessed in the light of scientific progress before any final decision on the disposal concept is taken.
A licensed, state-of-the-art solution will be chosen, as was the case with the spent fuel dry storage, for which the tried-and-tested HOLTEC technology was selected. Because of the existing spent fuel and radioactive waste, the quantity of spent fuel resulting from the extension of Krško NPP's operational lifetime does not qualitatively change the situation that needs to be addressed.

Question 9: One significant shortcoming of this EIA procedure is the lack of alternative solutions to the extension of the operational lifetime of an old nuclear power plant, which presents an entirely avoidable risk to large parts of Europe. We are therefore demanding the closure of the nuclear power plant at Krško.

In relation to this comment, the ministry explains that the alternative to lifetime extension is presented in Section 3 of the EIA Report. The EIA has been prepared in accordance with the Slovenian Decree on the method of drafting and on the content of the report on the effects of planned activities affecting the environment, which complies with the EIA Directive. The alternative to lifetime extension is presented in Section 3 of the EIA Report. The EIA procedure is being conducted for an extension of operational lifetime and in accordance with the requirements of the Espoo Convention and Slovenian national law governing EIA procedures. Regarding the materials and the opinions of ministries and organisations submitted and the transboundary consultations, the ministry notes that it cannot grant the request to close Krško NPP, although it has ordered a new EIA for closure in the operative part.

Comments submitted by Renata Brandner-Weiß, Waldviertler Energie-Stammtisch
The comments repeat themselves and relate to alternatives, the risk of severe accidents, the active seismic region, extreme weather events, aging, the risk of terrorist attack, the risk of severe accidents, and spent fuel and radioactive waste. The explanations are given on pp. 185–191 [pp. 200-207].

Question 1: Response to the opinion of Mag. Elisabeth Scheutz and Dr Rudolf Scheutz, Oberfeldstr. 7, 5102 Anthering

Mankind does not control nuclear energy.

The ministry explains that Krško NPP is controlled as it has a thorough system of internal structures and operating protocols in place. It is overseen by the SNSA and the Environment Inspectorate, which checks whether the measures set out in the various permits and licences have been carried out.
Operators of nuclear power plants oversee and manage technical processes, and ensure that the plant operates as required. The maintenance of a controlled nuclear reaction in the reactor is regulated by influencing the number of neutrons in the core and therefore the power of the reactor. This can be achieved by changing the concentration of boron (boric acid) in the primary coolant or by means of control rods that are lowered into or raised from the core. The boron and control rods are strong neutron absorbers. The engineered safety features ensure control over and the integrity of the power plant, even in the event of a highly unlikely accident or equipment failure, and prevent environmental impact. As it is extremely important for engineered safety features to operate if there is equipment failure or an accident at the nuclear power plant, all engineered safety features operate on the redundancy principle (i.e. they are duplicated).

Question 2: Responses to the opinion submitted by: OSR Univ.-Lektor Dr. Otto Widetschek, Brandschutzforum Austria GmbH, BFA

The comment is submitted on behalf of the Styrian Firefighting Association by the president of the Austrian Firefighting Forum.
An assessment of the transboundary environmental impact of the lifetime extension of Krško nuclear power plant from 40 to 60 years is under way with Slovenia in Austria. We have reviewed the EIA Report and would like to make a short statement and ask a series of questions in relation to fire safety.

General

- I would like to start by saying that in a report spanning 547 pages, only two pages relate to fire protection.

The ministry responds by saying that the existing fire-protection system has been addressed as required in the EIA Report for the extension of Krško NPP's operational lifetime. It was not possible to deal with fire protection at Krško NPP fully and precisely in the report because its focus is on preventive measures. That does not mean, however, that it is not one of the most important organisational components of the plant and one that will continue during the lifetime extension.

- The tactical expression "defence in depth" is also used in relation to fires and accidents, which is not normal practice in Austria. My first question would therefore be: what does "defence in depth" mean?

Following Krško NPP's explanation and after studying the material, the ministry explains that defence in depth is a nuclear safety concept that relates to the planning and operation of nuclear facilities and that aims to prevent and mitigate accidents (IAEA, Defence in Depth in Nuclear Safety, INSAG-10). Defence in depth is the principle of ensuring safety functions and does not relate solely to one barrier, but to a series of independent and redundant layers of protection. While each individual solution must be sufficient to prevent an accident, we nevertheless ensure that several possible solutions are always ready. Defence in depth includes the use of strict controls on access, physical barriers, redundant and diverse safety functions and effective emergency-response measures.

- Page 73 of the EIA Report states: Krško NPP has a fire safety programme (fire safety rules) that determines the organisation of fire safety, fire safety measures and supervision of their implementation, gives instructions on how to act in the event of a fire, and specifies a training programme to support successful fire protection. Two questions on this:

Question 1: What are the main points of the planned training programme? How large/extensive is it?

On the basis of the explanations, the ministry responds by saying that the Krško NPP fire safety programme (fire safety rules) prescribes the implementation and broad content of training for various groups of employees:

- administrative staff;
- technical staff;
- Krško NPP firefighters;
- firefighters from the external professional firefighting unit;
- technical staff that provide assistance to firefighters;
- fire watch staff;
- persons responsible for assisting in evacuation procedures.

Different training topics are prescribed for the different groups.
For example: Krško NPP firefighters complete their studies at the professional, national-level firefighting college. They are also required to complete a ten-week course in the basics of nuclear power plant theory. As part of the continuous professional training programme, they attend an annual course that periodically covers topics such as:

- chemicals and the extinguishing of fires;

- the classification and use of firefighting equipment;
- the use of water, foam, powder, CO_2 and FM200 in firefighting operations;
- hydrants, pipes and hydrant cabinets;
- fire-protection systems and their placement around different buildings;
- flammable liquids and gases;
- smoke and toxic gas hazards;
- communications;
- lighting;
- application of the fire plan; ▸ ...

Question 3: Are there separate courses for emergency intervention teams on how to deal with accidents and, if so, who is in charge of those courses?

On the basis of Krško NPP's statements, the ministry explains that there are separate courses for emergency intervention teams on how to deal with accidents. The fire department, which in the event of an accident is comprised of an extended firefighting team, undergoes training four times a year. In addition to this, Krško NPP holds at least 16 firefighting exercises every year. These are attended by firefighters, members of the fire department, operational staff and firefighters from the external professional firefighting unit.
The courses are organised and led by the Krško NPP training and fire-protection department.

Special questions
Question 4: Fire protection area: What structural measures have been adopted to prevent or contain the spread of fires?

The ministry responds by saying that structural measures are: the physical separation of redundant engineered safety features, the separation of premises into fire zones with sealed fire penetrations, fire doors and fire dampers within ventilation systems. In some cases, cables are also clad in non-flammable materials and non-flammable barriers have been installed within individual fire zones.

Question 5: Details:
- Presentation of a detailed structural fire-protection plan (there is reference to fire-protection regulations, but without details).

The ministry explains that fire protection has been included as appropriate in the Environmental Impact Assessment Report for the Extension of Krško NPP's Operational Lifetime. This is an already operational, precisely organised system that will not change. The detailed fire protection plan can be viewed at Krško NPP's head office.

- Presentation of a fire-protection plan that shows the potential risk and the division into fire zones, including a presentation of existing fire barriers and fire doors.

After studying Krško NPP's statements, the ministry explains that Krško NPP fire plans have been drawn up for all areas in the technological and non-technological parts of the plant, along with fire plans for tackling outdoor fires. The plans contain the floor plans with the characteristics of specific areas, the hazards, firefighting equipment, communications equipment, ventilation, fire doors, key numbers, the emergency intervention routes and the firefighting instructions.

Question 6: Technical fire protection
What technical fire-protection measures have been adopted to contain or prevent fire?

On the basis of information presented by Krško NPP and an inspection of the plant, the ministry responds by saying that technical measures are already functioning and comprise: the installation of automated firefighting systems, a fire-detection system, smoke- and heat-removal systems, an emergency lighting system and fire-surveillance cameras.

Question 7: Automated firefighting systems are in place. Are these designed for specific components or as overall protection?

The ministry responds by saying that automated firefighting systems cover individual components in some cases, while in others they cover entire fire zones.

Question 8: Which smoke-removal systems are in which parts of the building?

The ministry explains that more than 50 ventilation systems have been installed at Krško NPP. Some function as smoke-removal systems, depending on the system design. A mobile ventilator is used to ventilate premises that do not have smoke-removal systems in place.

Question 9: Is there a tested measuring system in place to monitor any leakage of hydrogen from the reactor core?

The ministry explains that Krško NPP has a hydrogen control (HC) system in the containment that is regularly tested and maintained.

Question 10: Fire safety organisation department
What organisational measures have been adopted to tackle fires and prevent releases of radioactivity?

On the basis of Krško NPP's statements, the ministry responds by saying that the organisation of fire protection is set out in the "Fire-Protection Programme (Fire Safety Rules)" document. Operational fire-protection activities are performed by professional firefighters, at least three of whom are present at the plant in every shift. An additional three firefighters are on call at Krško professional firefighting unit specifically for Krško NPP requirements and can reach the plant within ten minutes. An additional ten firefighters from that unit can reach the plant within 30 minutes and a further 20 within 60 minutes. Technical shift staff (four people per shift) and the fire department (20 people), who are on call, provide additional assistance to firefighters.

Question 11: Is there a practical system in place for managing fire protection? How is this checked and documented?

The ministry explains that the fire-protection management system is described in the fire protection plan (fire safety rules). A report on fire-protection status is presented annually to the Krško NPP management board and an independent team of external experts (Krško Safety Committee). Krško NPP's fire protection is also subject to inspections by the SNSA and the Inspectorate of the Republic of Slovenia for Protection Against Natural and Other Disasters. The installed active fire protection is regularly reviewed by a certified independent inspector, in line with the legislative requirements.

Question 12: Are all staff trained to prevent hazards, fight fires and provide first aid?
If yes, how often does this training take place?

After studying Krško NPP's statements, the ministry explains that all staff at the plant receive periodic fire-protection training. The frequency and content of the training programmes depends on the staff member's position. Administrative staff take a repeat course every three years, technical staff every two years, and firefighters and operational staff four times a year.

Question 13: The enclosed documents do not necessarily show whether Krško NPP has its own firefighting unit (reactor firefighting unit). If it does, how many people does it contain and what equipment and training do they have? Under what command is this firefighting unit during emergency situations?

After studying Krško NPP's statements, the ministry responds by saying that the plant's firefighting unit comprises:

- an on-call team of three (3) professional firefighters (head of shift and two firefighters) – "on-site 24/7";
- four (4) members of operational staff – "on-site 24/7";
- an on-call team of (3) professional firefighters from Krško professional firefighting unit – arrival at Krško NPP <10 minutes;
- an additional set of ten (10) professional firefighters from Krško professional firefighting unit – arrival at Krško NPP <30 minutes;
- an additional set of twenty (20) professional firefighters from Krško professional firefighting unit – arrival at Krško NPP <60 minutes;
- an additional set of twenty (20) fire department members – arrival at Krško NPP <60 minutes.

The firefighting unit uses classic firefighting equipment (mobile pumps, combined firefighting vehicles, telescopic firefighting arms, etc.) and equipment designed to lessen the impact of an emergency (high-capacity pumps, compressors, purpose-specific pumps, electricity generators, etc.).
In the event of classic fire, the head of the intervention is the head of the firefighting shift, who takes measures in agreement with the head of the operations shift at Krško NPP. In the event of an emergency, command is assumed by the "emergency director": in the first phase, this is the head of the operations shift, who is succeeded by the head of the technical support centre after the emergency management structure is constituted.

<u>Question 14</u>: Defence fire protection and civil protection
Are provisions in place to give due warning to local residents in the event of a fire or accident and to activate the external firefighting unit?

After studying Krško NPP's statements, the ministry responds by saying that the process of warning and providing information to the population takes place in accordance with the protection and rescue plan in the event of a nuclear or radiological accident. Plans have been drawn up at the levels of the Krško and Brežice municipalities and the Posavje region to deal with an emergency at Krško NPP, as has a national protection and rescue plan in the event of a nuclear or radiological accident.
The external Krško professional firefighting unit, which comprises 50 operational firefighters and firefighting equipment, is activated. An agreement has been signed between Krško NPP and the external Krško professional firefighting unit, which provides the required number of operational firefighters.

<u>Question 15</u>: Are there plans for assignment or evacuation in the event of a major fire or release of radioactivity?

The ministry's response is that protective measures for the population (including evacuation) are set out in the national protection and rescue plan in the event of a nuclear or radiological accident. Evacuation of the population in response to an emergency at Krško NPP is addressed in the Posavje regional protection and rescue plan in the event of a nuclear or radiological accident. An estimate of the time required for evacuation from the area of immediate protective measures around Krško NPP has also been produced. The implementation of protective measures for the population (including evacuation) is addressed in the regional plan.

<u>Question 16</u>: How many firefighting units and other external assisting entities are there within a radius of 10 km of Krško NPP and how many people do they comprise?

The ministry explains that in addition to Krško professional firefighting unit, the Krško firefighting association comprises 23 voluntary firefighting units with a total of 768 operational firefighters. The firefighting units in the neighbouring municipality of Brežice comprise around 700 voluntary operational firefighters. Voluntary firefighters within the civil protection administration are involved in activities in the vicinity of Krško NPP, while, according to the plan of measures, only professional firefighters operate within the plant's perimeter.

Question 17: What equipment and training do they have in the tackling of ordinary fires and, in particular, the release of radioactivity (personal dosimeters, dose-warning devices, devices for measuring dose strength, transmitters, etc.)?

On the basis of the explanations presented by Krško NPP, the external professional firefighting unit's equipment is modern and tailored to their daily emergency intervention tasks. The special equipment that would be used in the event of an emergency has been selected in line with the various accident scenarios and is located within the perimeter of the plant.
All firefighters have personal optically stimulated luminescence (OSL) dosimeters. When entering a controlled area of Krško NPP, they are further equipped with electronic dosimeters by the radiological protection unit.
Measurements of dose strength in different areas of the plant are performed by the radiological protection unit using the appropriate equipment. Staff from the radiological protection unit assess the radiological risk during a fire, carry out radiological controls of the area threatened by fire, and ensure that the staff who are tackling the fire have adequate radiological protection and are equipped with dosimeters.
Firefighters, radiologists, security guards and operational staff are equipped with handheld radios.

Question 18: Who ensures that more firefighters are equipped with personal dosimeters? Is this not planned in the event of a disaster? Is a civil protection alarm system or action plan in place for the population?

The ministry explains that the radiological protection unit at Krško NPP ensures that personnel are equipped with personal dosimeters. Warnings of a natural or other disaster are provided by a system of alarm sirens in the area. For a radiological hazard, a direct danger alarm is used (a wailing siren lasting one minute), followed by notification of protective measures via the media (radio, television). Voice messages may also be transmitted via the alarm system.

Responses to the final expert report UMWELTVERTRÄGLICHKEITSPRÜFUNG, KRŠKO/SLOWENIEN LAUFZEITVERLÄNGERUNG Abschließende Fachstellungnahme
SUMMARY
The comments partly repeat themselves. However, for the sake of transparency, the positions taken on the comments are also repeated.

1. Procedures and alternatives

Krško NPP provides around 38% of Slovenia's electricity. Alternatives to lifetime extension include power generation with other technologies and energy-efficiency measures. The European Commission assessed the plans for the use of renewable energy sources and measures to increase energy efficiency set out in Slovenia's National Energy and Climate Plan 2020 (NECP) as being unambitious to insufficiently ambitious. A recent study by Vienna University of Technology (RESCH et al. 2021) also concludes that more than 50% of Slovenia's electricity demand could be covered by photovoltaics and onshore wind power as early as 2030.
During the consultations, the Slovenian side stressed that alternatives had been examined within the framework of the NECP and in another study. It would be welcome if the alternatives assessed for their environmental impact were also presented within the framework of the ongoing EIA procedure, especially with regard to the critical assessment of the European Commission and the continuous improvement of the framework conditions for the use of renewable energy sources.

After studying Krško NPP's comments, the ministry responds by saying that the alternative to lifetime extension is presented in Section 3 of the EIA Report. Under the UNECE Good Practice Recommendations on the Application of the Convention to Nuclear Energy-Related Activities, the Espoo Convention, alternative methods of producing electricity are, as national issues of the party of origin, addressed at the strategic level (the Integrated National Energy and Climate Plan).

Accordingly, Slovenia and Croatia have developed their National Energy and Climate Plans (NECP) based on extensive analyses and modelling carried out by leading institutes, universities and companies in the fields of energy efficiency, renewable energy, greenhouse gas emission reduction, research and innovation. The analyses carried out as the basis for the National Energy and Climate Plans have shown that increasing the use of renewable and non-carbon resources and increasing energy efficiency are not in themselves sufficient to enable the targets to be met if we take the estimated electricity needs and the increased requirements for reducing greenhouse gas emissions into account.

The conclusions of a study produced by Vienna University of Technology, which sets out the options for the future use of renewables for energy purposes, highlight the natural conditions, such as solar radiation and the presence of wind, in Slovenia and Croatia. Unfortunately, they do not take into account other equally important factors, such as the rather limited scope for siting renewable energy facilities because of the presence of nature conservation and Natura 2000 areas in Slovenia, which the NECP takes account of.

Regulation (EU) 2018/1999 requires Member States to monitor the implementation of NECPs and report to the Commission every two years. The NECP must be updated every five years. The Regulation sets out how the compliance of national plans with EU energy policy objectives is to be assessed, and is the mechanism by which this is ensured.

Strategic alternatives are therefore not the subject of the procedure to extend Krško NPP’s operational lifetime.

2. Spent fuel and radioactive waste

The spent fuel elements from the extended operating period will first be stored in the spent fuel pool and then transferred to the temporary storage facility (dry storage) currently under construction at the Krško site. The planned commencement of operations at the dry storage has been postponed several times and is now scheduled for 2023. If the start of operations is again delayed, the capacity of the spent fuel pool will be increased. However, this should be avoided for safety reasons.

In 2015 Slovenia and Croatia agreed to build a joint deep spent fuel repository. Based on the two scenarios in the EIA Report, the commencement of operation is planned for 2065 or 2093. Krško NPP will carry out an analysis on the reprocessing of spent fuel by 2025. Both the Slovenian (ARAO) and Croatian waste management organisations (FOND – NEK) are members of ERDO, which advocates a multinational repository. The EIA documents do not contain information on the progress of these activities.

The ministry responds by saying that the construction of the spent fuel dry storage is on schedule and the start of operation will no longer be delayed. Completion of SF dry storage is planned for the end of 2022, while the relocation of 592 fuel elements from the spent fuel pool to dry storage will take place in the first half of 2023. The timetable for the disposal of spent fuel for the baseline and sensitivity case scenarios is given in Table 96 of the EIA Report. Slovenia and Croatia regularly report on progress in spent fuel management at the review meetings under the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.

3. Long-term operation of the reactor

Krško NPP has been in operation for almost 40 years. This means that the negative effects of the aging of structures, systems and components can present a safety issue, although the EIA Report (2022) states that negative consequences should be prevented by the Aging Management Programme (AMP). In 2017/18, the first Topical Peer Review (TPR 1) under Directive 2014/87/Euratom identified a number of shortcomings in the Slovenian AMP when set against the safety level envisaged for Europe. The scope of the structures, systems and components included in the AMP therefore does not comply with the applicable IAEA safety standard. Efforts are still underway to bring the AMP up to the state of the

art in science and technology as defined in the relevant IAEA SSG 48 Safety Standard of 2018. In this respect, according to the current state of the art in science and technology, the AMP does not yet exist. The pre-SALTO (Safety Aspects of Long-Term Operation) mission conducted in October 2021 also found deficiencies and recommended, *inter alia*, that the plant complete AMP verification. V
As part of the next (third) Periodic Safety Review, the AMP for equipment will be updated in accordance with IAEA requirements. The pre-SALTO mission is the first step in the SALTO peer review process in preparation for long-term operation (LTO). We welcome the fact that such an international mission is being carried out at Krško nuclear power plant. However, the actual SALTO mission will not take place until 2024/25, i.e. only after the operational lifetime has been extended. According to the IAEA, the most suitable time for a SALTO mission is in the last ten years before the originally planned end of operational lifetime.

Krško NPP conducted a self-assessment prior to the pre-SALTO mission to verify compliance with the IAEA SSG 48 recommendations. Krško NPP is essentially a power plant of the American type and one that meets 10 CFR 54 requirements for lifetime extension and Slovenian law.
The pre-SALTO mission reviewed key aspects of long-term operations (LTO) to the same extent as the SALTO mission and identified areas for improvements to existing processes. Every ten years Krško NPP carries out a Periodic Safety Review with reference to US and European regulations and recommendations. The PSR3 mission, to be completed before the end of 2023, will therefore additionally identify all areas for improvement, which will then be carried forward into an action plan.
The revised version of the WENRA Safety Reference Levels 2020 also calls for advanced management of the technical aging of structures, systems and components. The procedure described in the responses of 2022 is suitable for limiting the negative effects of technological aging. The precondition is that all essential components be covered. According to the evaluation of the first Topical Peer Review (TPR 1) and the pre-SALTO mission, this precondition has not yet been fully met.

On the basis of the materials and comments supplied by Krško NPP, the ministry responds by saying Krško NPP has covered all components relevant to aging in accordance with US NRC 10 CFR 54. This was confirmed by an independent peer review and endorsed by an SNSA resolution, which enabled the removal of the time restrictions from the licensing documents. All components relevant to aging are adequately monitored by means of aging programmes and managed via the master equipment component list database.
In accordance with the US NRC Generic Aging Lessons Learned (GALL) Report – NUREG-1801, Rev. 2 and IAEA SRS 82 Ageing Management for Nuclear Power Plants: International Generic Ageing Lessons Learned (IGALL), the programmes define all attributes for the care of these components, such as: ownership, preventive maintenance, acceptance criteria, aging effects and so on.

4. The fact that the regulatory authority is endeavouring to incorporate the WENRA 2020 reference level into the rules by the end of 2022 is to be welcomed. In this respect, a review of Krško NPP in relation to these requirements should already have been carried out as part of the ongoing third Periodic Safety Review. We do not yet know whether any remedial action will be necessary before the extension of operational lifetime is approved.

The ministry notes that Krško NPP’s responses to the Expert Report (Umweltverträglichkeitsprüfung KKW Krško/Slowenien Laufzeitverlängerung Fachstellungnahme, REP-0810, Vienna 2022) already explain that the plant’s compliance with the WENRA Safety Reference Levels for Existing Reactors (2020) will be checked during the third Periodic Safety Review, which is currently under way. According to the preliminary results of an independent review, Krško NPP does comply with the WENRA Safety Reference Levels for Existing Reactors 2020.
Krško NPP’s original design was based on US regulations from the 1960s. From today’s perspective, the engineered safety features of that time have a large number of significant shortcomings: the number of duplicated engineered safety features is too low and some safety functions are partly not functionally independent or spatially separated from each other, which means that they can have a negative

influence on each other. The reactor building is also exposed to external impacts. The EIA Report (2022) presents the extensive updates that have been carried out. However, for technical or financial reasons, not all project anomalies could be eliminated.

After studying Krško NPP's statements, the ministry responds by saying that the extensive safety upgrades set out in the extensive Safety Upgrade Programme and designed and carried out on the basis of a thorough review of the basic Krško NPP design, and of compliance with the very latest standards applied in the construction of today's nuclear power plants, have already been performed. The safety upgrade will be implemented with redundant and diversified systems, ensuring that under any conditions arising from internal or external events, all safety functions will be provided in such a way as to minimise the probability of damage to the core and virtually prevent negative impacts on the environment in the event of such an unlikely event. Therefore, at the design stage, there were no technical or financial reasons not to take all the measures to ensure nuclear safety at all times and, at the same time, eliminate all the shortcomings of the basic plant design and introduce solutions that place the plant at the very top of ranking of modern nuclear power plants in terms of safety criteria.

5. Fire protection at Krško NPP has safety deficiencies compared to the fire protection in place at new nuclear power plants. In accordance with Article 8e of Directive 2014/87/Euratom, the second Topical Peer Review (TPR 2) deals with the topic of fire protection, which is also relevant to the safety of nuclear facilities. It would be desirable for the results of TPR 2 for Krško NPP to be discussed at a bilateral meeting.

The ministry responds by saying that passive and active fire protection at Krško NPP is implemented in accordance with Slovenian legislation and international standards and guidelines (IAEA, US NRC, NFPA, and WENRA). Krško NPP's fire protection is also subject to inspections by the SNSA and the Inspectorate of the Republic of Slovenia for Protection Against Natural and Other Disasters.
The results of this TPR 2 and subsequent ones for Krško NPP can be presented at the regular annual meetings at which information on nuclear and radiation safety is exchanged between Slovenia and Austria. The ministry believes that cooperation and the exchange of information must continue regardless of the fact that the transboundary procedure will be completed. As the legal option is the implementation of Article 9 of the Espoo Convention, the ministry took the comment into consideration in this decision and determined the further exchange of information within the existing bilateral commission. Under the Espoo Convention, parties may establish a new bilateral cooperation body or use an existing one. As environmental protection and human safety are connected, agreement has also been secured at technical consultations that the existing bilateral commission is optimal for cooperation if the ministries competent for environmental assessment are adequately included (Espoo focal points). This has already been tested and implemented during the procedure at the first (expanded) bilateral meeting, which also provides the basis for the ministry's operative decision under point 19.

In relation to this comment, the ministry therefore explains that it has taken it into account by adding a measure in the operative part of this environmental protection consent (point II/1.19), which provides that the countries participating in the transboundary procedure must be apprised of the PSHA and any additional steps to improve nuclear safety as part of the monitoring of the situation under Article 9 of the Espoo Convention, for which the existing bilateral nuclear safety commissions, which include the ministries responsible for environmental assessment, should be used.

6. Regarding improvements to safety, the responses of 2022 refer mainly to the EU stress tests. The main part of the measures in the national action plan to address the deficiencies identified in the EU-wide stress test after the Fukushima accident (2011) is the previously planned Safety Upgrade Programme (SUP) at Krško NPP. The planned measures were completed at the end of 2021 after considerable delays. Although significant improvements have been made, it is not clear whether the level of safety achieved (particularly with regard to earthquakes) is sufficient.

After studying Krško NPP's statements and the opinion supplied by the SNSA, the ministry responds by saying that the Krško NPP Safety Upgrade Programme was implemented in accordance with the requirements of WENRA SRL (2014 and 2020) and IAEA – SSR 2/1, Rev. 1. Its implementation led to a level of safety being achieved that is almost comparable with that of new power plants. A basic comparison between power plants focuses on a comparison of core damage frequency (CDF) for all events. At Krško NPP, the CDF is slightly less than 1.4e-5/year and almost meets the criterion for new plants of 1e-5/year (NEA/CSNI/R(2009)16). These values relate to all events (to highlight: internal events, seismic events, internal and external flooding, internal fires, high-energy pipe fractures, aircraft crash, relevant combinations of events, strong winds and other hazards). Core damage at Krško NPP complies with the definition of the US NRC 10 CFR 50.46, Section 1b.

7. The possibility of a more powerful earthquake than previously assumed cannot be ruled out. After a powerful earthquake, the urgent deployment of a response team with mobile equipment is a major challenge. It is questionable whether the reactor can be cooled, as the plant was originally designed for a peak ground acceleration (PGA) of 0.3 g. The responses from 2022 also show that only one redundancy was adequately designed in seismic terms. From a safety point of view, this is not sufficient. In particular, it should be noted that the current seismic risk analysis has not yet been completed (see Section 5), which means that we currently do not know whether the protection against extremely powerful earthquakes is sufficient.

The ministry responds by saying that it has already given a response to the question regarding seismic design load in the "Accidents caused by external events" section in this document below. As the EU stress tests have shown and proved, this additional conservatism ensures that buildings and installations are designed for almost twice the design value – i.e. approx. 0.6 g on the open surface. The most important conclusions that can be drawn from the EU stress tests are:

- safe shutdown of the plant and its maintenance in a safe state are ensured even in the event of an earthquake that is twice the strength of the SSE (0.6 g);
- that core damage probability only increases with earthquakes above 0.8 g.

Krško NPP has also developed and implemented a Safety Upgrade Programme (SUP) which resulted in additional safety margins of 30% (0.78 g) being built into new facilities and equipment. The additional alternative systems implemented as part of the safety-related retrofit to ensure cooling of the core under all conditions resulting from external or internal events are implemented with redundant and diversified systems, both in terms of the physical configuration of the systems and in terms of the possible power sources and the sources of the cooling medium. In addition to cooling of the core via an alternative evaporator cooling system, a system for cooling and replacing primary coolant losses (alternative safety injection system) has also been installed. In addition to these two systems, an alternative system for cooling and recirculating the primary circuit has been installed. In addition, the concept of "defence in depth" offers redundant and diversified mobile equipment stored in a dedicated, seismically secured structure.

The preliminary results of the new updated PSHA show no significant changes from the PSHA conducted in 2004. Once the PSHA is completed and verified, we will also address the issue of seismic safety in the action plan for the third Periodic Safety Review (PSR3), where we will also update the probabilistic safety assessments in the light of the new PSHA – all in accordance with Slovenian nuclear legislation.

8. The IAEA, WENRA and Directive 2014/87/Euratom set different safety standards for existing and new power plants. WENRA also recommends that, as part of the lifetime extension process, each plant should be assessed to determine the extent to which it meets the safety objectives for new reactors. This assessment would clearly show which safety margins (deltas) comply with the currently required safety standard, which safety improvements would be "reasonably practicable" and which safety improvements would be technically impossible. It is not clear from the responses from 2022 whether this systematic review has been carried out.

On the basis of Krško NPP's statements, the ministry responds by saying that the WENRA requirements and documents are issued separately for existing and new reactors. Krško NPP has systematically reviewed the requirements in both documents. Krško NPP is an existing nuclear power plant, which means that it primarily incorporates the requirements for existing plants (WENRA SRL for Existing Reactors).
The WENRA RHWG report "Safety of New NPP Designs" (March 2013) was also implemented as far as was possible. Krško NPP has implemented all "reasonably practicable" design solutions, which comply with the WENRA requirements for new reactors:
1. pressuriser PORV Bypass MOVs, which are capable of releasing water;
2. an independent alternative AC voltage source (diesel generator 3), protected against external hazards and designed for DEC;
3. a diversified reactor trip system;
4. an independent auxiliary control room that ensures that the parameters can be monitored and alternative DEC engineered safety features managed;
5. passive seals resistant to high temperatures at the reactor pumps (RCP);
6. alternative systems (ASI, ARHR, AAF) for managing loss of feedwater and loss of ultimate heat sink (UHS);
7. baskets with trisodium phosphate that reduce radioactive sources (source term) in the containment;
8. passive autocatalytic recombiners (PARs);
9. a passive containment filtered venting system (PCFVS);
10. an alternative residual heat removal (ARHR) system and passive containment filtered venting system (PCFVS), which are designed for design-extension conditions, enable cooling in the recirculation operating mode, and prevent subsequent failure of the containment owing to excessive pressure.

The CDF could be reduced by about 70% with the implementation of the Safety Upgrade Programme (SUP).

9. Accident analysis (DTA and BDBA)

The EIA Report (2022) states that the upgrades have improved Krško NPP's robustness and reduced the risk of accidents. Although the calculated core damage frequency (CDF) is significantly lower, the CDF (less than 10-4 per year) is high compared to other plants. The large release frequency (LRF) has barely fallen since the upgrades, and is relatively high (probability of 5*10-6/year). For new nuclear power plants, these values are lower by a factor of between 10 and 100. The benchmarks for new nuclear power plants are also significantly lower according to IAEA data (2016b).

After studying Krško NPP's statements and the entire documentation on the matter in question, the ministry responds by saying that IAEA-TECDOC-1791 (Considerations on the Application of the IAEA Safety Requirements for the Design of Nuclear Power Plants) states that the generally accepted CDF for new power plants is <10E^{-05}/year. This statement is based on INSAG-12, paragraph 27 of which states: "The target for existing nuclear power plants consistent with the technical safety objective is a frequency of occurrence of severe core damage that is below about 10–4 events per plant operating year. Severe accident management and mitigation measures could reduce by a factor of at least ten the probability of large off-site releases requiring short term off-site response. Application of all safety principles and the objectives of para. 25 to future plants could lead to the achievement of an improved goal of not more than 10–5 severe core damage events per plant operating year."
The values that the author of the comment mentions are recommendations (IAEA, NRC) and legal limits (Rules on radiation and nuclear safety factors, JV5). According to the latest update of the PSA model (after accounting for SUP), Krško NPP's CDF is 1.35E^{-05}/year and its LERF is 1.41E^{-06}/year, which is comparable to the recommendations for new power plants.
The ministry further explains that Krško NPP meets the legal requirements and that the CDF and LERF values are significantly lower than the legal requirements and comparable to the recommendations for new nuclear power plants.

10. The reduction of the CDF for Krško NPP is the result of long overdue upgrades required for currently authorised operation. However, they are not sufficient for the extension of the operational lifetime. It should also be noted that the hazard analysis (internal and external) has still not been completed. The CDF value for Krško NPP could therefore be even higher. During the last update of the WENRA reference values in 2020, the hazards to be considered in the safety analyses were updated on the basis of recent experience and knowledge. The safety case will (initially) be adapted as part of the third Periodic Safety Review, which is currently under way. There are still some issues with the identification and evaluation of external events (see Section 5). If not all possible initiating events and combinations of such events are adequately considered, the values set for the CDF are not sufficiently justified.

The ministry explains that Krško NPP's PSA addresses all possible initiating events against the backdrop of the plant's design bases and the natural features of the site. Krško NPP regularly reviews and updates the list of initiating events. The list is also taken into account when the PSA model is updated (along with changes and updates to the plant). Generally speaking, plant updates have a positive safety effect on the plant, which is reflected in a reduction of CDF, which is why they are carried out. Changes in the surrounding area can have positive or negative effects on safety. For this reason they regularly update the external initiating events, and at least every ten years as part of the PSR. Updates are also influenced by the availability and adequacy of the methodology and by changes to standards and recommendations.

11. According to the PSA 2 for Krško NPP, some accident scenarios involving core meltdown can lead to failure or malfunction of the containment. These scenarios are associated with high emissions. The probabilities determined and the associated dose loads are not listed in the EIA Report (2022).
The responses of 2022 give the probabilities determined, but not the corresponding dose loads.
Generally speaking, it is possible to conclude from the responses from 2022 that severe accidents with higher doses than those addressed in the EIA Report are possible. These should be considered in the EIA however unlikely they may be. Instead of using the sequence of events to calculate the potential transboundary impacts set out in the Level 2 probabilistic safety assessment (PSA-2) for Krško NPP, an accident scenario was chosen that in no way covers all possible releases from the plant.
According to the EIA Report (2022), the worst accident is one that leads to core meltdown, with the assumption that containment integrity is maintained. However, maintaining a containment during an accident cannot be taken for granted in all disaster sequences. Although the calculated probability of an accident with a major release of radioactive material in the event of containment failure appears to be very low, the relevant doses for major accidents should be used to determine the radiological consequences in the context of the transboundary EIA.

The ministry responds by saying that an explanation of this issue has already been given in Krško NPP's response to the Expert Report (Umweltverträglichkeitsprüfung KKW Krško/Slowenien Laufzeitverlängerung Fachstellungnahme, REP-0810, Vienna 2022). As already explained in Krško NPP's statement on the expert report (Umweltverträglichkeitsprüfung KKW Krško/Slowenien Laufzeitverlängerung Fachstellungnahme, REP-0810, Vienna 2022), the radiological consequences of a worst-case accident were analysed with a frequency of once every 1 E6 years. The frequency of events that could endanger the integrity of the containment or bypass it in the event of a release of radioactivity shows that these events are significantly less likely. The selected severe accident has already been conservatively analysed. Under this scenario, 80% of the containment volume was emptied through the filtered outlet within three hours (filtering does not affect noble gases). The maximum design-basis unfiltered release from the containment directly into the environment was envisaged before and after this. Very unlikely scenarios with loss of containment integrity and/or containment bypass were analysed during the analysis of the Krško NPP PSA-2. There is no plausible scenario that would lead to catastrophic damage to the containment or a large direct release into the environment. All cases of containment damage or bypass involve releases through openings or cracks with a smaller cross-section than that of PCFVS release over a longer period of time; these are subject to physical mechanisms of reduction and deposition of radioactive material (all reduction mechanisms other than those in the PCFVS are neglected in the analysis performed). This release is at a lower elevation and the heat potential is lower than in the assumed sequence. The radiological consequences of such widespread release capable of Austria are not necessarily greater than the scenario analysed. With such releases, radiological impacts may occur at shorter distances than set out in the PSA-3 analysis; however, it is not reasonable to apply these results directly to an assessment of the risk to the population without addressing the probability of occurrence of such a sequence. This is why the EIA does not include a radiological analysis of this type.

12. Krško NPP has not been designed with an aircraft crash in mind. Krško NPP has a double-shell containment consisting of an outer protective structure made of reinforced concrete (0.76 m thick) and an inner steel shell (0.038 m). From the tests in the USA referred to in the responses from 2022, we know that aircraft engines can penetrate reinforced concrete that is less than 1 m thick. It is questionable whether a steel shell with a thickness of less than 4 cm could prevent the penetration of an aircraft engine. In addition, it is now known that the shaking/vibrations caused by an impact can cause considerable damage to the primary circuit. It can therefore be assumed that a severe accident could occur if a commercial aircraft was deliberately downed.

After studying Krško NPP’s technical explanations, the ministry responds by saying that the containment was designed in line with the “defence in depth” principle. The outer reinforced concrete shell protects against direct projectile impact. If there is a breakage in the reinforced concrete structure as the result of a powerful point load, fractures, buckling and spalling of the concrete can occur on the inside of the concrete shell. This spalling would spread in the space between the concrete shell and the inner steel pressure vessel/shell. Any concrete splinters or parts of the projectile would be caught by this steel casing. Both the concrete and the steel shell are seismically designed and can withstand high vibration loads from seismic and other sources (e.g. aircraft impact), as can all important systems and engineered safety features in the plant.
Krško NPP is constructed in such a way that its redundant engineered safety features are physically separate from each other. As part of the SUP, additional engineered safety features have been installed, along with coolant tanks, in two bunkered buildings that are physically separate and at a suitable distance from the engineered safety features of the plant’s main island. These systems are designed so as to ensure safe shutdown of the plant even in the extreme case of damage to the primary circuit.

13. WENRA’s Safety Objectives for New Nuclear Plants should be used as a reference for identifying reasonably practicable safety improvements at Krško NPP. According to WENRA Safety Objective O3, accidents with core melt which would lead to early or large releases have to be practically eliminated. The concept of “practical elimination” of early or large releases is not mentioned in the EIA Report (2022) or the responses of 2022.

After studying Krško NPP’s explanations and the SNSA opinion, the ministry responds by saying that the engineered safety features installed as part of the Krško NPP Safety Upgrade Programme, as well as other upgrades carried out previously, have raised the plant's robustness to the level of a Generation 3 plant in several aspects. This corresponds to Safety Objective O3 of the WENRA Safety Objectives for New Nuclear Power Plants. Some of the engineered safety features/functions under Objective O3 are:

- Krško NPP’s passive containment filtered venting system (PCFVS) and passive autocatalytic recombiners (PAR) are equivalent to those of Generation 3 nuclear power plants;
- Krško NPP does not have a special core catcher, but a connection between the containment and the reactor cavity (“wet cavity” design) has been built that makes it possible to flood the containment and thereby prevent MCCI;
- baskets with trisodium phosphate that reduce radioactive sources (source term) in the containment;
- alternative systems (ASI, ARHR, AAF) for managing loss of feedwater and loss of ultimate heat

sink (UHS).

14. Accidents caused by external events

A site-specific hazard survey has been carried out at Krško NPP. The descriptions of external impacts in the EIA documents are limited to seismic ground movements, flooding and certain extreme weather events. Other seismotectonic hazards (surface displacement, soil liquefaction, effects of ground motion near faults) and combinations of hazards are not or are insufficiently addressed. However, it was stated in the consultations that analyses of hazard combinations had been carried out.

The ministry explains that the earthquakes were combined with floods. In the event of a very powerful earthquake (0.3 g or more), we can expect damage to the flood embankments along the Sava, which could lead to flooding in the technological area of the plant if a flood with a recurrence interval of more than 10,000 years occurred at the same time. To protect against floods of this type, which could result from a combination of a powerful earthquake and high water, mobile flood gates were installed in 2016 at the entrances to the nuclear island and other facilities in the technological section of the plant (barriers with a seismic strength of 0.6 g), which protect the power plant from flooding up to a height of 2 m above the ground. Such a flood is several orders of magnitude higher than a flood with a recurrence interval of 10,000 years. It should be noted that the dams on the left side of the Sava riverbed provide adequate basic flood protection for the design-basis accidents, while the mobile barriers were installed only to manage a combination of a very powerful earthquake and a very high Sava flow rate. The recurrence interval for the simultaneous occurrence of an earthquake and flood, all with a recurrence interval of 10,000 years, is of the order of 100 million years or a frequency of $1E^{-08}$/year.

Soil liquefaction hazard analyses have been carried out on three occasions times: first, when the plant was being designed in the 1970s; and second, when the Seismic Probabilistic Safety Assessment (SPSA) was being conducted (as a separate part of the Probabilistic Seismic Hazard Analysis, PSHA, for the Krško NPP site). (that analysis of resistance of the ground to liquefaction at the Krško NPP site concluded, with a high degree of reliability, that liquefaction would not occur in earthquakes with a PGA of 0.8 g and that local instances of liquefaction could be expected with the damming of the Sava with a PGA greater than 1.0 g). The third analysis of liquefaction was carried out when Brežice hydropower plant was being constructed (2014–2016). That analysis also confirmed that local instances of liquefaction could be expected only with earthquakes with a PGA greater than 1.0 g. As liquefaction is not expected to occur on a large scale and the probability of local liquefaction events is negligible, the EIA does not specifically address liquefaction.

To investigate the issue of a rupture that may cause permanent ground displacement at the surface, a Probabilistic Seismic Hazard Analysis for ground displacement was carried out in 2013 in accordance with International Atomic Energy Agency guidelines (SSG-9, IAEA 2010). A total of 11 faults were considered, including the Libna fault. The results show that there is no risk of large ground displacements, while the risk of very small permanent ground displacements is negligible. The results of the Probabilistic Seismic Hazard Analysis for ground displacement were used to assess the risk to Krško NPP. Krško NPP's seismic analysis, which was independently reviewed by Faculty of Civil Engineering and Geodesy and the Faculty of Mechanical Engineering, showed that the plant's structures and systems could withstand significantly greater ground displacement than followed from the Probabilistic Fault Displacement Hazard Analysis for a recurrence interval of 10 million years (Krško NPP, 2013). The report is publicly available and is published on the website of the Slovenian Nuclear Safety Administration (http://ursjv.arhivspletisc.gov.si/si/info/posamezne_zadeve/o_potresni_varnosti_nek/index.html).).

Regarding the question of the impact of ground motion in the vicinity of faults, it should be noted that the PSHA for the Krško NPP site considers the impact of linear seismic sources in the immediate and wider vicinity of the plant. The effects of the distance of the fault lines on the seismic motion at the Krško NPP site are systematically considered. In addition to seismic source lines, it also considers seismic sources that could arise in specific areas.

Earthquake: Krško NPP is earthquake-resistant according to Slovenian Ordinance RG 1.60 on Ionising

Radiation Protection and Nuclear Safety. The peak ground acceleration (PGA) of the original design earthquake (safe shutdown earthquake, SSE) with a probability of occurrence of 10-4/year (recurrence interval of 10,000 years) was set at 0.3 g (open field). In 2004 and 2014, the seismic hazard increased in the end to PGA = 0.56 g. The EIA documents do not provide evidence of the resilience of existing structures and systems to a doubling of ground acceleration from 0.30 g to 0.56 g. Only new structures and systems implemented under the Safety Equipment Improvement Programme are designed for a PGA of 0.6 g or 0.78 g.

15. New geological, tectonic and seismological data from the vicinity of Krško NPP are reason enough to consider that the PSHAs carried out in 2004 and 2014 are no longer valid. This is confirmed by new data on active faults and the 2021 seismic hazard map of Slovenia, which shows a risk for the Krško area that is approx. 25% higher than the risk shown in the national seismic hazard map of 2001. While hazard maps are not applicable to Krško NPP, the sharp increase in threat suggests that new data, estimates and methods have a significant impact on the results of the new PSHA. However, these new data, estimates and methods were not used in the assessment of Krško NPP's nuclear safety.
The EIA documents on earthquakes therefore do not indicate that there would be no additional hazards and risks from extending the plant's operational lifetime. During the consultations, the Slovenian side let it be known that a new Probabilistic Seismic Hazard Analysis (PSHA 2022) was currently being prepared, to be completed in 2022 and revised in 2023. The group of experts believes that the PSHA should use an updated database of paleoseismological assessments of faults in the vicinity of Krško NPP and a new non-ergodic ground-motion model for the area.
It is therefore recommended that the decision to extend the operational lifetime be based on the PSHA 2022, and is irrelevant that the PSHA 2022 will be conducted for a possible new power plant to be built at the Krško site. As the site conditions for the potential new and the existing power plant are the same, the results of the PSHA 2022 according to WENRA (2021, RL E11.1) should also be applied to the existing plant.
In the draft for approval (2022), external hazards are as a matter of principle addressed as causes of discharges with significant environmental impacts. It is therefore recommended that the implementation of additional seismic mitigation measures, the need for which may arise from the new PSHA 2022, be included as a condition in the environmental impact statement, in a similar form to that for extreme weather events (draft environmental protection consent 2022, condition II/1/16). The current approach taken in environmental law procedures, which takes into account meteorological hazards that contribute only marginally to the overall risk of a power plant while ignoring the predominant risk factors of earthquakes, seems unbalanced and unreasonable.
During the consultations, the Slovenian side offered to provide the Austrian side with summaries of the PSHA 2022 results at bilateral meetings.

On the basis of Krško NPP's explanations, the ministry notes that a project to update the PSHA for the wider area of Krško NPP is currently under way in accordance with the provisions of the Ionising Radiation Protection and Nuclear Safety Act and the Rules on the operational safety of radiation and nuclear facilities. The new seismic hazard analysis will provisionally be updated at the end of 2022, with an independent review following in 2023. Based on the preliminary results of this study, no significant changes in the results are expected in relation to the currently valid seismic hazard study from 2004.
Regarding the seismic performance of Krško NPP, it should be noted that the seismic impact considered when the plant was being designed is comparable with the seismic impact determined by taking into consideration the design spectrum, scaled to a PGA of 0.6 g at surface, which roughly corresponds to a PGA value with a recurrence interval of 10,000 years (PSHA, 2004). The stress-test report estimated that core damage was unlikely with earthquakes with a PGA of up to 0.8 g at surface.
However, that estimate did not take into account the favourable impact of the new safety equipment installed at the plant in the last ten years in response to the Krško NPP Safety Upgrade Programme. The new DG3 diesel electricity generator has been qualified for a 50% increased load compared to the original seismic criteria. The seismic design load for new engineered safety features on the main Krško NPP island (including the above-mentioned safety features) was a PGA of 0.6 g at surface. When the

new safety features were being designed, the beneficial effect of the dissipation of energy from the interaction of movement between the ground and the structure was limited. The new facilities and systems separated from the foundations of the main island (second reinforced bunkered building, spent fuel dry storage, operational support centre) have been designed for a PGA of 0.78 g at surface (a 30% increase).

The issue of the application of the new PSHA will be addressed in the PSR3 action plan in accordance with Slovenian nuclear legislation. In this context, the probabilistic safety assessment will be updated to take into account the results of the new PSHA. Slovenia will keep Austria abreast of developments at a bilateral meeting; these meetings have become a fixture over the last decade.

In accordance with the approved Third NEK Periodic Safety Review Programme (PSR3), NEK ESD-TR-03/20, Rev. 1, December 2021, this should be completed by the end of 2023. The approved final PSR3 report, which will also contain an action plan for the implementation of changes and improvements, is a precondition for extending the plant's operational lifetime for ten years. Under the Rules on the operational safety of radiation and nuclear facilities, the deadline for implementation of the plan for changes and improvements is five years after approval of the PSR3 report.

The acquisition of an updated PSHA is also a requirement for PSR3 and one that will be carried forward into the PSR3 action plan. It will be completed and approved by the end of 2023 (PSR3-NEK-2.3, Hazard Analyses, PSR3 2.3-04 requirement, updated PSHA). Compliance with the PSR3 2.3-04 requirement will, in accordance with the PSR3 action plan, be adopted and given final approval by the SNSA.

A project is currently under way to update the PSHA in the immediate vicinity of Krško NPP, and began with field studies just over ten years ago. The study covers 12 seismic source lines within a 200 km radius of Krško NPP. In addition to seismic source lines, it also considers planar seismic sources or combinations of different types of seismic source; this increases the complexity of the study and is one of the reasons why it is taking so long. A new non-ergodic ground-motion model for the location has been developed on the basis of the study. Such models typically take account of local earthquake characteristics based on ground displacement measurements; in Slovenia's case, these have been provided by the Slovenian Environment Agency (ARSO) for more than 20 years. An independent review of the new PSHA is currently under way and will be completed in 2023. It will serve as final approval of the new revised version of the PSHA. Based on the preliminary results of the new PSHA, and the report produced by the Faculty of Civil Engineering and Geodesy (FGG) of the University of Ljubljana on the preliminary review of those results ("Overview of the non-ergodic ground motion model for Krško and preliminary PSHA results for the mean return period of 10,000 years", Rev. 0), it is not expected that the final results of the new PSHA will be significantly different from the results of the currently valid PSHA from 2004. After the new PSHA is completed, independently reviewed and approved by the SNSA, it will be used as input data for the updating of the seismic model in the Krško NPP probabilistic safety assessment.

The ministry also notes although the suggestion that the new seismic study be incorporated into PSHA 3 makes sense, it could not be included in the EIA in 2022 because the data was not available at the time the EIA was being produced and because the EIA had to be completed by the statutory deadline (at the same time, there was already enough data to enable a decision to be made). As this is material that will be produced in the future and is important for the country, the suggestion is taken into account in the safety inspections conducted every ten years by the SNSA in the form of a Periodic Safety Review, and can be added to this environmental protection consent as a condition. As this is an additional safety issue, the ministry has paid due regard to the suggestion and to point II/1.18 of the operative part of this environmental protection consent, which provides that **Krško NPP is required to draft an action plan for the third Periodic Safety Review (PSR3*) that includes an update of the PSHA for the Krško NPP site, submit it for approval to the SNSA no later than by the end of 2023 and, on this basis, carry out any additional measures required to increase the nuclear safety of the plant. The measure is laid down in accordance with the Ionising Radiation Protection and Nuclear Safety Act (ZVISJV-1) and the Rules on the operational safety of radiation and nuclear facilities (Official Gazette of RS, Nos. 81/16 and 76/17 [ZVISJV-1]).**

In the operative part of this environmental protection consent (point II/1.19), the ministry has also laid

down that neighbouring countries must also be apprised of this through bilateral commissions.
A more detailed explanation of both measures/conditions is contained in the “Reasoning” section of this decision (p. 280 [p. 301]).

16. From a seismic engineering perspective, the information in the EIA Report (2022), with reference to the stress-test report for the plant (SNSA 2011), sufficiently proves that the state of the art (regulations/standards) was given due attention in 2011. However, changes were made to guidelines, particularly those of the US Nuclear Regulatory Commission (NRC), between 2011 and 2022. These changes and the potential impacts on the nuclear facility are not addressed in the EIA Report. In the last two decades in particular, important knowledge has been gained about the seismic behaviour of equipment (i.e. structures and systems, but not buildings). Slovenian experts have indicated during consultations that they have studied these changes, and it has been demonstrated that the technical and scientific requirements for the above topics are being when it comes to seismic design.

In relation to these comments, the ministry explains that the impact of the new regulatory guidelines on Krško NPP’s nuclear facilities and systems were coordinated as part of the updates resulting from the action plan of the second Periodic Safety Review for the last ten-year period. New revisions to the guidelines in all areas, including seismic engineering, have been taken into account. The new regulatory guidelines are part of Krško NPP’s revised Safety Analysis Report (USAR).

17. Accidents involving third parties
Terrorist attacks and acts of sabotage can pose a significant threat to nuclear facilities and cause serious accidents. Krško NPP is no exception. However, the EIA documents only give cursory consideration to physical protection and security at the plant; in comparable EIA documents, these events are dealt with to a slightly greater extent. More information is available in the responses submitted in 2022. Although the classified nature of the security measures taken to guard against sabotage and terrorist attacks means that they cannot be discussed in detail EIA procedure, the relevant legal requirements should be mentioned in the EIA documents, with information on terrorist attacks being of particular importance given the fact that such attacks would have major impacts. The EIA documents should also include precise information on the legal requirements for protecting against the deliberate downing of a commercial aircraft. This issue is not addressed in the responses submitted in 2022, but is particularly important because the Krško NPP reactor building is at risk in the event of an aircraft crash. Aging can further reduce the resilience of buildings. A recent nuclear safety assessment in Slovenia showed deficiencies when it came to key nuclear safety requirements: Slovenia ranks 14th out of 47 countries on the 2020 nuclear safety list, with an overall score of 81 out of a possible 100. Low scores are given for “safety culture” (50), “cyber-security” (38) and “protection against internal threats” (64). These low scores indicate shortcomings in protection. (NTI 2021).
The IAEA supports countries in the field of nuclear security through its International Physical Protection Advisory Service (IPPAS). No such mission has ever been implemented in Slovenia. According to the responses (2022), no IPPAS mission is planned. It was explained that a security review would be conducted as part of the third Periodic Safety Review. It should be noted, however, that international inspections offer the possibility of increasing safety significantly.
Military attacks on nuclear facilities are another threat that deserve special attention in light of the current global situation.

In relation to these comments and after studying Krško NPP’s clarifications and the EIA Report, the ministry explains that requirements regarding security measures against sabotage and terrorist attacks (including the downing of an aircraft) are set out in Section 2.11.1 of the EIA Report. Legal and other bases. Krško NPP has incorporated the requirements arising from US NRC Interim Compensatory Measures Order EA-02-026, Section B.5.b, February 25, 2002 and NEI 06-12 “B.5.b Phase 2 & 3 Submittal Guideline” (following the WTC attack in the USA on 11 September 2001 and as part of moves to prepare nuclear power plants for such an event).
The police produce a threat assessment for nuclear facilities in Slovenia every year; this assessment

includes the threat of possible military and terrorist attacks and of sabotage. The technical and physical security measures are adapted in response to this assessment. Equipment vital to the safe operation and the shutting down of operation is installed in secure concrete buildings.
IAEA IPPAS missions took place in 1996 and 2010 at the invitation of the Slovenian government. Since 2019 the SNSA has been organising cyber-security exercises at nuclear facilities. These exercises were identified as best practice during a recent IAEA Integrated Regulatory Review Service (IRRS) mission. The last such exercise (KiVA2022) took place at the SNSA from 17 to 19 May 2022. The KiVA2022 exercise takes place at the interface between nuclear safety, security, emergency preparedness and cyber security. The exercise was prepared and conducted by the SNSA in cooperation with the IAEA and the Austrian Institute of Technology (AIT). Krško NPP continuously updates its cyber security in line with international standards and requirements, and participates in KiVA exercises.
As already explained in Krško NPP’s response to the expert opinion (Umweltverträglichkeitsprüfung KKW Krško/Slowenien Laufzeitverlängerung Fachstellungnahme, REP-0810, Vienna 2022), the result of the NTI does not reflect the actual situation. As the details of the results for Slovenia show (https://www.ntiindex.org/country/slovenia/), the result “No, or information not publicly available” is given for many of the indicators and sub-indicators. This is obviously because of a lack of publicly available information, which is understandable given the sensitive nature of physical security. The assessment would obviously be considerably higher if the same 2020 NTI-Index EIU-Methodology and real information were used. Consequently, we cannot use the assessment of the NTI Index as a reference for the level of physical security of nuclear facilities and materials in Slovenia. Information on the physical security of Krško NPP is classified and therefore not publicly available.

18. Transboundary impacts

Calculations for a design-basis and beyond-design-basis accident were submitted as part of the EIA procedure. While both calculations ruled out major adverse impacts on Austria, the authors nevertheless were of the opinion that this could not be confirmed on the basis of the data presented. That data showed that in the event of a beyond-design-basis accident, as calculated by the Slovenian side, parts of Austria could be so heavily contaminated that agricultural measures, such as an early harvest, would have to be implemented. This is an area at least 200 km away from Krško NPP and includes parts of Carinthia, the district of Lungau and a large part of Styria. As it has not yet been confirmed that the dose rates used for the calculations in the EIA Report are actually sufficient, a severe beyond-design-basis accident could lead to much more severe radiological consequences in Austria. In particular, the flexRISK project’s identification of the radiological impacts of a possible severe accident in indicates impacts that are greater (even more severe), than those identified in the EIA Report. In general, such accidents with serious consequences in Austrian territory cannot currently be ruled out. The authors of the final flexRISK report (Flexible Tools for Assessment of Nuclear Risk in Europe Final Report (2013)) discussed the shortcomings of their work and pointed out the limitations and uncertainties of the data used in the project. The project made use of available generic data, such as generic accident scenarios and radioactive inventories (source term), as well as available probabilistic safety assessments (PSA) that are not directly comparable. The authors themselves state that a comprehensive PSA would be required for each nuclear power plant, along with the use of appropriate computer codes and models.

After studying Krško NPP’s statements relating to these comments, the ministry explains that Krško NPP has carried out a series of upgrades in the areas of seismic hazard, flood protection, mitigation of the effects of fire, and the provision of additional sources of supply in the event of emergency situations or failure of the external power supply, etc. (EIA Report, Section 2.8). The Krško NPP SUP has led to a reduction in risk in the last few years. All safety upgrades are reflected in the Krško NPP safety analyses and in the PSA model, which shows a significant reduction in the core damage frequency (EIA Report, Section 2.8). We cannot take the flexRISK assessments, which are based on generic data and do not take into account possible safety improvements carried out at Krško NPP, as representative.
The type of release (direct, unrestricted release into the upper atmosphere) that occurred in the case of Chernobyl is not physically possible in the case of Krško NPP. Such an event falls into the category of events that cannot be regarded as credible. It should therefore not be addressed in the EIA analysis.

Krško NPP provided all relevant radiological data for the selected representative severe accident sequence as part of its additional responses to the expert report (Umweltverträglichkeitsprüfung KKW Krško/Slowenien Laufzeitverlängerung Fachstellungnahme, REP-0810, Vienna 2022). The generic ICRP 103 value was given as a measure of surface contamination to assess the radiological impact. It also shows the relationship between this limit value and the limit value applicable in Austria for the early harvesting of agricultural products. The implementation of such measures has the effect of removing the already low ingestive effect on effective doses, which have been shown to be below the dose limits for the implementation of protective measures in Austria.

Final recommendations
Recommendation 1: The EIA procedure should not ignore a consideration of alternatives to lifetime extension.

Response:
As has been explained on several occasions, the alternative to the lifetime extension project is presented in Section 3 of the EIA Report.

Recommendation 2: Spent fuel and radioactive waste: To reduce the risk posed by the Krško NPP site, spent fuel that has sufficiently decayed should, for safety reasons, be transferred to dry storage as soon as possible.

In relation to this recommendation, the ministry explains that when the dates of the envisaged campaigns of relocation to dry storage were being planned, consideration was given to the factors of technical feasibility, radiation and nuclear safety, and cost-effectiveness. The date of the campaigns and the number of fuel elements to be relocated have been acknowledged as optimal. Krško NPP will continue to review the timetable of the relocation of spent fuel from the spent fuel pool to dry storage, and adjust it as required to minimise the risks associated with spent fuel. As part of the safety upgrades to the spent fuel pool (SFP), Krško NPP has installed an alternative cooling system in its design basis systems (alongside the two existing, completely redundant systems), along with an alternative spray system to be used in the event of the loss of the design-basis cooling systems or of coolant/water in the spent fuel pool. This has further reduced the already small likelihood of fuel damage in the spent fuel pool. The newly installed spray system enables the fuel elements in the spent fuel pool to be cooled even if it is completely empty (i.e. without water). The system has been designed so that the spraying covers all the fuel elements inserted in the spent fuel pool, thereby ensuring that the residual heat is removed adequately. The configuration of this system is also completely independent of the other active systems at Krško NPP.

Recommendation 3: Long-term operation of a reactor of this type: It is recommended that all technically available safety improvements be made to prevent accidents.

In relation to this recommendation, the ministry responds by saying that Krško NPP has carried out a thorough analysis of beyond-design-basis accidents and drafted a Safety Upgrade Programme based on the national action plan within the framework of the EU stress tests. The SUP includes a large number of improvements and additional systems for managing beyond-design-basis accidents. Deterministic and probabilistic analyses were used to determine the most effective upgrades for improving nuclear safety. Tried-and-tested solutions were used because we did not want to install untested variants. The essential upgrades were carried out in the areas of seismic safety, flood protection, mitigation of the effects of fire, and the provision of additional sources of supply in emergency situations or when external AC power is lost, etc. (EIA Report, Section 2.8).
Krško NPP has also implemented the following design solutions, which comply with the WENRA requirements for new reactors:

1. pressuriser PORV Bypass MOVs, which are capable of releasing water;
2. an independent alternative AC voltage source (diesel generator 3), protected against external

hazards and designed for DEC;
3. a diversified reactor trip system;
4. an independent auxiliary control room that ensures that the parameters can be monitored and alternative DEC engineered safety features managed;
5. passive seals resistant to high temperatures at the reactor pumps (RCP);
6. alternative systems (ASI, ARHR, AAF) for managing loss of feedwater and loss of ultimate heat sink (UHS);
7. baskets with trisodium phosphate that reduce radioactive sources (source term) in the containment;
8. passive autocatalytic recombiners (PARs);
9. a passive containment filtered venting system (PCFVS);
10. an alternative residual heat removal (ARHR) system and passive containment filtered venting system (PCFVS), which are designed for design-extension conditions, enable cooling in the recirculation operating mode, and prevent subsequent failure of the containment owing to excessive pressure.

The ministry explains that it has taken the safety concerns into consideration and decided that any necessary additional safety measures shall be determined and carried out as part of the SNSA’s Periodic Safety Reviews in 2023 and 2033.

<u>Recommendation 4</u>: It is recommended that all requirements of the WENRA 2020 Reference Levels be reviewed as part of Periodic Safety Review 3 (PSR3), and that compliance with the RLs be taken as a precondition for approval of the lifetime extension.

Regarding this recommendation, the ministry explains that Krško NPP’s compliance with the WENRA Safety Reference Levels for Existing Reactors 2020 will be checked in the course of the third Periodic Safety Review, which is currently under way. According to the preliminary results of an independent review, Krško NPP does comply with the WENRA Safety Reference Levels for Existing Reactors 2020. The Periodic Safety Review (PSR) is a special administrative procedure laid down in nuclear legislation. The SNSA assesses and certifies by decision the successful completion of a PSR. A successful PSR is a further precondition for extending operation of the plant for a further ten years.

Under the terms of the bilateral agreement between Slovenia and Austria, details of the status of PSR3 will be presented at the regular annual meetings at which information relating to nuclear and radiation safety is shared.

<u>Recommendation 5</u>: It is recommended that more than one set of engineered safety features be designed to protect against DEC earthquakes.

As has been explained on several occasions, the conclusions of the EU stress tests:

- safe shutdown of the plant and its maintenance in a safe state are ensured even in the event of an earthquake that is twice the strength of the SSE (0.6 g);
- that core damage probability only increases with earthquakes above 0.8 g.

Krško NPP has also drafted and implemented a Safety Upgrade Programme (SUP) under which additional safety margins (an increase of 30% to 0.78 g) are built into new facilities and equipment. The additional alternative systems introduced as part of the safety upgrade ensure that the core is cooled in all situations that arise as the result of internal or external events. Systems have been implemented that are redundant and diversified in terms of physical system configuration, possible sources of electricity supply and sources of cooling medium. In addition to cooling of the core via an alternative evaporator cooling system, a system for cooling and replacing primary coolant losses (alternative safety injection system) has also been installed. In addition to these two systems, an alternative system for cooling and recirculating the primary circuit has been installed. In addition, the concept of “defence in depth” offers redundant and diversified mobile equipment stored in a dedicated, seismically secured structure.

<u>Recommendation 6</u>: It is recommended that the final alignment of aging management to the state of the art in science and technology, as outlined in the relevant IAEA safety standard (IAEA SSG 48, 2018),

be completed before lifetime extension is approved.

The ministry explains that the Krško NPP AMP was thoroughly reviewed with reference to IAEA SSG 48 (Ageing Management and Development of a Programme for the Long-Term Operation of Nuclear Power Plants) during the pre-SALTO mission to Krško NPP. The action plan for this review has been approved and is being implemented. The Krško NPP AMP and compliance with the requirements of IAEA SSG 48 are also being reviewed as part of the Periodic Safety Review conducted in accordance with IAEA SSG 25 (Periodic Safety Review). The PSR is a special administrative procedure laid down in nuclear legislation and conducted as part of the environmental protection consent procedure. The SNSA assesses the PSR and issues a decision certifying its successful completion. A PSR must be successfully completed before a decision can be taken to extend operational lifetime by ten years, while the EIA sets out the environmental conditions that must be met if operational lifetime is to be extended by 20 years.

Recommendation 7: It is recommended that the results of the SALTO mission be incorporated into the decision on whether to approve lifetime extension.

In relation to this recommendation, the ministry explains that these are management measures and that Krško NPP has, on the basis of the results of the pre-SALTO inspection, compiled an action plan that takes all of the recommendations and suggestions into account. The action plan defines a precise plan of implementation, with entities and deadlines, for each recommendation and suggestion. The action plan in question is also incorporated into the action plan for PSR3, which will confirm implementation. Most of the actions relate to minor adjustments/additions to Krško NPP programmes and procedures, with supplements and improvements to aging and qualification programmes, as well as recommendations for improvements in human resource management and the management of competencies and knowledge, and are not directly related to nuclear safety. All pre-SALTO findings and the action plan derived from these findings are entered in PSR3 Safety Factor 4 (Aging). This is part of the PSR3 procedure and the regulator’s review as required by nuclear legislation. A successfully completed PSR is a precondition for extending operation of the plant for ten years; similarly, implementation of the recommendations of the pre-SALTO mission is a precondition for allowing Krško NPP to continue to operate after 2023. A SALTO mission will review implementation of the pre-SALTO action plan and PSR3 at Krško NPP in 2024 and 2025, and produce new findings on the plant’s operation.

Recommendation 8: It is recommended that you explain the following information/topics at the bilateral meetings:

- Results and status of implementation of PSR3
- Calculations/experiments for the spray system for the spent fuel pool to make it possible to cool the fuel assemblies in the long term even if the coolant is completely lost as a result of a large leak.
- Results of TPR 2 on fire safety.

The ministry responds by saying that, under the Agreement between the Republic of Slovenia and the Republic of Austria on the Early Exchange of Information in the Event of Radiological Danger and on Issues of Joint Interest in the Area of Nuclear Safety and Radiation Protection, regular annual meetings are held to exchange information on nuclear safety and radiation protection. As agreed between the two countries, these topics/results can be presented at later meetings.

Recommendation 9: Analysis of accidents (DBA and BDBA) It is recommended that the WENRA safety objectives for new reactors be applied to determine reasonably practicable safety improvements for Krško NPP. Even if the probability of an accident scenario is very low, all additional safety improvements that are reasonably practicable must be carried out in order to reduce the risk. In this approach, it is recommended that the concept of practical exclusion be applied to accidents with early or large releases.

The ministry explains that Krško NPP therefore primarily incorporates the requirements for existing plants (WENRA SRL for Existing Reactors). The WENRA RHWG "Safety of New NPP Designs" (March 2013) was also implemented as far as possible.
Krško NPP has already implemented the following design solutions, which comply with the WENRA requirements for new reactors:

1. pressuriser PORV Bypass MOVs, which are designed to release water;
2. an independent alternative AC voltage source (diesel generator 3), protected against external hazards and designed for DEC;
3. a diversified reactor trip system;
4. an independent auxiliary control room that ensures that the parameters can be monitored and alternative DEC engineered safety features managed;
5. passive seals resistant to high temperatures at the reactor pumps (RCP);
6. alternative systems (ASI, ARHR, AAF) for managing loss of feedwater and loss of ultimate heat sink (UHS);
7. baskets with trisodium phosphate that reduce radioactive sources (source term) in the containment;
8. passive autocatalytic recombiners (PARs);
9. a passive containment filtered venting system (PCFVS);
10. an alternative residual heat removal (ARHR) system and passive containment filtered venting system (PCFVS), which are designed for design-extension conditions, enable cooling in the recirculation operating mode, and prevent subsequent failure of the containment owing to excessive pressure.

Recommendation 10: Before extension of operational lifetime is approved, it is recommended that an updated safety analysis of the possible effects of an aircraft crash be prepared, taking into account the state of the art in science and technology, and that the results be taken into account when deciding on whether to extend operational lifetime.

In relation to this recommendation, the ministry responds by saying that it has already been explained in Krško NPP's responses to the expert report (Umweltverträglichkeitsprüfung KKW Krško/Slowenien Laufzeitverlängerung Fachstellungnahme, REP-0810, Vienna 2022) that the plant has compiled an analysis of the impact of an aircraft accident on the plant and an action plan, and carried out a variety of safety improvements on the basis of the NEI 06-12 B.5.b Phase 2 & 3 Submittal Guideline requirements (Rev. 2) or the US NRC B.5.b requirement, which was published in 2002 (following the WTC attack in the USA on 11 September 2001 and as part of moves to prepare nuclear power plants for such an event). The ENSREG stress tests/extraordinary safety review showed that Krško NPP was well-designed and constructed and that, with the additional severe accident management equipment available at the site, was well-prepared for such events. The country-specific ENSREG stress-test reports were subjected to a rigorous international peer review (including by Austrian representatives) to enhance the credibility of the process.
Krško NPP has redundant engineered safety features that are physically separate from each other. As part of the Safety Upgrade Programme, Krško NPP has installed additional engineered safety features, at the cutting edge of science and technology, within two bunkered buildings (reinforced safety buildings) that are physically separate and at a suitable distance from the plant's main island, which is where the reactor is located in a double-shell containment area. This ensures that the plant's operation can be safely halted in the event of a large commercial airliner crashing into it.

Recommendation 11: It is recommended that an assessment of external and internal hazards be carried out in accordance with the latest scientific and technological knowledge and that the assessment be updated, if necessary, before lifetime extension is approved.

In relation to this recommendation, the ministry explains that Krško NPP's PSA addresses all possible initiating events against the backdrop of the plant's design bases and the natural features of the site. Krško NPP regularly reviews and updates the list of initiating events. The list is also taken into account when the PSA model is updated (along with changes and updates to the plant). Updates have a positive safety effect on the plant, including on lowering the CDF, which is also one of the reasons why they are implemented. Changes in the surrounding area can have positive or negative effects on safety. which is why we regularly update external initiating events, and at least every ten years as part of the PSR. Updates are also influenced by the availability and adequacy of the methodology and by changes to standards and recommendations.

Recommendation 12: It is recommended that the following information on incident analyses and PSA 2 results be made available during bilateral meetings in order to be able to make a reasonable assessment of whether Austria is potentially affected:

- the large (early) release frequency (L(E)RF);
- the proportion of meltdown accidents that lead to failure or bypassing of the containment;
- the list of beyond-design-basis accidents (BDBA) and, in particular, the associated source terms.

The ministry responds by saying that, under the Agreement between the Republic of Slovenia and the Republic of Austria on the Early Exchange of Information in the Event of Radiological Danger and on Issues of Joint Interest in the Area of Nuclear Safety and Radiation Protection, and if agreed between the two countries, topics/results that are not of a classified nature can be presented at the regular annual meetings held to exchange information on nuclear safety and radiation protection. The time-dependent radiological sources (source terms) used at Krško NPP PSA Level 2 and in the analysis of radiological impact on the environment are copyright-protected and cannot be distributed.

Recommendation 13: Accidents caused by external events: We recommend that systematic paleoseismological research be conducted to determine the speed of displacement and the frequency and magnitudes of paleo-earthquakes, and to minimise the uncertainties associated with an assessment of active, probably active and perhaps active faults in the immediate vicinity of Krško (<25 km).

The ministry explains that all of the above impacts were systematically considered in the existing 2004 PSHA for the Krško NPP site. As already stated in the "Accidents caused by external events" section, a project is currently under way to update the PSHA for the wider Krško NPP site. The project, which began with field research just over ten years ago, is financed by GEN. The preliminary study covers 12 seismic source lines within a 200 km radius of the plant. In addition to seismic source lines, it also considers seismic sources that could arise in specific areas. A new non-ergodic ground-motion model has also been developed for the location. This model takes into account the local characteristics of earthquakes on the basis of the ground-motion measurements that have been provided by ARSO for more than 20 years. Moreover, GEN launched a major project at the beginning of 2022 whose aim was to precisely define the geometry, kinematic parameters and the parameters of the Gorjanci structure.

Recommendation 14: It is recommended that the paleoseismology results be used in the updated PFDHA and PSHA.

In relation to this recommendation, it is explained that a PFDHA was carried out in 2013 based on the results of updated paleoseismological investigations. This has already been explained in the response to the first comment in the "Accidents caused by external events" section of this document. An updated PSHA is also being prepared.

Recommendation 15: The results of a PFDHA strongly depend on the input data (speed of displacement and frequency of earthquakes at the faults under consideration) and on the models used. It is recommended that the existing PFDHA for the Krško site be reviewed and, if necessary, updated in the light of new methodological developments and new data from ongoing paleoseismological research.

In relation to this recommendation, the ministry explains that the PFDHA from 2013 was independently reviewed by independent expert institutions and the SNSA. As a result, and because of the negligibly small probability of minor permanent ground displacement at the Krško NPP site resulting from powerful earthquakes and the proven robustness of Krško NPP's systems, there is no need or requirement to produce a new update of the PFDHA. When the new PSHA is completed, the properties of the seismic source lines from the new PSHA will be checked against the properties of the seismic source lines from the PFDHA. No significant deviations are expected. However, if significant deviations do occur, an examination will be made as to whether the PFDHA should be updated.

Recommendation 16: It is recommended that the results of PSHA 2022, which is currently being prepared for the possible new Krško NPP construction at the GEN 2 site in Krško, also be applied to the existing plant. As the site conditions are the same for both plants, the results of PSHA 2022 under WENRA (2021, RL E11.1) should also be applied to the existing plant.

In relation to this recommendation, the ministry explains that the issue of the application of the PSHA to the existing plant is addressed in the PSR3 action plan in accordance with Slovenian nuclear legislation. In this context, the probabilistic safety assessment will be updated to take into account the results of the new PSHA. Slovenia will keep Austria abreast of developments at a bilateral meeting; these meetings have become a fixture over the last decade.

Recommendation 17: It is recommended that no decision on the extension of Krško NPP's operational lifetime be taken until the independently verified results of PSHA 2022 are available.

The ministry responds by saying that the claim that the preliminary results are not expected to change significantly compared to the current seismic hazard study from 2004 is based on the results of calculations by an independent organisation (University of Ljubljana, Faculty of Civil Engineering and Geodesy).

Recommendation 18: It is recommended that the decision on whether to extend Krško NPP's operational lifetime be made on the basis of the following criteria: (1) the PSHA, which is currently being prepared and will be completed in 2022; (2) evidence that all safety-related SSCs comply with the requirements of the new PSHA. This recommendation is based on the considerable contribution made by earthquakes to the overall level of threat to the plant (57% of the total core damage probability).

In relation to this recommendation, the ministry explains that the decision on lifetime extension cannot be based on issues that are otherwise regularly addressed during Periodic Safety Reviews of the plant. We repeat the answer to a similar past question from Austria. The safety assurance process at Krško NPP is dynamic and continuous, which means that everything listed will have to be carried out when the results of the new PSHA are known. In 2015, as implementation of the PSHA is a protracted process, ARSO carried out an independent assessment of the impacts on the PSHA results from 2004. They found that the ground-motion models developed since 2004 could significantly increase seismic hazard. Owing to these uncertainties, Krško NPP took the position that the seismic design load for the new systems that have been constructed in recent years at Krško NPP and that are part of the plant's Safety Upgrade Programme should be increased to take account of a PGA of 0.78 g at surface. In addition, a non-ergodic ground-motion model for the immediate vicinity of Krško NPP began to be developed in 2018. A new non-ergodic ground-motion model was approved by an international peer-review panel in 2021. The new seismic hazard analysis, which will also take into account the new non-ergodic ground-motion model, is currently under way. It will provisionally be updated at the beginning of 2023, with an independent review following later in the year. Based on the preliminary results of the new PSHA and taking the non-ergodic ground-motion model into account, no significant changes in Krško NPP's seismic hazard from the results of the currently valid study of seismic hazard from 2004 are expected.
Krško NPP's nuclear and seismic safety is continuously reviewed during the Periodic Safety Reviews carried out every ten years. As stated, the application of the new seismic hazard study (PSHA) for the existing facility (Krško NPP) is addressed in the PSR3 action plan. Compliance with the requirements

of the action plan is mandatory for Krško NPP under Slovenian nuclear law.

Recommendation 19: It is recommended that the implementation of the safety updates that could result from PSHA 2022, which is currently being prepared, be made a condition for the environmental approval of the lifetime extension (analogous to the conditions for extreme weather and climate change). This recommendation is based on the considerable contribution made by earthquakes to the overall level of risk to the plant (57% of the total core damage probability) and the significant environmental impacts that could result from releases following an earthquake.

The ministry explains that it will set a safety update as a safety condition for ten-year operation, which will be reviewed by the SNSA in a special administrative procedure as it is a study that had not been completed and made available for evaluation when the EIA was being performed. As already mentioned in the answer to the above question (AE18), the decision on lifetime extension cannot be based on issues that are otherwise regularly addressed during Periodic Safety Reviews of the plant. We repeat the answer to a similar past question from Austria. The safety assurance process at Krško NPP is dynamic and continuous, which means that everything listed will have to be carried out when the results of the new PSHA are known. In 2015, as implementation of the PSHA is a protracted process, ARSO carried out an independent assessment of the impacts on the PSHA results from 2004. They found that the ground-motion models developed since 2004 could significantly increase seismic hazard. Owing to these uncertainties, Krško NPP took the position that the seismic design load for the new systems that have been constructed in recent years at Krško NPP and that are part of the plant’s Safety Upgrade Programme should be increased to take account of a PGA of 0.78 g at surface. In addition, a non-ergodic ground-motion model for the immediate vicinity of Krško NPP began to be developed in 2018. A new non-ergodic ground-motion model was approved by an international peer-review panel in 2021. The new seismic hazard analysis, which will also take into account the new non-ergodic ground-motion model, is currently under way. It will provisionally be updated at the end of 2022, with an independent review following in 2023. Based on the preliminary results of the new PSHA and taking the non-ergodic ground-motion model into account, no significant changes in Krško NPP’s seismic hazard from the results of the currently valid study of seismic hazard from 2004 are expected.
Krško NPP’s nuclear and seismic safety is continuously reviewed during the Periodic Safety Reviews carried out every ten years. As stated, the application of the new seismic hazard study (PSHA) for the existing facility (Krško NPP) is addressed in the PSR3 action plan. Compliance with the requirements of the action plan is mandatory for Krško NPP under Slovenian nuclear law.

Recommendation 20: Accidents caused by third parties: The EIA procedure should define the legal requirements for protection against deliberate crashes of commercial aircraft and other acts of terrorism and sabotage.

In relation to this recommendation, the ministry explains that the requirements for safety measures against sabotage and terrorist attacks (including aircraft crashes) are set out in Section 2.11.1 of the EIA Report. Legal and other bases. Krško NPP has incorporated the requirements arising from US NRC Interim Compensatory Measures Order EA-02-026, Section B.5.b, February 25, 2002 and NEI 06-12 “B.5.b Phase 2 & 3 Submittal Guideline” (following the attack on the WTC attack in the USA on 11 September 2001 and as part of moves to prepare nuclear power plants for such an event).

Recommendation 21: According to the results of the Nuclear Security Index, protection against cyber and insider attacks should be improved.

In relation to this recommendation, the ministry responds by saying that the results of the NTI do not reflect the actual situation. As the details of the results for Slovenia show (https://www.ntiindex.org/country/slovenia/), the result “No, or information not publicly available” is given for many of the indicators and sub-indicators. This is obviously because of a lack of publicly available information, which is understandable given the sensitive nature of physical security. The assessment

would obviously be considerably higher if the same 2020 NTI-Index EIU-Methodology and real information were used. Consequently, we cannot use the NTI Index assessment as a reference for the level of physical security of nuclear facilities and materials in Slovenia. Information on the physical security of Krško NPP is classified and therefore not publicly available.
Since 2019 the SNSA has been organising cyber-security exercises at nuclear facilities. These exercises were identified as best practice during a recent IAEA Integrated Regulatory Review Service (IRRS) mission. Krško NPP participates in exercises organised by SNSA. The last such exercise took place at the SNSA from 17 to 19 May 2022. The KiVA2022 exercise takes place at the interface between nuclear safety, security, emergency preparedness and cyber security. The exercise was prepared and conducted by the SNSA in cooperation with the IAEA and the Austrian Institute of Technology (AIT). A large number of observers were present at the exercise, including representatives from Argentina, Austria, Romania, Switzerland, the United Arab Emirates, the USA and WINS (World Institute for Nuclear Security).

Recommendation 22: The IAEA's International Physical Protection Advisory Service (IPPAS) should be deployed to support improvements in nuclear security.

In relation to these comments, the ministry explains that IAEA IPPAS missions took place in 1996 and 2010 at the invitation of the Slovenian government. Since 2019 the SNSA has been organising cyber-security exercises at nuclear facilities. These exercises were identified as best practice during a recent IAEA Integrated Regulatory Review Service (IRRS) mission.
Krško NPP enjoys a high level of physical security, which is regularly reviewed and improved in response to the threat assessment produced every year by the police. Krško NPP's physical security is being independently reviewed as part of PSR3, which is currently under way, in the review and production of an assessment of Safety Factor 17 (Physical security).

Recommendation 23: Transboundary impacts – Due regard should be given to the fact that Austria and Slovenia apply different dose reference values when it comes to deciding whether to introduce emergency measures.

Regarding this recommendation, the ministry responds by saying that EIA dose calculations do not take account of any protective measures that might be carried out. The total effective dose equivalent (TEDE) for the whole body and the thyroid, and the soil concentrations of gamma contamination activities from ICRP 103-2007 have been used as the criterion for assessing the level of impact. Regarding emergency measures, Slovenian legislation complies with ICRP 103-2007. Of course, Austria bases its protective measures and impact assessments on its own laws, while the EIA has been drawn up in accordance with internationally accepted criteria.
This is in line with the notification in the event of an accident. Article 5 of the Convention on Early Notification of a Nuclear Accident (Vienna, 26 September 1986) prescribes the information that must be provided to other countries; countries then use this information to determine the protective measures they will take to reduce the radiological consequences. As described in IAEA EPR-IEComm (2019) and the International Radiation Monitoring Information System (IRMIS) web application, which provides Member States with a tool for exchanging radiation monitoring data in routine and emergency situations.

Recommendation 24: It is recommended that, where physically possible, the transboundary effects of a severe accident involving failure or bypass of the containment be calculated independently of the estimated probability of occurrence.

Regarding the selection of the representative accident in the EIA Report, the ministry explains that the selection was made on the basis of the Krško NPP Safety Analysis Report and of deterministic and probabilistic safety assessments. The reference severe accident was selected as the limiting or envelope scenario presenting the biggest challenge to transboundary impact resulting from a very conservative (almost improbable) scenario involving the loss of all AC power supply, the availability of

safety/auxiliary systems, and the loss of operating crew for 24 hours (no action is taken by the operating crew in the first 24 hours). An explanation of the selection of the representative accident is given in Section 6.4 of the EIA Report.
An accident involving failure of the containment and addressed in the probabilistic safety assessments for Krško NPP envisages a smaller radioactive inventory (source term) in the containment and, consequently, a lower release of radionuclides than envisaged from total core meltdown in the selected representative accident used in the EIA. This means that the EIA addressed the highest possible radioactive inventory (source term).

MEASURES TAKEN AS PART OF THE TRANSBOUNDARY CONSULTATION CONDUCTED

Under the provisions of the Ionising Radiation Protection and Nuclear Safety Act (ZVISJV-1) and the Rules on the operational safety of radiation and nuclear facilities, Krško NPP is required to compile an action plan for the third Periodic Safety Review (PSR3), to include an updated PSHA for the site of the plant, to submit it to the SNSA in 2023 and, on this basis, carry out any additional measures to increase nuclear safety at Krško NPP.
Slovenia's neighbouring countries are apprised of the PSHA and the measures once a year as part of the monitoring process set out in Article 9 of the Espoo Convention. The existing bilateral nuclear safety committees are used for this purpose.
The ministry determined these two measures in the operative part of the environmental protection consent (points II/1.18 and II/1.19).

Reasoning:

In accordance with the provisions of the Ionising Radiation Protection and Nuclear Safety Act (ZVISJV-1) and the Rules on the operational safety of radiation and nuclear facilities, the third Periodic Safety Review (PSR3) is currently under way at Krško NPP with the aim of providing a comprehensive and independent review of safety at the power plant. In accordance with the approved Third NEK Periodic Safety Review Programme (PSR3), NEK ESD-TR-03/20, Rev. 1, December 2021, this should be completed by the end of 2023. The approved final PSR3 report, which will also contain an action plan for the implementation of changes and improvements, is a precondition for extending the plant's operational lifetime for ten years. Under the Rules on the operational safety of radiation and nuclear facilities, the deadline for implementation of the plan for changes and improvements is five years after approval of the PSR3 report.
The acquisition of an updated PSHA is also a requirement for PSR3 and one that will be carried forward into the PSR3 action plan. It will be completed and approved by the end of 2023 (PSR3-NEK-2.3, Hazard Analyses, PSR3 2.3-04 requirement, updated PSHA). Compliance with the PSR3 2.3-04 requirement will, in accordance with the PSR3 action plan, be adopted and given final approval by the SNSA.
A project is currently under way to update the PSHA in the immediate vicinity of Krško NPP, and began with field studies just over ten years ago. The study covers 12 seismic source lines within a 200 km radius of Krško NPP. In addition to seismic source lines, it also considers planar seismic sources or combinations of different types of seismic source; this increases the complexity of the study and is one of the reasons why it is taking so long. A new non-ergodic ground-motion model for the location has been developed on the basis of the study. Such models typically take account of local earthquake characteristics based on ground displacement measurements; in Slovenia's case, these have been provided by the Slovenian Environment Agency (ARSO) for more than 20 years. An independent review of the new PSHA is currently under way and will be completed in 2023. It will serve as final approval of the new revised version of the PSHA. Based on the preliminary results of the new PSHA, and the report produced by the Faculty of Civil Engineering and Geodesy (FGG) of the University of Ljubljana on the preliminary review of those results ("Overview of the non-ergodic ground motion model for Krško and preliminary PSHA results for the mean return period of 10,000 years", Rev. 0), it is not expected that the final results of the new PSHA will be significantly different from the results of the currently valid PSHA from 2004. After the new PSHA is completed, independently reviewed and approved by the

SNSA, it will be used as input data for the updating of the seismic model in the Krško NPP probabilistic safety assessment.
According to Article 1(vii) of the Act Ratifying the Convention on Environmental Impact Assessment in a Transboundary Context (Official Gazette of RS [Mednarodne pogodbe], No. 46/1998), an impact is every environmental consequence, including for human health and safety. Therefore, in addition to impacts on flora, fauna, soil, air, water, climate, landscape and historical monuments, consideration must also be given to safety, even though nuclear power plant safety is regulated separately at the international, European and national levels and the topics are interconnected and have relevance to the EIA and the ten-year Periodic Safety Reviews. While an EIA must be drawn up for the entire proposed lifetime extension period, i.e. 20 years, and not for a shorter period, a Periodic Safety Review is conducted every ten years and takes place in relation to the current operation of the plant. All the measures referred to in Article 112 of the Ionising Radiation Protection and Nuclear Safety Act are therefore laid down within the framework of extension of operational lifetime and must be carried out on a regular basis.

Based on the documentation enclosed and obtained, the following was established in the course of the procedure, as set out below in the grounds of this environmental protection consent.

Description of current situation
Krško nuclear power plant is located in the Municipality of Krško, southeast of the town of Krško, in the cadastral municipality of Leskovec, at the address Vrbina 12, Krško, in an area of long-term energy use on the left bank of the Sava. Krško NPP is located at latitude 45.938210 (north) and longitude 15.515288 (east), or 455617.556 (north) and 153055.037 (east) according to WGS-84 coordinates (x = 88353.76 m and y = 540326.67 m according to Gauss-Krüger coordinates). The location of the lifetime extension is, according to the applicable spatial planning act, i.e. the Ordinance on the municipal spatial plan for the Municipality of Krško (Official Gazette of RS, No. 61/15), located in an area of building land containing mainly industrial buildings classified as E (energy infrastructure) in spatial planning unit (SPA) KRŠ 025, and VI (water infrastructure area) in spatial planning unit (SPA) HJE 01.
As it is located near the intersection of regional roads and in the immediate vicinity of the railway line, the area has good road and rail connections. An industrial road leads up to the power plant and connects to regional road R1 Krško–Spodnja Pohanca. The plant also has an industrial railway line that connects it to Krško station.
The nearest residential areas are located northeast (Spodnji Stari Grad) at a distance of approx. 500 m, north (Spodnja Libna) at a distance of approx. 550 m, and west (Žadovinek) at a distance of approx. 1.4 km from the site of the planned lifetime extension.
The nearest nursery schools (Vrtec Dolenja Vas, Vrtec Krško) are located more than 2 km northeast and northwest, the nearest primary school (Osnovna šola Leskovec pri Krškem) about 2.6 km west and the nearest secondary school (Šolski center Krško-Sevnica) 2.2 km northwest of the Krško NPP location. Krško retirement home is more than 2 km away from the site of the lifetime extension.
The terrain is flat and the site of the lifetime extension is approx. 155 m above sea-level. The following manufacturing companies operate north of the location: SECOM d.o.o., principal activity: 22.230 (Manufacture of products from plastic for construction); GEN energija d.o.o., principal activity: 64.200 (Activities of holding companies); GEN-I d.o.o., principal activity: 35.140 (Electricity trading); Saramati Adem, d.o.o., principal activity: 41.200 (Construction of residential and non-residential buildings). The following companies operate east of the site: KOSTAK d.d. Center za ravnanje z odpadki (IED installation), principal activity: 36.000 (Water collection, treatment and supply). There are three IEDs at a distance of between 800 and 2,000 m from the site of the lifetime extension: VIPAP VIDEM KRŠKO d.d., KRKA d.d. and KOSTAK d.d. There are currently no establishments with an upper- or lower-tier major accident hazard (Seveso) in the area of Krško.

Description of proposed activity (lifetime extension)
The developer intends to extend Krško NPP’s operational lifetime from 40 to 60 years, i.e. from 2023 to 2043. This does not change the position, location, dimensions, technical design or production capacity

of the plant, or its mode of operation. The extension of the operational lifetime does not entail the construction of new structures or facilities that would change the physical characteristics of the plant.
Krško NPP has an output power of 696 MWe, which accounts for ~38% of the total amount of electricity generated in Slovenia. This makes it the country's largest electricity producer. Half of the energy produced is exported to Croatia.
Krško NPP is equipped with a Westinghouse light-water pressurised reactor with a thermal power of 1,994 MW. Its net electrical output is 696 MW. The plant is connected to the 400 kV network that supplies electricity to consumers in Slovenia and Croatia.

All of Krško NPP's technologically important buildings stand on a massive reinforced concrete plate that is anchored on the clay-sand layers of the Pliocene sediments of the Krško Polje plain. This plate forms a solid, earthquake-safe foundation. The buildings are designed and constructed in a way that enables them to withstand the expected earthquakes in this area without suffering major damage.
The reactor building, which contains the reactor with the coolant loops and the engineered safety features, consists of an inner steel pressure shell and an external reinforced concrete protective building. The tunnels into the reactor building for people and equipment are fitted with air locks with double doors. The pipe and cable penetrations through walls are double-sealed. Adjacent to the reactor building are an auxiliary building, a component cooling building, fuel handling building, emergency diesel generators building and the turbine building.
The cooling water and essential service water intakes are on the bank of the Sava above the dam. This ensures sufficient water supply in all conditions. The cooling wastewater discharge is below the dam. In the event of insufficient water in the Sava, the condensate is cooled by cooling towers with forced draft cooling cells.
The storage space for intermediate and low-level radioactive waste is on the southwest rim of the plant. The administrative building with workshops and the switchyard is on the northern rim, near the entrance to the plant.

<u>Reactor with coolant loops</u>:
The Westinghouse pressure reactor with two coolant loops consists of a reactor vessel with internal equipment and a closure head, two steam generators, two reactor coolant pumps, a pressuriser, piping, valves and auxiliary reactor systems.
Ordinary demineralised water is used as the reactor coolant, neutron moderator and solvent for boric acid. The reactor coolant gives off heat in the steam generator. This heats the feedwater on the secondary side of the steam generator and turns it into steam. The coolant pressure is maintained by the pressuriser by means of electric heaters and water sprays that are fed by water from the cold leg of the reactor's coolant loop.
The meters for neutron flux, temperature, reactor coolant flow, pressure and water level in the pressuriser give the required data for operating the work process and maintaining the safety of the reactor system.
The power of the reactor is controlled by means of control rods. The drive mechanisms of the control rods are fixed to the reactor vessel shutter head. Their absorption rods reach into the reactor core. Long-term changes in the reactivity of the core and its poisoning with fission products are compensated by changing the concentration of boric acid in the reactor coolant.

<u>Nuclear fuel</u>:
The reactor core consists of 121 fuel elements. A fuel element consists of fuel rods, a lower and upper nozzle, spacers and guide tubes for the absorption rods, and instrumentation. The fuel rods consist of fuel pellets of uranium dioxide that are clad with zirconium alloys.
Almost half of the fuel elements are replaced with new elements during an outage. Fresh fuel elements are dry-stored. Spent fuel elements are stored underwater in the spent fuel pool, where they cool down. The technology for storing spent fuel is being upgraded with the introduction of dry storage. The dry storage building for spent fuel is being constructed within the existing nuclear facility in accordance with building permit no. 35105-25/2020/57 of 23 December 2020 granted by the Ministry of the Environment

and Spatial Planning, Spatial Planning, Construction and Housing Directorate, Dunajska c. 48, 1000 Ljubljana.
When the fuel is changed, the fuel elements are brought along the water canal through the wall of the reactor building in the reactor pool. The fuel is loaded while the reactor is open and the space above it is filled with water. The charging machine hoists spent fuel elements from the reactor core and replaces them with fresh ones. A fuel element usually stays in the core for at least two fuel cycles. One fuel cycle lasts 18 months.

Turbine generator and electrical system:
The turbine is propelled by saturated vapour produced by the steam generators. The steam in the double-flow high pressure part of the turbine expands to pressure of 0.8 Mpa, then after the moisture is removed and it is superheated it expands in the two low-pressure parts of the turbine to pressure of 5 kPa. It condensates in the four-part condenser, after which the condensate pumps return the condensate through the heaters into the steam generators.
When the Sava flows at more than 100 m^3/s, the condenser is cooled by flow-cooling. If the flow rate is lower, flow-cooling is combined with cooling towers, with a smaller quantity of water being taken from the Sava and the remainder recirculated in the cooling towers.
The electricity generator produces three-phase current with 850 MVA of power, cos phi 0.876 and voltage 21 kV. The rotor of the three-phase generator is cooled by hydrogen and the stator is water-cooled. The exciter does not have brushes.
Krško NPP is connected to the 400 kV electricity grid. Electricity flows from the generator via two transformers into the power plant's switchyard and from there via one transmission line towards Maribor, along two lines towards Ljubljana and Zagreb, and via two transformers to the 110 kV Krško distribution substation.
For its own needs, the power plant uses electricity produced by its own generator, or takes it from the 400 kV system. If the latter is down, then it uses the 110 kV line from the Krško substation. Additional electrical energy can be provided by Termoelektrarna Brestanica (gas-fired power plant), which is located approx. 7 km from Krško NPP. If necessary, Brestanica power plant can disconnect all other users and provide electricity solely for Krško NPP's use.
In the event of a loss of off-site power, Krško NPP has three independent diesel generators (DG#1 and DG#2 producing 3.5 MW each, and DG#3 4 MW). These can provide electricity within ten seconds. Each generator can power the equipment necessary to shut down the plant safely. Krško NPP is also equipped with mobile generators, to be activated in the event of an urgent need for electricity due to damage to the internal electrical grid.

Radioactive waste:
Krško NPP operations produce gaseous, liquid and solid radioactive waste.
For the treatment of waste radioactive gases, the plant has two parallel closed loops with a compressor and catalytic incinerator for hydrogen, and six tanks for the decay and storage of compressed fission gases. Four gas tanks are used during regular operation while two are for when the reactor is not in use. The capacity of the tanks is sufficient to store gas for more than one month. Over that period, most short-lived fission gases decay, while the remaining gases go into the atmosphere when the meteorological conditions are favourable. Automatic radiation monitors in the plant ventilation stack prevent uncontrolled discharge when the concentration of radioactive gases is greater than the allowed limit.
Liquid radioactive waste is treated in a system consisting of tanks, pumps, filters, an evaporator and two ion exchangers. Blowdown water from the steam generators is treated separately. The radioactivity of the wastewater released into the Sava is much lower than the permitted level. The effective dose for an adult from releases into the Sava was 0.006 μSv per year (time spent on the bank and the consumption of fish) in Brežice in 2020. The calculated annual effective dose for an adult 350 m from the Krško NPP dam is 0.014 μSv. If the average habits of the reference person are taken into account, the effective dose received is several times lower. Tritium H-3 accounts for the biggest single share of the total effective dose (44%), with the predominant exposure pathway being the consumption of fish.

The estimated effective doses are several thousand times lower than 0.1 mSv, which is defined in Article 18 of the Decree on limit doses, reference levels and radioactive contamination (Official Gazette of RS, No. 18/18) as the dose to be used to calculate the implemented concentrations for drinking water.
All solid radioactive waste that is produced during the plant's operation, as well as during maintenance work and repairs, is collected in the solid waste plant. Most of the waste consists of used ion exchangers, sludge from the evaporator, spent filters and other contaminated solid waste such as plastic, paper, cloths, personal protective equipment, tools and mechanical parts.
After being dried, extracted for incineration, compacted or solidified (depending on the purpose), the solid radioactive waste is put into different packages: 208 l steel barrels, 200 l stainless steel barrels or 150 l stainless steel barrels with biological protection. The barrels and pressings are then placed into tube type containers, which are then temporarily stored at the plant. Thanks to sophisticated modern cleaning devices and the constant monitoring of the plant's surroundings, the radiation dose contributed to the environment by Krško NPP during operation is less than 0.1% of the annual dose received from the natural background and artificial sources.
Radioactivity on the Krško Polje plain has been measured at 50 different points around the power plant since 1974. At these points, measurements are also taken of the atmosphere, water and precipitation, as well as biological samples, when the plant is operating; the data is then compared with natural radioactivity and radioactive fallout prior to operation. The state of the water and biotope in the Sava and the groundwater is also monitored; these measurements also continue when the plant is in operation.

Preparation of water for process purposes:
There are two process water systems:
- the water filtering system (PW – water pretreatment system); and
- the system that produces demineralised water (WT – water treatment system).

The filtered (PW) and demineralised (WT) water systems are located in the pretreatment building. The whole system for producing process water is controlled by computer, and is operated remotely by means of two PLCs (programmable logic controllers). Although the process water systems do not belong to a safety class, the loss of these systems can cause the automatic loss of components that require process water for their normal operation.
Raw water is drawn either from wells or the public water supply. It is collected in the raw water tank; from there it is pumped through two-layered filters, where the water steriliser (sodium hypochlorite) is added, into the PW tanks. The water-filtering system is designed to provide all users with filtered water, while the system for producing demineralised water is designed to produce water that is as pure as possible and provide it to consumers in the primary and secondary circuits.
The water treatment system is designed to provide filtered water for the water treatment system (WT), seal water for CW and CT pumps, and the distribution of PW water:
- during normal operation of the power plant, the system produces 45.9 m^3/h of PW water;
- in the period of increased consumption after the annual outage, the system provides 129.2 m^3/h of PW water.

The system for producing WT water:
- produces demineralised water;
- prepares chemicals to support the water-purification process;
- stores and distributes demineralised water.

The system for preparing demineralised water (WT) is designed to prepare the required amount of water of the prescribed quality; it also enables demineralised water (DW) to be stored and pumped to different consumers. The DW system is designed to distribute highly purified water from the WT system to consumers on the primary and secondary side of the power plant.
The DW system is designed to provide a maximum flow rate of 70 m^3/h (308.2 gpm) into the DW tanks. The two DW tanks have capacities of 379 m^3 (10,000 gallons) and 1,000 m^3 (26,000 gallons).

Krško NPP technology:
Krško NPP produces heat through the fission of uranium nuclei in the reactor. The reactor consists of

the reactor vessel and its fuel elements, which constitute the core. In the primary circuit, demineralised water with boric acid circulates through the reactor. Under pressure, it carries the released heat into the steam generators.
In the steam generators on the secondary side, steam is produced that drives the turbine. This in turn drives the electricity generator. When the steam leaves the turbine, it condenses in the condenser, which is cooled by water from the Sava. The condensate is then pumped back into the steam generators, where it again turns into steam.
Water from the Sava flows through the condenser (the "tertiary loop"), where it makes the steam condense and discharges surplus energy into the river. All the reactor equipment and that of the corresponding primary cooling loop is located in the reactor building, which is also called the "containment building" because of its function.
The reactor vessel containing the fuel elements is tightly closed and under high pressure during operation. The power plant's operation must be shut down and the reactor coolant system cooled down when the planned refuelling is carried out. The period between two refuellings is called the fuel cycle, which at Krško NPP lasts 18 months. After the end of each fuel cycle, spent fuel elements are replaced with fresh elements. A fuel element usually stays in the core for at least two fuel cycles.

The primary circuit consists of the reactor, steam generators, reactor coolant pumps, a pressuriser and piping.
The heat released in the reactor core heats the water that circulates in the primary circuit. The heat of the water is transmitted through the walls of the pipes in the steam generators to the water in the secondary circuit. The reactor coolant pumps ensure that water circulates in the primary circuit. The pressuriser maintains the pressure in the primary circuit and prevents the water from boiling at the core. All components of the primary circuit are installed in the containment, which isolates the primary circuit from the environment, even in the event of an accident.

The secondary circuit consists of steam generators, a turbine, a generator, a condenser, feed water pumps and piping.
The steam generators are essentially boilers in which water from the secondary circuit evaporates to steam to power the turbine. The energy from the steam is converted into mechanical energy in the turbine. The generator converts this energy into electricity and transfers it to the electricity grid via transformers.
Expended steam from the turbine flows into the condenser, where it condenses, i.e. is converted into water, when it comes into contact with the cold pipes. The feed water pumps pump the water from the condenser back into the steam generator, where steam is again produced.

The tertiary circuit consists of the condenser, cooling pumps, cooling towers and piping.
The tertiary circuit is designed to cool the condenser and remove the heat, which cannot be usefully utilised for electricity production.
The cooling pumps draw the water from the Sava into the condenser and then discharge it back to the river. Because it absorbs heat from the expended steam, the water heats up as it flows through the condenser. The heating of the Sava is Krško NPP's most significant impact on the environment, as it can affect the river's biological properties. This impact is limited by administrative decisions that specify the maximum permitted temperature increase and maximum quantity of water that may be abstracted. The cooling towers are activated in the event of adverse weather conditions. In extremely unfavourable weather conditions, the power of the plant has to be reduced in order to comply with the limits set.

<u>Technical data on facility</u>:
<u>Basic data on power plant</u>:

Reactor type:	Pressurised light-water reactor
Reactor thermal power:	1,994 MW
Gross electrical power:	727 MW
Net electrical power:	696 MW

Thermal efficiency:	36.6%

<u>Basic data on fuel</u>:

Number of fuel elements:	121
Number of fuel rods in a fuel element:	235
Fuel rod array:	16 x 16
Fuel rod length:	3.658 m
Cladding material:	Zircaloy-4, ZIRLO
Chemical composition of fuel:	UO2
Total quantity of uranium:	48.7 t

<u>Basic data on reactor coolant</u>:

Substance:	H_2O
Additives:	H_3BO_3
Number of cooling loops:	2
Pressure:	15.41 MPa (157.1 kp/cm^2)
Temperature at reactor inlet:	287°
Temperature at reactor outlet:	324°

<u>Basic data on control rods</u>:

Number of assemblies:	33
Neutron absorber:	Ag-In-Cd
Composition percentage:	80–15–5%

<u>Basic data on steam generators</u>:

Material:	INCONEL 690 TT
Number of steam generators:	2
Pressure of steam leaving generator:	6.4 MPa (65.6 kg/cm^2)
Steam flow rate from both generators:	1,088 kg/s

<u>Basic data on turbine and generator</u>:

Maximum power:	730 MW
Inlet pressure of fresh steam:	6.4 MPa (63 ata)
Temperature of fresh steam:	280.7°C
Turbine rotation speed:	157 rad/s (1500 rot./min)
Steam moisture at inlet:	0.10%
Condensation pressure (vacuum):	5.1 kPa (0.052 ata)
Average condensate temperature:	33°C
Rated power of generator:	850 MWA
Rated voltage:	21 kV
Rated frequency of generator:	50 Hz
Rated cos 0:	0.876

<u>Basic data on transformers</u>:

Block transformers: rated power: 2 x 500 MVA, voltage ratio: 21/400 kV
Unit transformers: maximum permitted continuous power: 2 x 30 MVA, voltage ratio: 21/6.3 kV
Auxiliary transformer: maximum permitted continuous power: 60 MVA, voltage ratio: 105/6.3/6.3 kV

<u>Engineered safety features</u>:

Engineered safety features prevent the uncontrolled release of radioactive material into the environment. A high level of attention is already paid to nuclear safety during the reactor and power plant design process. Engineered safety features have been designed to provide safety functions in all operational states, even in the event of the failure of specific equipment.

A nuclear power plant is in a safe state if three basic safety conditions are met at all times:
1. effective reactivity control (reactor power control);
2. cooling of the fuel in the reactor, the spent fuel pool and the spent fuel dry storage;
3. confinement of radioactive material (release of radioactive material into the environment prevented).
The release of radioactive material into the environment is prevented by four successive safety barriers:

- the first barrier is the nuclear fuel (or fuel pellets) retaining radioactive material within itself;
- the second barrier is a waterproof cladding that encloses fuel pellets and prevents leakage of radioactive gases from fuel;
- the third barrier is the primary circuit boundary (pipe walls, reactor vessels and other primary components) that confines the radioactive water for reactor cooling;
- the fourth barrier is the containment that hermetically separates the primary circuit from the environment.

The basic objective of the first three barriers is to prevent radioactive material from passing to the next barrier, while the fourth barrier prevents radioactive material from being released directly into Krško NPP's surrounding environment.
Since the operation of engineered safety features in the event of a defect, a failure or a highly unlikely accident at a nuclear power plant is paramount, all engineered safety features are redundant (Krško NPP has two trains of engineered safety features).
To comply with safety conditions and maintain safety barriers, the operation of only one train of engineered safety features is always sufficient. Furthermore, all engineered safety features and their individual devices are systematically tested during the operation of the power plant and during regular outages.

<u>Spent fuel</u>:
Since it began operating, Krško NPP has stored all spent fuel inside the fence encircling the plant's technological section in the spent fuel pool (SFP) located in the fuel handling building (FHB), as was planned in the original design. The removal of residual heat from the spent fuel takes place via the spent fuel pool's active cooling system. The safety upgrades that have been carried out include improvements for the alternative cooling of the spent fuel pool.
An analysis of possible improvements to fuel storage was part of the response taken to the Fukushima accident by the nuclear industry and administrative bodies. It follows from the conclusions of analyses by Krško NPP and the analyses and decisions of the SNSA that the introduction of dry storage for spent fuel constitutes an important safety upgrade in response to the new safety requirements. The proposed technical solution for the dry storage of spent fuel is noted in the Resolution on the National Programme for Radioactive Waste and Spent Fuel Management 2016–2025 (ReNPRRO16–25) (Official Gazette of RS, No. 31/16).
The main purpose of the spent fuel dry storage building is to provide a technological upgrade of the plant's temporary spent fuel storage arrangements. Spent fuel dry storage is a safer way of storing spent fuel; this is because the cooling system is passive, which means that no device, system or energy source is needed for cooling and operation; it also improves radiation safety and the robustness of the system. The building and the spent fuel casks will be located on-site, inside the fence encircling the plant's technological section.
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. Dry storage is recognised worldwide as the safest and most widespread technological solution for storing spent fuel. In addition to the passive cooling method, better radiation safety and robustness, spent fuel dry storage also has other benefits, above all better protection against intentional and unintentional negative human influences or acts.
After several years of cooling in the spent fuel pool (SFP), the spent fuel is transferred to special canisters. These are hermetically sealed and placed in a suitable overpack (for transfer, storage or transport). These canisters in special storage overpacks are then placed in the spent fuel dry storage building. The building is divided into several areas: handling, technical and storage.
Spent fuel will be stored in the building until a decision on the national strategy for spent fuel disposal or re-processing is made. A total of 1,323 fuel elements were being stored in the spent fuel pool at the

end of 2020, including two special containers with fuel rods and a fission chamber from 2017. The first phase of dry storage loading follows in 2023, when the initial 592 spent fuel elements will be transferred. In the second phase in 2028, the next 592 spent fuel elements will be transferred.

Safety Upgrade Programme (SUP):
In compliance with Slovenian legislation in the field of nuclear safety (Rules on radiation and nuclear safety factors, Official Gazette of RS, Nos. 74/16 and 76/17 [ZVISJV-1]), Krško NPP has analysed the systems, structures and components from the aspect of severe accidents. On the basis of analyses, Krško NPP is required to take all reasonable measures to prevent and mitigate the consequences of severe accidents in line with the deadlines set. Following the accident at Japan's Fukushima Daiichi power plant in March 2011, this process was given high priority. SNSA decision no. 3570-11/2011/7 of 1 September 2011 required a severe accident analysis and Safety Upgrade Programme to be drawn up.
Even prior to the accident in Japan, Krško NPP was already implementing certain upgrades, such as the installation of a third diesel generator to power the engineered safety features, which contributes to safety and also supports modernising initiatives in the wake of the Fukushima disaster. It also reacted rapidly and effectively in the wake of the Fukushima disaster. The programme proposed by Krško NPP as a response to the SNSA decision complies with the requirements of the Western European Nuclear Regulators' Association (WENRA) and is comparable with industrial practice in other European countries.

Periodic Safety Review:
The first paragraph of Article 112 of the Ionising Radiation Protection and Nuclear Safety Act (ZVISJV-1, Official Gazette of RS, Nos. 76/17, 26/19 and 172/21) provides that the operator of a radiation or nuclear facility is required to ensure regular, comprehensive and systematic assessment and monitoring of the radiation or nuclear safety of a facility by means of Periodic Safety Reviews.
The frequency, content, scope, duration and method of performing Periodic Safety Reviews, and the method of reporting on those reviews, are defined in the Rules on the operational safety of radiation and nuclear facilities (Official Gazette of RS, Nos. 81/16 and 76/17 [ZVISJV-1]). A successful Periodic Safety Review is a precondition for extending operation for ten years.
For the operator of a radiation or nuclear facility, the aim of the Periodic Safety Review is to:

- review the overall impacts of plant aging, the impacts of modifications to the facility, operational experience, technical development, impacts of changes on the site and any other potential impacts on radiation or nuclear safety, and to determine the compliance with the design bases, based on which the operating licence was issued, with international safety standards and international practice, thereby confirming the facility is at least as safe as projected during the design phase and that it continues to be fit for safe operation;
- use the latest relevant, systematic and documented methodology based on deterministic as well as probabilistic approaches to analyses and assessments of radiation and nuclear safety;
- eliminate, at the earliest opportunity, any deviations from the design of the facility established during a Periodic Safety Review, taking into account their significance for nuclear safety;
- examine and organise knowledge of the facility and processes, as well as the complete set of technical documentation;
- identify and evaluate the significance for safety of deviations from applicable standards and international best practice;
- carry out all appropriate and reasonable modifications resulting from the Periodic Safety Review;
- carry out modifications in such a way that a written assessment of the state of each item of content is compiled, documented and supported by relevant analyses.

In keeping with the requirements, Krško NPP successfully carried out two Periodic Safety Reviews, the first in 2003 and the second in 2013. The SNSA issued decisions approving both reviews. The comprehensive safety assessments undertaken as part of the Periodic Safety Review confirmed that the power plant was safe and that it was capable of operating safely until the next review. The third

Periodic Safety Review is currently under way and will be completed in 2023.

Independent international expert reviews:
Krško NPP participates in a number of independent international expert reviews (missions), which examine in detail all aspects of safe and reliable operation of the power plant. These reviews are carried out by various organisations: IAEA (International Atomic Energy Agency), WANO (World Association of Nuclear Operators) and others.
The aim of the missions is to promote improvements concerning nuclear safety and reliability of nuclear power plants through the exchange of information between foreign experts and Krško NPP, and to promote communication and comparisons between WANO members. A comparison of own practices with global experiences and an objective assessment of operation status are directed towards achieving the highest standards of nuclear safety, availability and excellence in the operation of nuclear power plants.
The assessors examined NPP within the context of the high operational standards as defined by the nuclear industry in the field of safety culture and human behaviour, organisation and administration, improvements in efficiency and operational experience, operation, maintenance, chemistry, work process management, engineering, configuration control, nuclear fuel efficiency, equipment reliability, radiological protection, training and qualifications, fire protection, occupational health and safety, organisation and measures in the event of an emergency, and implementation of international recommendations. The observers also observe the operational shift scenarios to assess the response of operating personnel to potential unplanned events.
In the mid-1990s, analyses of selected accident scenarios that go beyond-design-basis accidents were also performed as part of the Level 2 probabilistic safety assessments for the power plant. These analyses included situations with reactor core damage and containment failure, known as severe accident analyses. These analyses provided a platform for the preparation of Severe Accident Management Guidelines (SAMG). Furthermore, equipment was inspected and some modifications were made to allow a more appropriate response both from the equipment and personnel in the event of such accidents. Some examples include: the strategy of flooding the space under the reactor vessel (wet cavity) in the event of the reactor vessel meltdown, replacement of the recirculation sump strainer in the containment and thermal insulation of the containment piping. After purchasing a simulator for operator training and preparing the SAMG, Krško NPP is also able to perform emergency preparedness drills for accidents that go beyond-design-basis accidents. The functionality of the SAMG procedures was also tested during the training exercises.
At the invitation of the SNSA, a RAMP (Review of Accident Management Programmes) mission, organised by the IAEA, was held at Krško NPP in 2001. The mission reviewed the scope and adequacy of the aforementioned analyses and the guidelines for severe accident management. The RAMP recommendations were partially implemented in the post-review period, while the remaining recommendations required additional and in-depth analyses, which were carried out by Krško NPP in the framework of the action plan for the first periodic safety review (e.g. generation, distribution of hydrogen and risk management for the case of hydrogen explosion in the containment in the event of a severe accident). As part of the action plan for the Periodic Safety Review, Krško NPP also prepared specific grounds for emergency operating procedure (EOP) instructions, and revised the set-points on the basis of analyses for these instructions. All the actions from this action plan were completed (and also reviewed and approved by the SNSA as part of various administrative procedures).
As part of the stress tests, a review of severe accident management (equipment, procedures, organisation etc.) was also carried out. Alongside the IAEA and WANO reviews in 2017 and 2019, a review of the suitability of organisation for managing accidents was also carried out. In 2018 the validation of the new SAMG on the Krško NPP simulator was successfully carried out.

Aging Management Programme (AMP):
The Aging Management Programme was drawn up as part of the Periodic Safety Review (PSR1) and with the actions that stemmed from the final report for PSR1.
Krško NPP has completed all actions from the Periodic Safety Review that referred to the plant’s lifetime

extension. In the administrative procedure, the SNSA approved those sections of the changes to the Krško NPP Safety Analysis Report (USAR) and the Krško NPP Technical Specifications (Krško NPP TS) referring to the extension of operational lifetime (SNSA decision no. 3570-6/2009/28 of 20 April 2012 and SNSA decision no. 3570-6/2009/32 of 20 June 2012), and approved the Aging Management Programme (AMP) in its entirety. The Krško NPP Aging Management Programme is based on US legislation NUREG-1801, Generic Aging Lessons Learned, Revision 2. The AMP programme therefore covers all passive and long-lived systems, structures and components. The European AMP, prepared by the IAEA (International Generic Aging Lessons Learned (IGALL) for Nuclear Power Plants), envisages that the aging programme will also address active components. Krško NPP monitors active components in accordance with the Maintenance Rule (10 CFR 50.65) and Environmental Qualification Programme (10 CFR 50.49).
The review of the aging of active components and the maintenance itself were prepared on the basis of:

- 10 CFR 50.65 – Requirements for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants, Regulatory Guide 1.160,
- "Monitoring the Effectiveness of Maintenance Rule at Nuclear Power Plants", Rev. 3 and NUMARC 93-01,
- "Industry Guideline for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants", Rev. 4A.

An important part of the AMP consisted of the time-limited aging analyses (TLAA), among which the AMP-TA-10 analysis "Update of USAR Chapters 11 and 15" should be highlighted, as it has shown that extending Krško NPP's operational lifetime does not change the existing situation or lead to new environmental hazards or burdens.
The compliance and integrity of the aging programme was reviewed in the course of a number of missions:

- 2014, WANO Peer Review mission at Krško NPP (AMP);
- 2017, IAEA OSART + LTO + PSA mission;
- 2017, active participation by Krško NPP in the preparation of the national ENSREG Topical Peer Review (TPR) on Aging Management;
- 2019, WANO Peer Review of the Krško NPP AMP.

A special aging management programme was drawn up for the dry storage project.
All missions (including the 2017 OSART mission) and the SNSA review, along with the decision issued in the procedure described above, demonstrated the compliance of the aging programme with international recommendations and the Rules on the operational safety of radiation and nuclear facilities. In addition, the Krško NPP AMP was reviewed and evaluated in 2021 as part of the IAEA pre-SALTO (Safety Aspects of Long Term Operation) mission. The pre-SALTO mission carried out a thorough review of the aging management programmes and their implementation on the basis of IAEA standards and the international best practice. The AMP will, however, be evaluated comprehensively and systematically as part of the third Periodic Safety Review (PSR3), in accordance with the programme approved by the SNSA in decision no. 3570-7/2020/22 of 23 December 2020.

<u>Key safety characteristics of the plant in 2021</u>:
All the safety modifications and upgrades listed below represent the latest state of the art at Krško NPP in its present state.

<u>Major modifications in the primary circuit</u>:

- Replacement of steam generators

The replacement of steam generators was carried out as part of the modernisation of the plant. The modernisation process comprised a number of subprojects. The first involved the design, manufacture, finishing, assembling, testing and transporting of the new steam generators, and the second dealt with safety analyses and the acquisition of permits for the replacement. The third, which was completed when the outage began, involved building a comprehensive personnel training simulator and analysing the plant's response in different situations. The replacement of the steam generators and the installation of the simulator took place in 2000.

- Introduction of a new system for measuring the temperature of the primary circuit

The temperature measurement system for the primary coolant had a bypass installed on the A and B coolant loops that was connected to the hot, cold and intermediate legs and had a total of 30 valves. Due to the difficultly of maintenance and the possibility of leaks, all valves and bypass lines were removed during the 2013 outage, while the temperature measuring sensors were installed directly in the primary coolant pipe. This solution reduces the number of operational and maintenance interventions and the risk of primary coolant leaks.

- Upgrade of reactor coolant pump motors

Both electric motors of the reactor coolant pump were renewed and upgraded. The control panel and visual indicators for monitoring bearing temperature, oil levels in bearings and motor vibrations have also been modernised. The upgrade took place in 2007 and 2010.

- Replacement of the reactor vessel closure head

In line with operational experience in the industry, the reactor vessel closure head was replaced. Materials with better corrosion-resistant properties and improved manufacturing processes ensure safer and more reliable operation of the plant. The reactor vessel closure head was replaced in 2012.

<u>Most significant modifications in the secondary circuit and electrical systems</u>:

- Replacement of low-pressure turbines

Owing to their obsolescence and the need to optimise electricity production, both low-pressure turbines were replaced. The new low-pressure turbines have a higher internal efficiency than the old turbines. The replacement took place in 2006.

- Replacement of the stator and rotor of the main generator

The modification involved the replacement of the stator part of the generator (outer and inner housing, core, winding, main connections with bushings, hydrogen coolers), stator cooling water system, hydrogen temperature control valve, local alarm panel, installation of a new hydrogen dryer and the modernisation of control instrumentation with data transfer to the main control room. Krško NPP decided to replace the rotor of the main generator, taking into account the estimate that all generator subcomponents are designed and manufactured for a 30-year operational life span under normal operation conditions and reliability. The generator rotor was replaced with a new one that has better characteristics in terms of efficiency and reliability. The stator and rotor of the main generator were replaced in 2010 and 2012 respectively.

- Replacement of the turbine regulation and protection system (turbine operating and monitoring system)

The old digital electrohydraulic system (DEH) of the turbine control system was replaced by a new programmable digital electrohydraulic system (PDEH), manufactured by the original supplier.
The installation of the new PDEH turbine operating and monitoring system also involved replacing the turbine emergency trip system (ETS), control systems for steam superheating and moisture separation, and the relocation of the operating and testing controls for twelve valves of the steam separation system from the autonomous panel to the new PDEH-system. The replacement took place in 2012.

- Replacement of the exciter, voltage regulator and main generator switch

The third project related to the upgrading of the generator system involved replacing the exciter and the voltage regulator of the main generator.
The replacement of the main generator switch was one of the upgrades of the generator system carried out to enhance the reliability of plant operation. The project involved the replacement of the main generator switch and all its associated equipment and the replacement of overvoltage protection. As the new generator switch requires neither water cooling nor compressed air to function, both the existing

compressor plant and the cooling system of the old generator switch were removed. The system was replaced in 2016.

- Refurbishment of the switchyard and replacement of the 400-kilovolt system buses

In accordance with the Agreement on Technical Aspects of Investments, the switchyard was thoroughly refurbished in cooperation with the system operator (ELES). The refurbishment began during the 2010 outage and continued during the 2012 and 2013 outages, when all the primary equipment including circuit breakers, isolators and buses, and measuring and control systems, was replaced.
Some of the 400-kilovolt buses with insulating supports and portals were replaced in the section stretching from the double fence between Krško NPP and Krško RTP (distribution substation) to the Krško NPP transformer field. The replacement of buses is the first phase of the joint project between Krško NPP and ELES to reconstruct the 400-kilovolt switchyard.

- Installation and connection of the energy transformer

Krško NPP replaced the main transformer (400 MVA rated power) with a new 500 MVA transformer. The new transformer eliminates the bottleneck in electricity distribution to the grid and restores the basic configuration of the power plant with two transformers of equal power. The replacement took place in 2013.

Most significant modifications in the tertiary circuit and subsystems:

- Extension of the cooling tower system

The design modification is the result of changes in the power plant and the environment. The cooling system of the Krško NPP tertiary circuit was improved with the introduction of carefully chosen technical solutions. Four new cooling cells (new cooling tower – CT3) were installed, and all the electrical equipment of the cooling tower system was replaced. The expansion took place in 2008.

- Reconstructions resulting from the construction of Brežice HPP

As a result of Brežice HPP, the level of the Sava at the Krško NPP site has risen by 3 m, to the level of 153.20 m a.s.l. As a result of these changed hydraulic circumstances, it was necessary to reconstruct certain systems at the Krško NPP site so that they could still operate within the existing design bases following the rise of the level of the Sava. This has made normal maintenance of the affected systems and structures possible.

- Modification to the dam’s hydraulic system

The modification encompassed all the mechanical, construction, electrical and I&C activities required at the Krško NPP dam as a result of the construction of Brežice HPP. The following activities had to be carried out in response to the hydraulic changes on the Sava upstream and downstream of Krško NPP:

Construction part:

- arrangement of access to and the surrounding area of the dam;
- expansion of the repository for outage floodgates;
- raising of the pillars of the spillways and the construction of a new bridge for the crane;
- reconstruction of the foundations of the spilling basin with an additional steel crest;
- installation of additional guides on the dam’s side walls;
- extension of the foundations of the crane tracks;
- an additional embankment to complete the plateau of the expanded repository.

Mechanical part:

- supply and installation of downstream outage segmental floodgates (six new elements);
- supply and installation of upstream outage floodgates (two new rolling segments), supply and installation of new mobile lifting frames, 2 x 100 kN for manipulating the downstream outage floodgates on the water channels using the crane track;
- supply and installation of lifting tongs for grabbing and releasing elements of the downstream

outage floodgates (they hang from the mobile lifting frame);
- supply and installation of a load transfer mobile hydraulic device for transporting the downstream outage floodgates from the mobile lifting frame to the depot for the floodgates with crane track;
- supply and installation of equipment for the repository for downstream outage floodgates, which encompasses a set of bases for installing the floodgates;
- reconstruction of the hydraulic lifting equipment of the radial floodgates, which includes electric, motor and hand-powered hydraulic units, hydraulic cylinders and piping with flexible pipes for flexible connections.

Electrics and control:
The current system for controlling and monitoring the equipment on the Krško NPP dam, which includes the regulation of the height of the Sava by taking measurements of flows and levels, was replaced by a new system. Two-way data connections with the control equipment of Brežice HPP and Krško HPP were also set up. These enable these dams and the Krško NPP dam to be controlled jointly.

- Reconstruction of the CW system (cooling water)

To ensure the power plant's normal and safe operation in the event of an increase in the level of the Sava resulting from the construction of Brežice HPP, the tertiary circulating water (CW) system also required certain reconstruction work, including:
- the installation of extra stop logs for isolating the CW inflow facilities, enabling maintenance of the coarse screens and travelling screens and CW pumps;
- the reconstruction and modernisation of CW cleaning systems – a new device for cleaning the screen racks (two new and more powerful machines);
- CW 105TSC-001 travelling screens; -006 modernisation (increased speed of movement of the screens, modification of the safety valves);
- the installation of an extra pump for flushing the screens and extra nozzles for each screen;
- replacement of the electrical cabinets and modification of the control system, upgrading of measurements of water level differences on the coarse screens and travelling screens;
- reconstruction of the CW de-icing piping to prevent the accumulation of ice in the CW;
- installation of a new pump to meet the requirements of the functioning of the de-icing system;
- modification of the nozzles on the de-icing piping (extra nozzles on the CW de-icing piping);
- renewal of the handling surfaces (platforms).

- Reconstruction on the essential supply water (SW) system

Following the construction of Brežice HPP, it also became necessary to carry out a reconstruction on the tertiary safety cooling system (SW system), which ensures cooling of the safety components. The reconstruction included:
- the installation of extra barriers and the re-qualification of the existing ones;
- modifications to the SW pumps control system;
- the installation of new working platforms;
- the upgrading or replacement of the existing sediment removal system;
- modernisation of the system for measuring the level of silt in the intake basin;
- adaptation of the system of cathode protection for underwater structures and pipelines.

- Reconstruction of the PW (filtered water system) and sanitary drain systems

Owing to the construction of Brežice HPP, it was also necessary to reconstruct the system of underwater wells, rainwater drainage and sewerage pipes:
- Underground wells: in order to keep the water table at the same level as before construction, three underground wells have been built inside the diaphragm wall, with accompanying connecting piping to the existing pretreatment building.
- Rainwater drainage system: demolition of the existing pumping station for rainwater drainage and the construction of a new one at the same location.
- Faecal sewage system:

- construction of a new gravitational discharge above the future elevation of the Brežice HPP dam at 153.50 m a.s.l.
- replacement of the two existing submersible pumps.

Other design-related modifications to improve safety:

- Improvement of the AC safety power supply – DG3

The power plant's AC safety power supply was improved by providing an alternative source in the event of the complete loss of AC power supply (station blackout, SBO). The upgrade of the safety power supply included the installation of an additional diesel generator (DG3) with a power of 4 megawatts (6.3 kV, 50 Hz, start-up time less than 10 seconds), which is connected to the MD1 or MD2 safety buses via a new 6.3-kilovolt bus (MD3). The upgrade took place in 2006 and 2013.

Krško NPP safety upgrade projects:

Following completion of the SUP, Krško NPP is prepared for any severe accident that might occur, as required by the Ionising Radiation Protection and Nuclear Safety Act and the Rules on radiation and nuclear safety factors. The SUP was reviewed and approved by the SNSA in February 2012 in decision no. 3570-11/2011/09. Krško NPP began to prepare the design output for the SUP back in 2012. The following year it filed the first applications for the implementation of the first two safety upgrade modifications (installation of a passive autocatalytic system for hydrogen recombination and the installation of a passive containment filtered venting system). These two modifications represent key solutions for severe accidents and were approved by the SNSA in October 2013.

- Phase 1 – Installation of passive autocatalytic hydrogen recombiners in the containment

The installation of passive autocatalytic hydrogen recombiners limits the concentration of explosive gases (hydrogen and carbon monoxide) in the containment in the event of a severe accident. The installed equipment does not require a power supply for its operation; it therefore works even if there is complete failure of the AC power supply to the power plant. The safety upgrade ensures the integrity of the containment in the event of a severe accident. The autocatalytic recombiners were installed in 2013.

- Phase 1 – Construction of the system for filtered venting of the containment

The installation of passive venting (relief) of the containment ensures a minimum release (less than 0.1%) of radioactive fission products of the core (with the exception of noble gases), which are released into the containment in the event of a severe accident, when the pressure in the containment rises above the design-basis level. The integrity of the containment as a barrier preventing the uncontrolled release of radioactive material into the environment is therefore preserved. A dry filter system was installed, consisting of five aerosol filters in the containment, an iodine filter in the auxiliary building, piping with a rupture disc, valves, an orifice, a nitrogen plant, a radiation monitor and the necessary instrumentation. The primary objective of the modification is to maintain the integrity of the containment by preventing it from collapsing in the event of severe accident that could result in uncontrolled pressure increase. The system was installed in 2013.

- Phase 2 – Flood safety of Krško NPP facilities

In 2012 design solutions were prepared to ensure the flood safety of Krško NPP facilities up to an elevation of 157.530 m above sea level, including in the event that the downstream and upstream embankments of the Sava collapsed. Design solutions included passive and active flood-protection elements. Passive elements include the watertight external walls of buildings, the replacement of external doors with watertight ones, and the replacement of seals on penetrations through the external walls with watertight ones. Active flood protection is ensured with the installation of water barriers and check valves on the drainage systems. The new Krško NPP flood-protection system has been designed and dimensioned so as to provide functional protection even in the event of an earthquake with a ground acceleration of 0.6 g. The project was completed in 2017.

- Phase 2 – Construction of the emergency control room

The main reason for the construction of the emergency control room was to provide an alternative control location in order to allow safe shutdown and cooling of the power plant if the main control room was evacuated and control of the status in the containment in the event of a severe accident with core damage. Construction of the control room was completed in 2019.

The new emergency control room provides an alternative location for shutdown and cooling of the power plant (if the main control room is lost); Krško NPP is therefore equal to comparable nuclear power plants in northern Europe, which built similar bunkered emergency control rooms in the 1990s. More recent nuclear power plants already have this solution integrated into their basic design.

The emergency control room has additional instrumentation installed that operates independently of the main control room and is used for control of the power plant in the event of a severe accident.

- Phase 2 – Upgrade of the technical and operating support centres

Along with the construction of the emergency control room, the new technical support centre (TPC) was also upgraded. The capacity of the existing underground shelter has been increased, while the new operational support centre (OPC) building provides conditions that allow a team of up to 200 people to work and remain there on a long-term basis, even in the event of extreme earthquakes, floods and other unlikely emergencies. In addition to extra air filters, the building has a new diesel generator that provides the centre with an independent power supply source. The upgrade was completed in 2021.

- Phase 2 – Alternative cooling of the spent fuel pool

The project included the installation of a new spray system (fixed distribution of nozzles for spraying the spent fuel pool), a pool-cooling system with a mobile heat exchanger (a new mobile heat exchanger for alternative cooling of the spent fuel pool) and a pressure relief damper in the fuel handling building (FHB). The upgrade of the system was completed in 2020.

- Phase 2 – Installation of bypass motor-operated relief valves of the primary circuit

This modification provides a flow path for the controlled relief of the primary circuit in design-extension conditions if the existing relief valves are not available. Implementing the strategy for the coordinated relief and feed of the primary circuit ensures cooling of the core, thereby preventing core damage. The design modification was completed in 2018.

- Phase 2 – Alternative cooling of the reactor cooling system and the containment

The main aim of the design modification was to install an alternative system for long-term residual heat removal. The primary function of the new system is to remove residual heat from the reactor cooling system in design-extension conditions by removing the coolant from the hot leg of the reactor cooling system, cooling via the heat exchanger and returning the coolant to the cold leg of the reactor cooling system, and removing the residual heat from the reactor cooling system by recirculating water from the containment sump back to the reactor cooling system. It is also possible to cool the containment by spraying. The design modification was completed in 2021.

- Phase 3 – Construction of the reinforced bunkered building (BB2) with additional water tanks for the removal of residual heat from the reactor

The upgrade includes the construction of a new Bunkered Building 2 (BB2) with auxiliary systems and the connection of various new systems within the new building to the existing Krško NPP systems, buildings and components. BB2 is designed to accommodate an alternative safety injection system (ASI), an alternative auxiliary feedwater system (AAF) and safety power supply to BB2. The AUHS is ensured by the construction of BB2 and the installation of the ASI and AAF systems. A building permit (nos. 35105-68/2018/8 1093 and 35105-29/2018/6 1093-04 24 July 2018) was obtained for the construction of this building and all the systems installed within it (AAF, ASI, etc.). Construction was completed in 2021.

- Phase 3 – Alternative auxiliary feedwater (AAF) system

This upgrade is part of the third phase of the SUP and includes the installation of an additional pump for filling the steam generators, including all piping and valves that allow the new system to be connected to the existing auxiliary feedwater system. The new alternative system for filling the steam generators will in design-extension conditions or in the event of the loss of existing auxiliary feedwater system, provide an alternative source of cooling water for one or both steam generators, allowing heat to be removed from the primary circuit and cooling of the reactor. The design modification was completed in 2021.

- Phase 3 – Alternative safety injection (ASI)

This upgrade, also part of the third phase of the SUP, includes the installation of an alternative safety injection system for the injection of borated water into the reactor coolant primary circuit. The system installed in the new BB2 consists of a tank containing 1,600 m^3 of borated water, a high-pressure pump and the main motor-operated valve, the accompanying piping connected to the existing Krško NPP system and the equipment to support the system operation and control. The project was completed in 2021.

- Phase 3 – Spent fuel dry storage (SFDS)

Spent fuel dry storage constitutes a technological and safety upgrade within the existing Krško NPP energy complex. In addition to the passive cooling method, better radiation safety and robustness, spent fuel dry storage also has other benefits, above all better protection against intentional and unintentional negative human influences or acts. While spent fuel dry storage is a temporary and safer form of storing spent fuel during Krško NPP operation and also after its shutdown, it is not intended to serve as a way of disposing of spent fuel permanently and finally. The dry storage is under construction and is expected to be completed in the first half of 2023. The spent fuel dry storage is located in the technological part of Krško NPP, west of the location of the present spent fuel pool.

- Phase 3 – Installation of high-temperature seals in the reactor coolant pump

The upgrade includes the installation of a new sealing insert in the reactor coolant pumps with high-temperature seals (HTS). The HTS enable the power plant to better respond to a potential loss of complete AC power supply in case of disruptions in the supply of sealing and cooling water for the reactor coolant pump seals, leading to leaking of the primary coolant. The installation of HTS therefore prevents the loss of primary coolant. The project was completed in 2021.

Existing utilities, energy and transport arrangements

The extension of Krško NPP's operational lifetime does not change the utilities, energy and transport arrangements, which remain the same as currently.

A connection to the public water supply already exists. Potable water is used for sanitary and fire safety needs (hydrants).

The cooling water and essential service water intakes are on the bank of the Sava, above the dam. This ensures sufficient water supply in all conditions. The cooling water discharge is below the dam. In the event of insufficient water in the Sava, the condensate cooling water is cooled by cooling towers with forced draft cooling cells. The developer uses water from the Sava for process purposes on the basis of partial water permit no. 35536-31/2006 of 15 October 2009, decision no. 35536-26/2011-9 of 23 May 2013 and the decision amending water permit no. 35530-7/2018-2 of 22 June 2018, which gave the developer water rights for the direct use of water for process purposes (Sava and the well on the right bank) at a maximum rate of 29,000 l/s, i.e. a maximum 915,000,000 m^3/year, and is valid until 31 August 2039.

Water permit no. 35530-100/2020-4 of 14 November 2020 (valid until 31 October 2050) was acquired in 2020 for three wells on the nuclear island. They can provide 3 x 5 l/s and a total of up to 3 x 70,000 m^3/year.

Water permit no. 35530-48/2020-3 was granted on 9 September 2021 for requirements relating to the additional filling of tanks containing borated water and demineralised water, for cleaning and testing the well pump, and for emergencies. Water is pumped from well SPW006 BB2 at the maximum rate of 8.0 l/s and no more than 230 m^3/year. Water is taken from the Sava at the location determined by the coordinates GKY=540294, GKX=88198, in cadastral municipality 1321 Leskovec, land parcel no. 1246/6.
All wastewater (communal, process, rainwater) from Krško NPP flows into the Sava via nine discharges. The developer obtained an environmental protection permit concerning emissions into waters (decision no. 35441-103/2006-24 of 30 June 2010), which was amended by decision no. 35441-103/2006-33 of 4 June 2012 and decision no. 35444-11/2013-3 of 10 October 2013.

There are several transformer stations on the site of the lifetime extension that provide electricity for users at Krško NPP and are managed by the developer.

Krško NPP is situated on the left bank of the Sava in Krško's industrial/energy zone. A local road leads up to the power plant and connects, via a bypass road, to the regional road R1 Krško–Spodnja Pohanca. The plant also has an industrial railway line that connects it to Krško station. From its junction with the future main road to the entrance to the Krško NPP site, the access road is 320 m long, is flanked by a railway line, and has parking spaces along its length. There are two car parks at the end of the access road: one measuring approx. 9,000 m^2 and the other measuring approx. 5,200 m^2.

These are the existing parking spaces:
- 37 parking spaces parallel with the access road;
- 58 parking spaces arranged at an angle of 45° to the access road;
- 368 parking spaces at the northeastern side of Krško NPP;
- 153 parking spaces on the eastern side of Krško NPP;
- new parking spaces on the sandy surface along the access road (approx. 60 parking spaces).

The facilities are heated by means of a heating plant designed for the preparation of hot water. The heating medium is saturated steam from the auxiliary steam heating system. The heat exchanger heats the water to 110°C, which is the outlet temperature. The return heating water at the inlet to the heat exchanger has a temperature of 70°C.

There is no central system for cooling the buildings in the non-technological part of Krško NPP. In principle, each building has its own cooling unit.

While operating at full power, Krško NPP requires approx. 35 MW of electricity for its own use. During poor hydrological conditions, the production process uses around 40 MW of electricity.

Krško NPP had 630 employees at the end of 2020.

The production of electricity depends on the fuel cycles – periods of uninterrupted operation at full power. These periods are followed by outages, which is when the power plant is stopped to allow the nuclear fuel to be changed (part of the spent fuel is replaced with fresh fuel), preventive equipment checks to be carried out, parts replaced, the integrity of materials verified, control tests performed and corrective measures to the existing state carried out. A fuel-replacement outage usually lasts up to 30 days. The 31st fuel cycle, which began when the power plant was connected to the grid on 28 October 2019, is an 18-month cycle.

<u>Area of impact of the lifetime extension</u>

The area in which the lifetime extension could cause an environmental burden capable of affecting human health or property is set out in the Environmental Impact Assessment Report for the Extension

of Krško NPP's Operational Lifetime From 40 to 60 Years – Nuklearna elektrarna Krško d.o.o. no. 100820-dn, October 2021, supplemented on 8 November 2021, 10 January 2022 and 5 May 2022 (following public consultation), E-NET OKOLJE d.o.o., Linhartova cesta 13, 1000 Ljubljana, Section 9 and in graphical form in Appendix 3;
During operation, the area is defined as the area within the Krško NPP perimeter fence, which covers land in cadastral municipality 1321 Leskovec, land parcel no. 1197/44.

Information on the presence of protection, protected, degraded and other areas

The wider area of the lifetime extension is not at risk from erosion, and, since it lies on flat land, is also not in an area at risk of a landslide.
The Krško NPP area is located on the Vrbina floodplain, which is the transition point between the eastern edge of Krško Polje and the western edge of Brežiško Polje. According to the flood-warning map (source: Environment Atlas), rare and catastrophic floods do not occur in the area around the plant, although they may occur north, east, and south of its perimeter. According to the flood map (iKRPN), the entire riverbed of the Sava, which runs parallel to the southern boundary of the Krško NPP area, is classed as an area at high risk of flooding.
The site of the lifetime extension is located away from areas protected by regulations governing nature preservation and cultural heritage conservation, and areas where it could affect them. The far southern part encroaches on the second water protection zone on the right bank.
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 Krško NPP does not cause excessive noise for the nearby residential buildings.
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 most recent measurements taken in 2021 showed that, despite the presence of low-frequency sources of electromagnetic radiation from Krško NPP operations, the area did not have excessive amounts of radiation and, moreover, that these sources were too far away to have an impact on nearby residential areas.
When operating, the emissions from Krško NPP's ventilation system release radioactive materials into the air. The dose resulting from the total annual activity of emitted noble gases for 2020 amounted to approx. 0.012% of the annual limit, which was similar to 2019 and to previous years.
The chemical status of the Sava at the Sava Krško–Vrbina water body 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. Krško NPP does not place an excessive burden on 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 strontium activity in other Slovenian rivers are similar to or higher than those measured in the Sava in the vicinity of Krško NPP. The naturally occurring radionuclides of the uranium (U-238, Ra-226 and Pb-210) and thorium (Ra-228 and Th-228) decay series have been detected on a regular basis in all water samples. The values were similar to those measured in other Slovenian rivers.
In 2020 all the radioactive effects of Krško NPP at the perimeter fence (the estimate is approximately valid at a distance of 500 m from the middle of the reactor as well) and 350 m downstream of the Krško NPP dam were estimated to be less than 0.071 µSv annually on the nearby population.
The estimated value is small in comparison with the authorised dose limit for the population in the vicinity of Krško NPP (the effective dose of 50 µSv annually at a distance of 500 m and more for contributions via all exposure pathways). The estimated value of the radioactive impacts from Krško NPP along the perimeter fence is approx. 0.0029% of the typical, unavoidable natural background. The estimate also approximately applies at a distance of 500 m from the reactor shaft.

Environmental characteristics of the existing situation and the lifetime extension

Use/consumption of natural resources

Krško NPP uses the natural resource of water (potable water from the public water network, water from the wells and river water from the Sava for process purposes). Potable water is used for sanitary and fire protection purposes, while the river and well water are used for process purposes. The planned lifetime extension will not lead to an increase in water consumption,

and will not take place on agricultural land. The lifetime extension will not reduce the size of the area containing the best or other agricultural land.

The mining of mineral deposits is not a planned as part of the lifetime extension. The planned lifetime extension is not expected to lead to deforestation or to arrangements that could potentially affect forest functions.

If the plant ceases operation, there will be a considerable reduction in the use/consumption of natural resources. The spent fuel pool and a number of other safety components will still have to be cooled. Water will be withdrawn from and returned to the Sava at the rate of approx. 1.6 m^3/s.

By-products and by-product management

No by-products will result from the lifetime extension.

Impact on soil

The extension of Krško NPP’s operational lifetime will not require any additional construction work, nor will there be any interventions in or on the soil. The lifetime extension will not change the manner in which wastewater is discharged. There will be no emissions of pollutants into the soil during operation, as all wastewater from Krško NPP is already being discharged into the Sava after appropriate treatment. All waste is appropriately stored and does not present a danger of soil contamination. There will be no emissions of soil pollutants when operations at Krško NPP are terminated.

Impact on flood safety

Extending Krško NPP’s operational lifetime will not have any effect on the flood safety of the buildings. Flood protection was already provided when the power plant was being planned and with the construction of embankments along the Sava, upstream and downstream of the plant. The entrances and openings in the buildings are built above the elevation that could be reached by 10,000-year floods. The power plant is safe in the event of a design-basis flood, even without a protective embankment. After Krško NPP ceases operating, there will be no impact on the flood safety of the nuclear facility or of the area, as the structures and flood-protection embankments in that area will remain in the same condition as they were during operation.

Impacts of emissions of substances into the atmosphere

Krško NPP is responsible for negligible emissions into the atmosphere. 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. Lifetime extension will not give rise to any new emissions of SO_2, NOx and PM_{10} 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 atmospheric dispersion. The power plant has an indirect positive effect on air quality because it produces electricity in such a way that it avoids the emissions produced in plants that run on fossil fuels.

The operation of the cooling towers releases heat into the air, together with droplets and damp air. In certain conditions, this leads to the formation of a visible plume of steam. The effect of the cooling towers, which is local in nature, depends to a large extent on the weather conditions around the tower. Owing to climate change, the power plant will in future probably use the cooling towers to an even greater degree in order to keep the thermal load on the Sava within ΔT 3°C. The magnitude of the effect will remain within the existing limits, the only difference being that the impact could last longer.

After Krško NPP ceases operating, pollutants will temporarily be released into the air from the auxiliary boiler room, which will be used as heating premises and for safety purposes (to prevent freezing). As heat will no longer be needed to generate supplementary steam, the total quantity of fuel used will be reduced. Temporary emissions will occur as a result of the testing of the diesel generators, which will remain on site as an emergency source of electricity.

Impact on the climate, including from greenhouse gas emissions

Nuclear power plants do not generate greenhouse gas emissions when they produce electricity. Instead, emissions are generated by on-site ancillary activities: three diesel generators for the emergency supply of electricity, auxiliary steam boilers, on-site transport and SF6 greenhouse gases. Following lifetime extension, the plant will generate approximately the same annual emissions as currently. Total greenhouse gas emissions for the 2024–2043 period could reach approx. 23.46 kt CO_2-eq. This is negligible relative to national emissions (0.13% of total national emissions in 2018 and 0.28% of all emissions from the electricity and heat generation sector). Extending Krško NPP's operational lifetime will also have a positive impact by contributing to the reduction of greenhouse gas emissions relative to other electricity-generating technologies.

There will be no major emissions of greenhouse gases when operations at Krško NPP are terminated.

Radiation impacts – ionising radiation

The estimate of the impact of ionising radiation on the existing situation is taken from the "Monitoring of radioactivity in the vicinity of Krško NPP – Report for 2020" document (Jožef Stefan Institute, IJS-DP-13463, April 2021).

Liquid effluents in 2020

When Krško NPP is in operation, environmental concentrations of discharged radionuclide activity (with the exception of H-3) are significantly below the limits of detection, or else it is difficult to separate any contribution made by these radionuclides from the background (C-14, Cs-137). Their impact on human beings and the environment is therefore evaluated indirectly from data on discharges into the atmosphere and liquid effluents. Public exposure is assessed using models that describe the spread of radionuclides via various pathways in the environment.

The model calculation, which is based on liquid effluents and data on the annual flow of the Sava, and takes into account the characteristics of the reference group (i.e. fishermen who fish in the reservoir up to 350 m downstream of the Krško NPP dam, spend considerable amounts of time on the bank and consume fish from the river), has shown that the effective dose for an adult from discharges into the Sava was 0.006 μSv per year (time spent on the bank and the consumption of fish) in Brežice in 2020. The calculated annual effective dose for an adult 350 m from the Krško NPP dam is 0.014 μSv. If the average habits of the reference person were taken into account, the effective dose received would be several times lower. H-3 accounts for the biggest single share of the total effective dose (44%), with the predominant exposure pathway being the consumption of fish. Spending time on the bank accounts for most of the total dose load from discharges of Co-60 and Co-58. H-3 would contribute the most to the dose load from the consumption of Sava water (100%), which is an unlikely exposure pathway into the human body. The construction of the Brežice hydropower plant and creation of the reservoir led to changes in the methods and pathways of public exposure. The estimate of the effects of discharged radionuclides is based on old assumptions and does not take into account all the hydraulic parameters and the configuration of the Sava channel, such as mixing at the dam, the uncertainty of flows, and the swelling of the Sava downstream into the groundwater (before the construction of the Brežice HPP reservoir). A study is being drafted that will result in a new model that reflects the current situation. It will also be used to calculate doses along this pathway and serve as a starting point for any alterations to the monitoring programme.

The highest estimated annual effective dose in the surrounding area of Krško NPP in 2020 due to drinking water from the water supply system on the Krško Polje/Brežiško Polje was calculated at the Brege pumping station (4.5 μSv for an adult reference person, 6.4 μSv for children and 26.9 μSv for infants). Practically all the load derives from naturally occurring radionuclides, Artificial radionuclides contribute a maximum of 1.2% to the load, primarily as a result of global contamination rather than Krško NPP operations. This percentage is even smaller for children and infants. In comparison with the

other two pumping stations and with the Ljubljana water supply system, the impact of naturally occurring radionuclides is highest for Brege. There is a direct link at this pumping station between the surface and the groundwater in the case of the use of chemical agents in agriculture, as the measurements contained in the “Report on the quality of drinking water in the public water supply systems and on the discharge and treatment of wastewater in the Municipalities of Krško and Kostanjevica na Krki in 2019” (Kostak, Krško, March 2020). The higher concentration of naturally occurring radionuclides (potassium K-40) in water, which is around three times higher for Brege than for Rore, is also evidence of this.
The estimated annual effective doses from artificial radionuclides in drinking water in the Brežice and Krško water supply system are far below the authorised dose limit (50 µSv), while the activity concentrations are below the derived activity concentration limits calculated by taking into account the fact that the value of the effective dose limit is 100 µSv per year.

Atmospheric releases in 2020

Effective dose from emissions monitoring

When calculating doses, several conservative assumptions were made with regard to weather conditions (least favourable annual dilution factor per wind direction), level of discharge (ground discharge) and the permanent presence of an imaginary person at a distance of 500 m. The purpose of this calculation is to make a comparison with the administrative dose limit in the immediate vicinity of the power plant, not to ascertain the actual irradiation of the population, which is (understandably) significantly lower.
Given that the emission of the more typical fission products is negligible, the contributions of H-3 and C-14 (as C_xH_y) were more significant in relative terms, accounting for 93% of the total dose. The contribution made by discharged noble gases was 7% of the total dose, while other radionuclides were less important.
The dose is calculated for radiation from the cloud of noble gases and for internal irradiation resulting from the inhalation of other radionuclides. The effective dose is calculated by using the Lagrange model of annual dispersion for ground discharge, and amounts to 0.45 µSv at a distance of 500 m from the reactor shaft.

Effective dose from emissions monitoring

The following groups of radionuclides are considered when the impact of atmospheric discharges is being evaluated:

- noble gases that are exclusively significant with regard to external exposure during cloud passage;
- pure beta emitters, such as H-3 and C-14, that are biologically significant only in the case of entry into the organism via inhalation (H-3, C-14) and ingestion (C-14);
- beta/gamma emitters in aerosols (isotopes of Co, Cs, Sr, etc.) via pathways: inhalation, external radiation from deposition, ingestion of radionuclides deposited on plants;
- isotopes of iodine in various physical and chemical forms, significant in the case of inhalation during cloud passage and as a result of intake into the body with milk.

Tables 1 and 2 below provide an evaluation of atmospheric emissions using a model calculation of the dilution coefficients in the atmosphere for 2020 and for individual groups of radionuclides by most important exposure pathway for the adult population of Spodnji Stari Grad, which is the nearest settlement to the exclusion zone (Table 3), and at the Krško NPP perimeter. The estimates also apply in approximate terms at a distance of 500 m from the reactor shaft (Table 4). There is a limit applying to additional public exposure at the edge of the exclusion zone (500 m from the reactor shaft). Furthermore, the total annual effective dose of the contributions from all exposure pathways may not exceed 50 µSv per individual. The tables show that contributions to the annual effective dose for an adult are 0.0079 µSv at the Krško NPP perimeter and 0.0066 µSv in Spodnji Stari Grad.
The dilution factors for external radiation from cloud and inhalation have been assessed with the Lagrange model since 2007. This model includes the characteristics of the terrain in the vicinity of Krško NPP and a larger set of meteorological variables. The model uses all the measured data in the EIS

ecological information system managed by Krško NPP. For emissions, this is the flow of gases from the main Krško NPP exhaust. The model also requires the speed of the discharged gases and the cross-section of the exhaust stack. A temperature of 25°C was determined as the temperature of the flue gases. The contribution made by radiation from deposition was, until 2010, further estimated using the Gaussian model, with consideration given to ground discharge. The atmospheric immersion estimate in 2020 is comparable to that of previous years in terms of data scatter.

Table 1: Public exposure to radiation of adults in Spodnji Stari Grad resulting from atmospheric discharges from Krško NPP in 2020

Method of exposure	Exposure pathway	Most significant radionuclides	Annual dose (mSv)
External radiation	Inversion (cloud), radiation from deposition	noble gases (Ar-41, isotopes of Xe) aerosols (isotopes of I and Co, Cs-137)	$3.6E^{-7}$ $7.2E^{-16}$
Inhalation	Cloud	H-3, C-14, I-131, I-132, I-133	$6.3E^{-6}$
Ingestion	Plant-based food	C-14	0[21]

[21]The result is below the measurement uncertainty.

Table 2: Public exposure to radiation (adults) at the Krško NPP perimeter resulting from atmospheric discharges from the plant in 2020

Method of exposure	Exposure pathway	Most significant radionuclides	Annual dose (mSv)
External radiation	Inversion (cloud), radiation from deposition	noble gases (Ar-41, isotopes of Xe) aerosols (isotopes of I and Co, Cs-137)	$5.6E^{-7}$ $4.7E^{-15}$
Inhalation	Cloud	H-3, C-14, I-131, I-132, I-133	$7.3E^{-6}$
Ingestion	Plant-based food	C-14	$5.0\ E^{-5}$

C-14 measurements were conducted on samples of wheat and corn at the Jožef Stefan Institute in 2020. The measurement results show the expected slight increase in the specific activity of C-14 in samples at a distance of up to 1 km from the reactor shaft relative to the samples taken at the reference point in Dobova. The estimated annual effective dose from the ingestion of C-14 is therefore $5E^{-5}$ mSv higher in the vicinity of Krško NPP (up to 1 km from the plant) than at the control point in Dobova. When calculating the C-14 dose received in the vicinity of Krško NPP, the conservative assumption was made that local residents consumed food from the immediate vicinity of the plant (close to the edge of the exclusion zone) two months a year and food from elsewhere (Dobova) for the other ten months. In the case of the calculation of the C-14 dose as well, due regard is paid to the fact that residents consume food produced in the Krško/Brežice area (from the Krško NPP perimeter to Dobova).
The difference between the calculation of the C-14 dose and the dose received from the entry of other radionuclides into food lies in the fact that a weighted average of the specific activity of C-14 is taken into account with respect to the sampling location. This is not possible for other radionuclides because of the different sampling methods involved. The C-14 dose relates to food and not to a specific type of food, as the specific activity of C-14 (in Bq per kg of carbon) does not differ according to type of food. The ratio between the C-14 and C-12 isotopes is constant in all organisms and reflects the ratio between the two isotopes in the atmosphere. In the case of artificial C-14 discharges, the ratio between the C-14 and C-12 isotopes may change in the atmosphere as well as in organisms, as C-14 isotopes replace C-12 isotopes in organic molecules.

Natural radiation

Measurements of external radiation in the vicinity of Krško NPP in 2020 confirmed previous findings, i.e. that it was a typical natural environment such as is found elsewhere in Slovenia and around the world. The annual dose equivalent H*(10) of gamma radiation and the ionising component of cosmic radiation in the vicinity of Krško NPP was, on average, 0.90 mSv outdoors. This is higher than the estimated annual effective dose for indoor premises of 0.83 mSv (1998). To this it is necessary to add the contribution of H*(10) neutron cosmic radiation, which is 0.07 mSv per year for the Krško NPP area. The total effective dose of natural external radiation H*(10) in 2020 in the vicinity of Krško NPP was therefore 0.97 mSv per year. The relevant annual effective dose (taking into account the conversion factors from the Radiation Protection 106 publication) is 0.81 mSv per year, which is lower than the global average of 0.87 mSv per year.

As the specific activity of naturally occurring radionuclides in food is comparable with average values around the world, we take the conclusions from UNSCEAR for the effective dose from food intake (UNITED NATIONS, Sources and effects of Ionizing Radiation, Report to the General Assembly with Scientific Annexes, United Nations Scientific Committee on the Effects of Atomic Radiation, UNSCEAR, YN, New York, 2000).

Individual contributions to the natural radiation dose are shown in Table C of the original document. The total annual effective dose is estimated at 2.39 mSv, which is comparable with previous years in terms of value scatter, as well as with the global average of 2.4 mSv per year.

Naturally occurring radionuclides in 2020

The measured activity of naturally occurring radionuclides (uranium and thorium chain, K-40, Be-7) does not differ markedly from the values measured at other locations in Slovenia or the values set out in the literature. This applies to the Sava, groundwater, water supply system and sediment, as well as to air and food. It is also the case that the values are comparable with those of previous years.

Chernobyl contamination, nuclear test explosions and the Fukushima accident (2020)

In 2020, as in previous years, the anthropogenic radionuclides Cs-137 and Sr-90, which originate from the Chernobyl disaster and from nuclear test explosions, are still measurable in the soil. There was no detectable impact in 2020 from the radionuclides discharged into the atmosphere after the accident at the Fukushima nuclear plant in Japan in 2011.

The contribution of Cs-137 to external radiation was estimated at less than 0.017 mSv per year, which is 2.5% of the average annual external dose from natural radiation in the vicinity of Krško NPP. The estimate is comparable with the estimates of previous years.

The predicted effective dose resulting from the inhalation of radionuclides that are the consequence of general contamination (Cs-137 and Sr-90) is estimated at $2.7E^{-7}$ mSv per year for an adult individual.

Traces of Cs-137 and Sr-90 from nuclear tests and the Chernobyl disaster were measured in individual types of food. In 2020 the effective dose as a result of eating such food was estimated to be 3 E–4 mSv per year for Cs-137 and 1.3 E–3 mSv per year for Sr-90, which is a total of around 0.8% of the annual effective dose from naturally occurring radionuclides (excluding K-40) in food. The estimated dose is comparable to the figures from previous years.

The greatest contribution to the annual effective dose comes from C-14 that arrives in the food chain via natural exposure pathways and as a result of the above-ground nuclear tests that took place in the 1960s.

Comparison with previous years (2020)

Table 5 shows the individual contributions to the annual effective dose from Krško NPP emissions between 2016 and 2020 as they apply to an adult at the perimeter of the plant. The estimates also approximately apply at a distance of 500 m from the reactor shaft. The exception is the dose from external irradiation, which is measured by TLDs. During the construction of Krško NPP, the top layer of earth was removed and gravel strewn on the surface. As a result, the average annual environmental dose equivalent in the vicinity of the plant is 40% higher than that recorded at the perimeter. Consequently, the average environmental dose equivalent for the area surrounding Krško NPP is given.

Table 3: Summary of annual exposures of the population in the vicinity of Krško NPP 2016–2020

		Annual effective dose E (mSv)				
Source	Exposure pathway	2020	2019	2018	2017	2016
Natural radiation	Gamma and ionising cosmic radiation Cosmic neutrons Ingestion (K, U, Th)	0.76** 0.06 0.27	0.64** 0.08 0.27	0.70** 0.09 0.27	0.69** 0.08 0.27	0.68** 0.1 0.27
	Inhalation (short-lived progeny of Rn-222)	1.30	1.30	1.30	1.30	1.30
	Total natural radiation	2.39	2.29	2.36	2.34	2.35
Krško NPP direct radiation along the perimeter	Direct radiation from Krško NPP facilities	indeterminable	indeterminable	indeterminable	indeterminable	Indeterminable
Krško NPP	External radiation from cloud	$5.6E^{-7}$	$1.2E^{-6}$	$9.4E^{-7}$	$7.1E^{-7}$	$6.9E^{-7}$
Atmospheric discharges* (at the Krško NPP perimeter)****	External radiation from deposition (isotopes of I and Co, Cs-137) Inhalation from cloud (H-3, C-14) Ingestion (C-14)	$4.7\ E^{-15}$ $7.3E^{-6}$ $5.0\ E^{-5}$	$2.7E^{-12}$ $1.6E^{-5}$ $8.0E^{-5}$	$2.1E^{-12}$ $3.0E^{-5}$ $8.0E^{-5}$	$1.2E^{-12}$ $2.4E^{-5}$ $1.0E^{-4}$	$5.8E^{-12}$ $1.3E^{-5}$ $1.0E^{-4}$
Krško NPP liquid effluents (Sava)	Reference group (350 m below Krško NPP dam) Adult, Brežice	$1.4\ E^{-5}$ $6.3\ E^{-6}$	$1.2E^{-5}$ $5.4E^{-6}$	$8.0E^{-6}$ $4.0E^{-6}$	$8.0E^{-6}$ $4.0E^{-6}$	$2.7E^{-4}$ $1.3E^{-4}$
Chernobyl contamination Nuclear tests	External radiation** Ingestion of plant and animal food (excluding C-14) Ingestion of plant-based food (C-14) Ingestion of fish	$<1.7E^{-2***}$ $1.6\ E^{-3}$ $1.5\ E^{-2}$ $8.9\ E^{-5}$	$<1.3E^{-2***}$ $1.0E^{-3}$ $1.5E^{-2}$ $1.4E^{-4}$	$<2.3E^{-2***}$ $1.5E^{-3}$ $1.5E^{-2}$ $7.5E^{-4}$	$<3.3E^{-2***}$ $1.4E^{-3}$ $1.5E^{-2}$ $1.1E^{-3}$	$<4.0E^{-2***}$ Ingestion total: $1.4E^{-3}$

* The totals for Krško NPP contributions are not stated, since contributions are not all additive in that they do not relate to the same groups of the population.
** Estimate of the effective dose of external radiation from environmental dose equivalent of dose H*(10), taking into account conversion factor E/H*(10) = 0.84 for 600 keV photons (Radiation Protection 106, EC, 1999).
*** This estimate does not take into account the fact that the population spends about 20% of its time outdoors and that the indoor radiation shield factor is 0.1. This is a conservative estimate.
**** The estimate also approximately applies at a distance of 500 m from the reactor shaft.

When we add the values for atmospheric and liquid effluents, we find that the impact of the monitored discharges from Krško NPP on the population is significantly below the authorised dose limit. One should emphasise at this point that different population groups are involved, and that the total value is therefore only a rough estimate of the annual effective dose.

An analysis of the estimate annual effective doses received by reference groups from Krško NPP emissions shows that the total value fell between 2005 and 2011. Since 2012 the annual effective dose per individual at the perimeter of the plant (the estimates also apply approximately to a distance of 500 m from the reactor shaft) has been slightly higher as a result of the impact of C-14 on the food chain during the growing period and changes to the assumptions within the dose calculation. However, it still remains two orders of magnitude below the authorised dose limit. We observed an increase in the annual effective dose in 2013 and 2014. However, this can be attributed exclusively to the contribution of C-14 to liquid effluents, something that had not been taken into account in previous years.
The value for 2020 is the second lowest of the last 31 years (the lowest was in 2010). These low values can be attributed to the small controlled releases from Krško NPP (high-quality fuel) and the fact that no regular outage took place in 2020. When comparing the contributions in individual years, one should also take into account the fact that, since 2007, calculations of external radiation from cloud and inhalation have used the Lagrange model, which can give a lower exposure value, and that the values of the contribution to the dose made by the ingestion of C-14 (from atmospheric discharges) were, up until 2006, estimated on the basis of discharges and data from similar power plants.
We are therefore able to say that the radiation effects of Krško NPP are several orders of magnitude lower than global contamination and the effects of the use of radionuclides in medicine. The estimated value of the radiation effects (annual effective doses) of Krško NPP on the population at the perimeter of the plant (and approximately 500 m from the reactor shaft) is approx. 0.003% of the typical, unavoidable natural background.
Measurements were taken in the vicinity of Krško NPP of other radionuclides that are mostly a part of global contamination (C-14, Sr-90, Cs-137) or of use in medicine (I-131), or are of cosmogenic origin (H-3, C-14). The contributions to the annual effective dose are collected, by medium for all artificial radionuclides received by the population (adults) from the closest settlements or reference locations, in Table 5, with a comparison with previous years also provided. In 2020 the largest contribution from external radiation came from the presence of Cs-137 in the soil (global contamination). The second largest contribution came from C-14 in food. We can also say that the total contributions are falling year by year, with reduced estimates of Cs-137 radiation in the soil making the biggest contribution to this fall. It is also found that all methods of public exposure were negligible in comparison with natural radiation, dose limits and authorised dose limits.

Conclusions – 2020

A summary of public exposure in the area around Krško NPP for 2020 is given in Table 5, which shows the contributions of natural radiation, the impacts of Krško NPP at the perimeter, and the residual impacts of Chernobyl contamination and nuclear test explosions:

- in 2020 all the radioactive effects of Krško NPP at the plant perimeter (the estimate is approximately valid also at a distance of 500 m from the reactor shaft) and 350 m downstream of the Krško NPP dam were estimated to be less than $7.14E^{-5}$ mSv a year;
- the estimated value of the radiation effects from Krško NPP along the plant perimeter is approx. 0.003% of the typical, unavoidable natural background. The estimate also approximately applies at a distance of 500 m from the reactor shaft;
- the estimated value is small in comparison with the authorised dose limit for the population in the vicinity of Krško NPP (the effective dose of 50 µSv annually at a distance of 500 m and more for contributions via all exposure pathways);
- the sum total of all radiation effect contributions was the second lowest of the last 31 years. We can attribute these low values to the small controlled discharges from Krško NPP (high-quality fuel) and the fact that no regular outage took place in 2020. Credit for the low impact of the plant should also go to its employees, who are careful to control and limit discharges;
- the consumption of food (86.9%), leading to the intake of C-14, accounts for the biggest contribution to the total effective dose;
- the effective dose from inhalation accounts for 10.2% of the total effective dose. With regard to

radionuclides, the biggest contribution comes from H-3;
- the effective dose from external radiation accounts for 2.9% of the total effective dose. Regarding radionuclides, the most significant contribution comes from Co-60; ¬ the sum of effective dose contributions calculated from the measurements of samples from the environment is falling year by year, with reduced Cs-137 radiation in the soil making the biggest contribution to this fall. This is a remnant of the atmospheric and precipitation depositions following the Chernobyl nuclear reactor disaster in 1986.

If the operational lifetime is extended, emissions of radioactive material into the environment will be equal to the existing total. Krško NPP is continuously upgrading and improving its safety and process systems, which means that the burden on the environment is constantly decreasing. The estimated annual effective dose to an individual most affected by Krško NPP's impacts in 2020 was less than 0.1 µSv (0.071 µSv). Compared to the annual effective dose from natural background radiation in Slovenia, which amounts to approx. 2,500 µSv, Krško NPP's contribution is negligible, as well as being several 100 times lower than the 50 µSv dose limit.
When the spent fuel dry storage starts operating, the dose at the Krško NPP perimeter near the storage facility will increase. However, the annual dose at the Krško NPP perimeter following the storage of spent fuel will not exceed the 200 µSv limit (RETS 3.11.7).
The dose rate on the outside wall of the spent fuel dry storage building will not exceed the limit of 3 µSv/h, as defined in point 3.2.b.2.1 of specification SP-ES5104 or the fourth point of the first paragraph of Article 4 of the Rules on radiation protection measures in controlled and monitored areas (SV8A, Official Gazette of RS, No. 47/18), which defines the limit average dose rate within eight hours for controlled areas. The surroundings of the spent fuel dry storage therefore do not need to be declared a controlled area.

Regarding the measures below as set out in the EIA Report and stemming from the operating licence (decision/approval to commence Krško NPP operation, National Energy Inspectorate decision no. 31-04/83-5 of 6 February 1984 and SNSA decision no. 3570-8/2012/5, amendment to Krško NPP's operating licence of 22 April 2013), the ministry explains that they are not laid down in the operative part of the environmental protection consent because the developer is required to implement them by the provisions already referred to:
- annual dose limit for external radiation at the Krško NPP perimeter: 200 µSv;
- maximum permissible annual effective dose from emissions of radioactive material 500 m from the centre of the reactor: 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.

The developer is already carrying out the following measures, and will continue to do so during the period of the lifetime extension:
- 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;
- adequate design and implementation of structural protection (adequate wall thickness, labyrinth design of rooms);
- the 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 dedicated facilities designed for this purpose.

Similarly, the ministry has not used the operative part of this environmental protection consent to determine the measures envisaged for the operation of the spent fuel dry storage, as these measures are included in building permit no. 35105-25/2020/57 of 23 December 2020 granted by the Ministry of the Environment and Spatial Planning, Spatial Planning, Construction and Housing Directorate, Dunajska c. 48, 1000 Ljubljana for a facility with environmental impact, i.e. the spent fuel dry storage at the Krško NPP site.

After Krško NPP ceases operating, nuclear fuel will no longer be in the reactor, but stored safely in the spent fuel pool and/or in spent fuel dry storage.

Ionising radiation from dry storage will be present at the Krško NPP perimeter, while the gaseous and liquid effluents will be considerably smaller or completely non-existent. All protective measures to prevent the impact of ionising radiation on the environment will therefore have to be taken.

Impact of waste

Radioactive waste:

Table 4 shows the quantity of low- and intermediate-level waste (LILW) as on 31 December 2020:

Table 4: Inventory of processed LILW located in the storage building – on 31 December 2020[5]

Type of waste	Designation	No. of packages	Gamma activity (Bq)*	Alpha activity (Bq)*	Volume (m^3)
Incineration products	A	[1]70	$5.14 \cdot 10^{9}$	$1.14 \cdot 10^{8}$	14.6
Dried spent ion-exchange resins from the secondary cycle	BR	[2]1	$8.80 \cdot 10^{8}$	$1.33 \cdot 10^{6}$	0.2
Compressible waste	CW	[3]7	$1.95 \cdot 10^{8}$	$3.34 \cdot 10^{5}$	1.5
Dried evaporator concentrate	DC	9	$1.75 \cdot 10^{9}$	$1.70 \cdot 10^{5}$	1.8
Dried sediments	DS	1	$3.39 \cdot 10^{7}$	$6.30 \cdot 10^{3}$	0.2
Evaporator concentrate	EB	2	$2.28 \cdot 10^{8}$	$1.19 \cdot 10^{5}$	0.4
Spent filters	F	117	$1.10 \cdot 10^{11}$	$4.74 \cdot 10^{7}$	24.3
Other waste	O	[4]7	$3.56 \cdot 10^{8}$	$1.28 \cdot 10^{6}$	1.5
Dried spent ion-exchange resins from the primary cycle	PR	1	$1.43 \cdot 10^{10}$	$9.69 \cdot 10^{6}$	0.15
Compressed waste 1988, 1989	SC	617	$1.29 \cdot 10^{10}$	$2.09 \cdot 10^{8}$	197.4
Spent ion exchangers	SR	689	$1.87 \cdot 10^{12}$	$3.75 \cdot 10^{9}$	143.3
TTCs containing compressed waste from 1994 and 1995, and pressings from ongoing supercompaction (2006, 2007, 2008, 2010, 2011, 2012, 2013 and 2014).	ST	1,853	$5.32 \cdot 10^{11}$	$6.73 \cdot 10^{8}$	1,601.0
TTCs into which standard non-compacted drums are inserted	TI	364	$1.23 \cdot 10^{13}$	$1.93 \cdot 10^{10}$	316.2
Total		3,738	$1.49 \cdot 10^{13}$	$2.41 \cdot 10^{10}$	2,302.6

* Alpha activity is determined on the basis of activity ratios of alpha emitters and radionuclide 137-Cs, as was found in the reference samples.

[1] An additional 19 packages located in the decontamination building will be relocated to the Krško NPP LILW storage facility (4.0 m^3).

[2] An additional 53 packages located in the decontamination building ready for incineration (10.6 m^3).

[3] An additional 393 packages located in the WMB and DB, ready to be sent for incineration (81.7 m^3).

[4] An additional 28 packages located in the WMB prior to measurement and storage in the RWSB (5.8 m^3).

[5] An additional 80 ingots located in the decontamination building (8.8 m^3).

At the 13th meeting of the Intergovernmental Commission for Monitoring the Execution of the Treaty between the Government of the Republic of Slovenia and the Government of the Republic of Croatia on the Regulation of Status and Other Legal Relations Regarding Investment in and the Exploitation and Decommissioning of Krško Nuclear Power Plant (MDP) held on 30 September 2019, a decision was made, based on the report from the Coordination Committee, that a joint solution for the LILW waste repository was not possible. The total quantities of LILW to be shared between the Slovenian and Croatian parties, determined on the basis of the waste inventory in the Krško NPP storage facility and the estimates of future LILW generation during Krško NPP operation and decommissioning, are shown in Table 5:

Table 5: Total quantity of LILW to be shared between the Slovenian and Croatian parties.

Period of LILW generation	Source of data	Mass (t)	Volume (m^3)	Activity (Bq)[6]
1983–2018[7]	Inventory	4,877.4	2,294.9	5.98 E^{13}
2018–2023	Estimate	264	163.4	1.44 E^{13}
Total by 2023	Estimate	5,141.4	2,458.3	7.42 E^{13}
2024–2043	Estimate	883.7	546.6	4.83 E^{13}
Decommissioning of Krško NPP	PO3[8]	2,860	2,842	/
Decommissioning of spent fuel dry storage	PO3	392	407	/

[6] Value excluding radioactive decay.
[7] Until 2020, some of the waste was further processed.
[8] Third Revision of the Krško NPP Radioactive Waste and Spent Fuel Disposal Programme, Version 1.3, September 2019, Agency for Radwaste Management (ARAO), Ljubljana, Fund for Financing the Decommissioning of Krško NPP, Zagreb (PO3), Table 4-17.

Each party will manage its half of LILW in accordance with national radioactive waste management strategies and programmes.

Under the baseline scenario, the Slovenian half of the waste should be disposed in Vrbina in two phases: in the first phase, from 2023 to 2025, disposal of the currently stored LILW from Krško NPP operation and other sources; in the second phase, from 2050 to 2058, disposal of the remaining LILW from Krško NPP operation together with the LILW from decommissioning, at which time the procedures for the final closure of the repository will also be initiated. The LILW from other sources refers to the LILW that meets the acceptance criteria for waste disposal and originates from the central radioactive waste storage facility.

The Croatian scenario envisages that the Croatian half of the operational LILW will be transported to Croatia to the radioactive waste management centre (CRAO), which will be built in compliance with the Strategy. The most-favoured location for the radioactive waste management centre is Čerkezovac, which is home to a military logistics complex that the army does not intend to use in the future. Čerkezovac is located in the municipality of Dvor on the southern slopes of the Trgovska Gora massif.

Spent fuel:

All spent fuel at Krško NPP is currently stored in the spent fuel pool, where 1,694 cells are available in storage racks. A total of 1,323 fuel elements were being stored in the spent fuel pool at the end of 2020, including two special containers with fuel rods and a fission chamber from 2017. The spent fuel elements will be relocated from the spent fuel pool to storage over four relocation campaigns: Campaign I (2023, 592 fuel elements), Campaign II (2028, 592 fuel elements), Campaign III (2038, 444 fuel elements), Campaign IV (2048, remaining fuel elements).

Management of other waste:

There are around 36 existing types of waste (2020) that are generated in all production and support processes, 19 of which are hazardous types of waste. 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 approx. 12.3 tonnes. All waste, except for radioactive waste, is handed over for treatment to a contractor (Krško NPP does not treat this other waste). Waste is separated by type at the source, while waste is stored temporarily in accordance with valid regulations. A closed area is used for the temporary storage of hazardous waste. Waste is removed regularly. Continuous records are kept of the quantities of hazardous waste in temporary storage. The company continuously implements various technical and organisational measures to reduce the quantities of generated waste and to improve its management, i.e. improved waste separation at the source. Krško NPP also holds an ISO 14001:2015 certificate.

The lifetime extension will not change the rate at which waste is created. The types and annual quantities of waste (including radioactive) produced by Krško NPP will not change substantially as a result of the plant's lifetime extension relative to the existing status.
If Krško NPP's operational lifetime is extended to 2043, 3,005 m^3 (storage volume) or 6,025 t of operating LILW will be generated by the plant. If Krško NPP operates until 2023, the respective figures will be 547 m^3 or 884 t lower, i.e. 2,458 m^3 or 5,141 t.
In addition to operating LILW, LILW resulting from decommissioning will be produced after Krško NPP ceases operation. A portion of this LILW will be produced during the decommissioning process after the end of operation. There will be 2,860 t or 2,842 m^3 (storage volume) of such waste regardless of whether Krško NPP continues to operate until 2023 or 2043. Some of the LILW from decommissioning will be produced during the decommissioning of the spent fuel dry storage (2103–2106). There will be 392 t or 407 m^3 of such waste. Small quantities of HLW will also be produced during the decommissioning process.
Pre-conditioning of waste for Vrbina LILW repository:
LILW packages will be taken by the competent organisations in Slovenia (ARAO) and Croatia (FOND). The division itself will take place in the waste manipulation building (WMB). Existing tools and equipment will be used for the process. In order to reduce the radiological pressures on those carrying out the activity, additional protection will be employed in the form of mobile protective walls, remote handling, etc. The WMB was designed precisely for the purpose of conditioning LILW before it is sent for processing (incineration, melting), which are activities that Krško NPP is already carrying out, and for the final handover and packaging in special canisters for final takeover by ARAO and FOND.

Existing packages will be directly placed in the planned N2d, RCC or ISO IP2 transport canisters at the WMB. The building has been designed in such a way as to ensure radiological protection of the surrounding area and the environment, as well as provide adequate working conditions in the building itself (thickness of walls, closed ventilation filter system, implementation of a closed floor drainage system, etc.). Prior to the insertion of the packages into the canisters, the formal transfer of the ownership of the LILW from Krško NPP to the receiving organisations (ARAO and FOND) will take place. The covering of the N2d and RCC canisters with filling mortar using mobile equipment is also planned. After the completion of the drying process and the hardening of the filling mortar, the canisters will be loaded onto lorries and taken from the Krško NPP site, whereby all requirements for the transport of radioactive material will be observed. ARAO and Fond will be responsible for organising transport.
That portion of the LILW that cannot be placed directly into RCC or N2d canisters and that will have to be further processed will be placed in ISO IP2 transport canisters and taken from Krško NPP to the competent receiving organisations. After the external contractor has processed and conditioned the LILW abroad, the waste will be returned for long-term storage in Croatia or Slovenia.

The environmental burden on account of spent fuel during the extended operational lifetime of Krško NPP will be the same as the current burden in terms of scope and form, i.e. the burden in the final years of operation. 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 EIA was carried out for spent fuel dry storage and building permit no. 35105-25/2020/57 of 23 December 2020 granted for the facility by the Ministry of the Environment and Spatial Planning, Spatial Planning, Construction and Housing Directorate, Dunajska c. 48, 1000 Ljubljana.
Spent fuel is being temporarily stored in its existing state in the spent fuel pool located in the fuel handling building. Because the fuel is underwater, this pool is considered to be wet storage, which

means that the water needs to be continuously cooled. Dry storage introduces a new, technologically safer way of storing spent fuel that leads to a gradual reduction in the number of spent fuel elements in the pool, which in turn significantly increases the level of nuclear safety. The planned construction of dry storage ensures a safer and completely passive way of storing spent fuel. That facility will accommodate the storage of 2,600 fuel elements.
There was a total of 1,444 fuel elements stored at Krško NPP at the end of 2020:
- 1,323 in the spent fuel pool (SFP) inside the fuel handling building (FHB), including two special containers with fuel rods and a fission chamber from 2017; and
- 121 in the reactor pressure vessel (core) in the reactor building.

A total of 1,553 spent fuel elements will be generated if Krško NPP operates until the end of 2023, and an estimated 2,281 spent fuel elements will be generated if it operates until the end of 2043. Extension of the operational lifetime from 2023 to 2043 is expected to result in the generation of a further 728 spent fuel elements at Krško NPP.
There are around 36 existing types of waste (2020) that are generated in all production and support processes, 19 of which are hazardous types of waste. The method of managing this waste will not change from the way it is currently being managed.

After Krško NPP ceases operating, the maintenance and emptying of fluid systems and the decontamination of appliances and facilities will produce the same form and quantity of radioactive waste as during operation.
Extension of the operational lifetime from 2023 to 2043 will produce an extra 547 m^3 or 884 t of LILW. Extension of the operational lifetime from 2023 to 2043 will result in the generation of an additional 728 spent fuel elements.

Regarding the measures set out in the EIA Report in relation to waste management, the ministry explains that it has not set them as a condition in the operative part of the environmental protection consent because they are measures that derive from regulations and are therefore binding on the developer. Similarly, the ministry has not used the operative part of this environmental protection consent to determine the measures envisaged by the spent fuel dry storage project, as these measures are included in building permit no. 35105-25/2020/57 of 23 December 2020 granted by the Ministry of the Environment and Spatial Planning, Spatial Planning, Construction and Housing Directorate, Dunajska c. 48, 1000 Ljubljana for a facility with environmental impact, i.e. the spent fuel dry storage at the Krško NPP site.

Impact of noise emissions

No new sources of noise emissions, such as ventilating or cooling devices, are envisaged as resulting from the lifetime extension. Krško NPP’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 lifetime extension. Noise emissions during the operating period will be the same as currently. Owing to climate change, there could be a rise in air temperature and a reduction in the flow rate of the Sava, which could lead to an increase in the operation of cooling towers. However, we estimate, on the basis of the trend of climate variables, that the number of days on which the cooling towers operate will not change significantly. There will be no noise emissions after operations cease at Krško NPP (or else only some temporary noise due to activities connected with the termination of the lifetime extension).

Environmental impact of electromagnetic radiation pollution

No new sources of electromagnetic radiation are envisaged (e.g. transformer stations) as a result of the lifetime extension of Krško NPP. Likewise, there are no plans to fit the existing transformer stations with new transformers or replace them with transformers of greater capacity. Emissions of electromagnetic radiation will remain the same as present. The entire Krško NPP site is classified as a Level II electromagnetic radiation protection area, while nearby residential areas that are more sensitive to radiation are classified as Level I electromagnetic radiation protection areas. The main sources of low frequency electromagnetic radiation at the Krško NPP site are transformers and power lines. The developer operates several transformer stations. The 2020 report on measurements of low-frequency electromagnetic fields ("Report on the initial measurements of electromagnetic radiation performed for RTP 400/110 kV Krško and the reconstructed part of the 400 kV switchyard at Krško NPP", Elektroinštitut Milan Vidmar, Hajdrihova 2, Ljubljana, June 2014) shows that the limit values for Level II radiation protection were not exceeded at the Krško NPP site or at the boundaries of the site. There will be no more sources of electromagnetic radiation once Krško NPP ceases to operate.

Environmental impact of vibration pollution

The site of the lifetime extension 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 associated with 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, or the transport of products. The scale 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 at Krško NPP does not include machines, devices or activities that could be a significant source of vibrations in the environment. After Krško NPP ceases operating, the majority of devices that could cause vibrations to the environment will stop operating. This means that the activities that cause vibrations at the Krško NPP site will be significantly reduced.

Impact of light pollution

The extension of the operational lifetime does not change the effect of light shining out into the surroundings of the plant. Light emissions into the environment will be identical to present emissions. As its external lighting is an integral part of the technical systems for ensuring physical protection and security, Krško NPP 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 and 44/22 [ZVO-2]), but by the Rules on the physical protection of nuclear facilities and nuclear and radioactive material, and the transport of nuclear material. Nevertheless, Krško NPP continuously strives to comply with requirements for reducing light pollution, for example by using the appropriate, horizontally mounted lights with level glass, not turning lights upwards to a greater degree more than is envisaged in the design to achieve appropriate illumination levels, and installing modern energy-efficient solutions (LEDs, etc.) when lights are being replaced. After Krško NPP ceases operating, light emissions into the environment will be identical to the present emissions; this is because the facility will remain under security control.

Impact on the landscape

Since its construction at the beginning of the 1980s, Krško NPP has been a spatially dominant element of the Krško Polje/Brežiško Polje and serves as a point of orientation for residents and visitors. The Krško NPP complex is bordered on three sides by intensive orchards, while a fully open view of the complex is only afforded from the south, i.e. the right bank of the Sava. The plant cannot be seen in full from the majority of locations, and it is mainly the reactor building, which stands out due to its height, that is visible. The plant is visible from the slope in Libna, the Krško–Brežice regional road, the main railway line, the edge of Sp. Libna and the edge of Sp. Stari Grad, the edge of Žadovinek, the sloped area of Krško on the right bank, the edge of Drnovo, the sloped area of Leskovec, the edge of Kerinov Grm and the edge of Gorica. Krško NPP is visible from the surrounding flat farmland, from roads on the left and right banks of the Sava, and from the Krško–Brežice motorway. The plant is not visible or noticeable from other settlements and areas due to the lie of the land, distance and the swaths of vegetation that lie between those areas and the plant. In addition to Krško NPP's building, the high-voltage power lines that connect to the Krško substation on the northwestern corner of the complex are also visible: DV 2 x 400 kV Beričevo–Krško, DV 400 kV Mihovci–Krško, DV 400 kV Zagreb–Krško, DV 110 kV Krško–Brežice, DV 110 kV Brestanica Krško and DV 110 kV Krško–Hudo.

The appearance of the plant will not change during the lifetime extension. At the beginning of the lifetime extension, the spent fuel dry storage will already have been built, while no other construction works are planned. 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 Krško NPP's visibility in the surrounding area. 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 southeast.

Impacts on land
The site of the lifetime extension is located in an area of building land on which mainly industrial buildings classified as E (Energy infrastructure) have been built. The purpose-specific and actual land use will not change with the planned lifetime extension of Krško NPP.

Impacts on 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. The river and underground water is used in supporting cooling processes and is not used as a raw material (is not incorporated in products). Following use and appropriate treatment, all water is returned to the environment, i.e. to the Sava. The water pumped from the three temporary wells returns directly into the Sava via the rainwater drainage system. The lifetime extension will not impact valuable natural features in the vicinity during operation.
If the lifetime extension is terminated, there will be a considerable reduction in the use of natural resources in comparison with regular operation. The spent fuel pool will still have to be cooled, as will a number of other safety components (water will be abstracted and returned to the Sava at a rate of approx. 1.6 m^3/s). If the lifetime extension is terminated, there will be no impact on the protected natural areas in the vicinity of the activity.

Transboundary impacts
Krško NPP's current level of production does not exceed the limit values for substance emissions and radiation into the environment. The limit values are not expected to be exceeded even after Krško NPP's operational lifetime is extended. The area in which the lifetime extension causes an environmental burden that could affect human health or property will be limited to the narrower Krško NPP site. Under normal operation, the lifetime extension will have no transboundary effects on the factors resulting from individual influences or their mutual effects.
The "Calculation of doses at certain distances for design-basis (DB) and beyond-design-basis (BDB) accidents at Krško nuclear power plant" study (FER-MEIS, 2021) dealt with the design-basis large-break loss of coolant accident (LB LOCA) and the design-extension conditions (DEC-B). The results of the study show that the 30-day effective dose at a distance of 10 km from the power plant is 1.16 mSv, which is more than two times lower than the annual natural background dose in Slovenia (approx. 2.5 mSv). The thyroid dose (13.5 mSv) at a distance of 3 km from Krško NPP is below the limit prescribed by law for iodine prophylaxis, which is 50 mSv for seven days (Decree on limit doses, reference levels and radioactive contamination, Official Gazette of RS, No. 18/18). The distance of Krško NPP 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, and 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 or on human health and property.

Decision

Following a review of the complete documentation relating to the administrative matter, the ministry found that the lifetime extension was acceptable for the environment if all of the design and environmental protection conditions set out in the operative part of this environmental protection consent were observed and implemented, and all the mitigation measures set out in the laws and implementing regulations, the Ordinance on the municipal spatial plan for the Municipality of Krško (Official Gazette of RS, No. 61/15) and the Ordinance on the development plan for Krško nuclear power plant (Official Gazette of RS, Nos. 48/87, 59/97 and 21/20) were implemented consistently.

Conditions

Following an examination of all of the documents enclosed by the developer with the application for the environmental protection consent, it was established that the request for the environmental protection consent could be approved, which made it necessary, pursuant to the third paragraph of Article 61 of the ZVO-1, to determine the conditions that the applicant had to observe in order to prevent, reduce or eliminate adverse effects on the environment.

A) Protection of surface waters and groundwater

A1) Present state of the environment

Krško NPP is located at the northwestern edge of the Krško Polje/Brežiško Polje, on the left bank of the Sava, a few kilometres downstream of the town of Krško. In the Krško area, the Sava enters a wide valley before reaching Brežice, then narrows again after the confluence with the Krka. After Brežice, the river opens towards Čatež and further downstream towards the Samobor basin in Croatia and the narrower aquifer between Medvednica and Samoborska Gora. From a hydrogeological point of view, the two aquifers are interconnected, with downstream extensions from Krško and across Čateško Polje towards the Samobor and finally Zagreb aquifers, where the Sava and its connected underground aquifers function as a kind of corridor between the Krško–Brežice and Zagreb aquifers. Numerous water pumping wells are in operation along this aquifer corridor in both Slovenia and Croatia.

The distribution of the hydraulic conductivity of alluvial deposits along the Sava shows the highest values (K = 4 cm/s) in the central part of the Krško Polje/Brežiško Polje, as well as in the central part of the Samobor basin. The hydraulic conductivity of the Sava alluvial deposits decreases as the aquifer narrows in the area of Brežice, at Čateško Polje, and at the transition from the Samobor to the Zagreb aquifer. Groundwater in the alluvial aquifer flows to the south and southeast under the hydrological conditions of low and medium water levels. The exception occurs at high water levels, when the Sava feeds the alluvial aquifer along its entire length.

Krško NPP is situated on the left bank of the Sava in the area of the alluvial aquifer. A dam has been built next to the power plant on the Sava, raising the level of the river to allow gravitational supply of cooling water to Krško NPP. The slowing of the river flow at the dam results in an increase in groundwater levels on the left and right banks upstream of Krško NPP, and a groundwater recharge in all hydrological conditions (low, medium, and high water levels).

Krško NPP was built on the left bank of the Sava in the form of an “island” and using a sealing curtain measuring 144 m x 192 m. The plant and all its installations are located behind this curtain. The top of the curtain is built at an elevation of 154.5 m a.s.l., while the bottom lies at 141.0 m a.s.l., amounting to a total depth of 13 m. Krško NPP is therefore almost fully isolated from the highly water-permeable Quaternary aquifer. The construction of the Brežice HPP caused the maximum water level of the Sava to rise to an elevation of 153.20 m a.s.l., compared to the maximum water level of 151.21 m a.s.l. recorded prior to its construction.

As part of an inspection of the operation of the sealing curtain, carried out on the interior and exterior sides of the curtain, pairs of piezometric boreholes were drilled in 2009 and a parallel measurement of groundwater levels inside and outside the sealing curtain was performed. A potential difference Δh of 0.3 to 1.3 m was recorded on the two sides of the curtain.

Relative to Krško NPP and the surrounding area enveloped by the sealing curtain, the negative groundwater gradient demonstrates that the groundwater is “bypassing” the protected area of Krško NPP, and flowing without direct impact towards the Sava, which drains groundwater on its left bank.

All pairs of piezometers record a difference in the groundwater level; the smallest difference is recorded on the southeastern side of Krško NPP, which may indicate that the resistance to the flow of groundwater is lowest at this part of the sealing curtain. In all cases, a slightly lower groundwater level was recorded within the sealing curtain, although surface and groundwater levels generally rose by around 1 m following the construction of Brežice HPP. In order to ensure that groundwater levels remain at levels seen before the construction of Brežice HPP, the Slovenian Water Agency issued water permit no. 35530-100/2020 (14 November 2020) in 2020 for the construction of three wells within the sealing curtain area with a maximum permitted pumping rate of 5.0 l/s at an individual well, or a total of 70,000 m^3/year per well. The wells have been constructed and pumping tests conducted. The thickness of the Quaternary aquifer at the locations of the wells is around 3.2 m, and the aquifer permeability is 2.3 x 10^{-3} m/s. In this way, the groundwater level within the sealing curtain area is maintained at the previous level.

Another well (depth approx. 13 m) has been in use within the Krško NPP perimeter since 9 September 2021. Water is pumped from the well at a maximum rate of 8.0 l/s (230 m^3/year). The mean value of the permeability coefficient obtained through trial pumping is 1.4 x 10-2 m/s. In accordance with water permit no. 35530-48/2020-3 of 9 September 2021, the impact on the water regime is monitored by measuring the current and total quantities of water intake at least once a day. Measurements are also taken of the groundwater level at least once a day. The measurements must clearly show the groundwater level when the well is at rest and when pumping is taking place.

At the town of Krško, the Sava flows into the VTPodV_1003 Krška Kotlina (Krško Basin) groundwater body, which covers the entire Krško Polje/Brežiško Polje (plain). Its surface area is 96.76 km^2. It is approximately 9 km wide and 18 km long. According to the Water Area Management Plan, VTPodV_1003 Krška Kotlina has been assessed as an extremely vulnerable groundwater body since 2016.

Three typical aquifers are defined within VTPodV_1003 Krška Kotlina. The first is an intergranular alluvial aquifer, formed by the sediments of the Sava and Krka and their tributaries. These are extensive, local and moderately to highly productive aquifers. The second aquifer or group of aquifers formed in Pleistocene and Tertiary sediments under the alluvial deposits of the Sava. These are intergranular, extensive and local aquifers of low to moderate productivity. The third aquifer or group of aquifers comprises thermal aquifers formed in carbonate rocks in the bedrock of Tertiary strata. Aquifers in carbonate rocks are karstic/fissured aquifers. They can be extensive, local, and of low to high productivity.

Within the VTPodV_1003 Krška Kotlina water body, there is one larger groundwater pumping station, Brege (around 60 l/s), which supplies the town of Krško, as well as eight smaller local pumping stations. The Drnovo pumping station is currently not operating due to high levels of nitrates in the water. There are designated water protection areas for all potable water pumping stations. The water protection area of the largest pumping station at Brege extends to the Sava, upstream and downstream of the Krško NPP dam.

The construction of the Brežice HPP reservoir changed the hydrological and hydrogeological conditions in VTPodV_1003 Krška Kotlina. Water flow along the Sava towards Brežice has slowed down due to the construction of the dam, which slows the flow of water to an elevation of 153.20 m – the maximum level of the reservoir with a volume of around 3,120,000 m^3. All accompanying construction along the Brežice HPP dam and the upstream part of the reservoir serves the purpose of preserving the previous state of balance between the lake, groundwater and the biosphere. Embankments have been built along the northeastern and southwestern sides of the lake to limit the uncontrolled expansion of the lake area into the Krško Basin. Seepage through the embankments on both sides of the lake is controlled with drainage channels along the embankments, i.e. gravitational drainage into the Sava downstream of the dam. The embankment next to Krško NPP, reaching from the dam to an elevation of 154.5 m, has all the characteristics of a flood dyke with no water seepage into the left bank. A groundwater enrichment facility has been built upstream of the Krško NPP dam on the right bank of the Sava, which treats groundwater flowing towards potable water pumping stations on the right bank of the river and the Krško NPP pumping station. In this way, the wider area of Krško NPP is protected from the projected high water levels of the Brežice HPP reservoir, the infiltration of Sava waters into the right bank, where important potable water pumping stations are located, is increased, and a connection to groundwater on both banks is ensured with levels elevated by around 1 m.

The surface water body into which wastewater from Krško NPP is discharged, and which is used by the power plant for process and cooling purposes, is the Sava Krško–Vrbina water body. The quality of the Sava is assessed on the basis of regular monitoring conducted by ARSO. According to ARSO data, the chemical status of the Sava at the Sava Krško–Vrbina water body in the 2009–2013 period was assessed as good, with a high degree of reliability. In terms of mercury in organisms, the status was assessed as poor, with a low degree of reliability (this parameter was assessed as poor for all water bodies except the Krupa water body).

In the 2009–2015 period, the ecological status of the Sava at the Sava Krško–Vrbina water body was assessed as good, with a high degree of reliability. The same assessment was given to its ecological status with regard to the concentrations of specific pollutants.

In the River Basin Management Plan (RBMP) for the Danube River Basin District 2016–2021, the assessment of the status for this water body was in line with the monitoring results referred to above.

The assessment of the state of water bodies for the Danube River Basin Management Plan 2022–2027 (RBMP3), which is being drafted, is based on the monitoring data from the 2014–2019 period. The assessment of the chemical status includes the state of waters and the status of the biota. The former is assessed as good, the latter as poor (or, together, as poor with a high degree of reliability). With a medium level of reliability, the ecological status is assessed as good. The ecological status with regard to the levels of specific pollutants is assessed as very good. With regard to specific pollutants, the state of the Sava Krško–Vrbina water body was assessed as very good, with a high degree of reliability.

The increased values of mercury and BDE in biota are not linked to Krško NPP operation. The Draft Danube River Basin Management Plan 2022–2027 states as follows:

"Assessments of the chemical status of surface waters for the biota matrix show that, in Slovenia as in all European countries, mercury and brominated diphenyl ethers (BDE) are the substances that cause poor chemical status of surface water bodies
because they fail to meet the Environmental Quality Standard (EQS) for biota. The previous water management plan indicated a poor chemical status as a result of the EQS being exceeded for mercury in biota in 98.6% of surface water bodies. Mercury and brominated diphenyl ethers are classed as persistent bioaccumulative toxic contaminants (PBT) and accumulate in organisms. A similar situation is to be found in all European countries that have carried out analyses of these substances in fish.

In Slovenia, monitoring was conducted in biota at 60 surface water bodies, in international profiles, in areas without any human impact, and in polluted areas. The EQS for organisms were exceeded at all measuring points at which analyses of mercury and BDE were conducted. In light of this, the poor chemical status for the parameters of mercury and BDE
was extrapolated to all surface water bodies. A low confidence level is therefore attached to the poor chemical status determined for biota in all surface water bodies in Slovenia
whose chemical status was determined by extrapolation."

Estimates indicate that the highest inputs of the contaminants concerned into the Danube RBD are the result of atmospheric depositions in the river basins of the Drava, Srednja Sava, Spodnja Sava and Savinja. Estimates further show that inputs of hydrogen and sulphur from atmospheric deposition fell between 2013 and 2015, with a slight increase observed in 2016. Data was available for 2015 and 2016 for the remaining selected contaminants. As a result, any increase or reduction in the input of contaminants into surface waters cannot be estimated with any degree of reliability.

Taking this into account and comparing the data estimates on the types and strengths of pressures from atmospheric deposition with an assessment of the status of surface water bodies, it is estimated that atmospheric deposition exerts a significant pressure that causes poor chemical status by breaching the EQS for mercury in biota.

The ecological status of the Krško–Vrbina water body is assessed as good and very good for specific elements of quality. As regards hydromorphological status, some elements have been assessed as exerting significant hydromorphological pressures on the water body: hydrological regime in the main flow and inflow, continuity of the main flow and the morphological conditions of the main flow.

The production process of Krško NPP requires cooling water from the Sava, which is collected at two points upstream of the plant's dam:

- up to 1.606 m^3/s of water for the small cooling system (essential service water, ESW) is collected at the small pumping station at the far southeastern part of the Krško NPP complex; and
- up to 25 m^3/s of water for the large cooling system (circulating water, CW) is collected at the pumping station behind the submersible wall upstream of the Krško NPP dam.

Water from the ESW system returns to the Sava upstream of the dam at discharge V1, and water from the CW system through the CW discharge facility at the V7 location. Since the water for the CW system is heated as it passes through the condenser, Krško NPP is obliged to ensure, in compliance with the environmental protection permit, that:

1. the waste heat emission ratio in the 24-hour average for the removal of wastewater into the Sava via discharges V1 and V7 is equal to 1;
2. the synergistic action of the aforementioned discharges, as well as other Krško NPP discharges, does not cause the Sava to exceed its natural temperature by more than 3°C at any period of the year;
3. the cooling water recirculation system via the cooling towers is activated in a timely manner so that the Sava does not exceed its natural temperature by more than 3°C;
4. if the combined cooling system is insufficient to fulfil this condition, Krško NPP is required to reduce the power of the power plant in a timely manner (since the upgrading of the cooling towers, there has been no reduction in plant power);
5. the temperature of water discharged at discharge V7 does not exceed 43°C.

The quantity of the water abstracted from the Sava is stipulated in partial water permit no. 35536-31/2006-16 of 15 October 2009, which was amended by decision no. 35536-54/2011-4 of 8 November 2011 and decision no. 35530-7/2018-2 of 22 June 2018 in response to changes in the quantity of water abstracted from the Sava. The amendment of the water permit of 22 June 2018 sets out the total allowable amount of water offtake from the Sava at 29 m^3/s. The permitted annual quantity of offtake for process purposes (Sava and the well on the right bank) is 915,000,000 m^3.

As part of operational monitoring at Krško NPP, the temperature of the Sava is regularly measured before the river enters the plant for process management requirements and in order to control the maximum temperature of discharges and control any rise in the ΔT after full mixing (3°C).

Measurements at Radeče were taken at Radeče water gauging station, which was the main national station for that section of the Lower Sava (Spodnja Sava) from 1909 to 1998. Operations at the station were discontinued in 1998 because it was located on the Vrhovo HPP reservoir. The data series can be continued by taking data on the Sava at Hrastnik and on the Savinja at Veliko Širje, where the stations of the national network are currently located. Measurements of the Sava before it enters the Krško NPP complex are carried out at measuring point MM1 at the following location: Y=540280, X=88332, Z=150 m a.s.l., cadastral municipality 1321 Leskovec, land parcel no. 1246/6. The Brežice reservoir, which began operating in September 2017, does not significantly affect Krško NPP operations in terms of the thermal load on the Sava. Studies of the thermal load on the Sava conducted prior to the construction of the reservoir ("Interactions of energy buildings along and on the Sava from the perspective of the thermal load on the Sava", Revision A (IBE, 2012a)), and the measurements and analyses after the filling of the reservoir ("Energy buildings along and on the Sava – Thermal analysis of the Sava in August 2012" (IBE, 2012b) and "Analysis of river temperatures in the Lower Sava in July and August 2019 and the verification of previous studies" (Revision A, IBE, April 2020) established the following:

- the average monthly temperatures of water flowing into the HPP chain (into the Vrhovo reservoir) have increased by between 1.5 and 2°C in the summer months over recent decades, while temperature peaks in the same period have increased by between 3 and 4°C. This means a significantly higher "natural temperature background" for Krško NPP operation;
- HPP reservoirs along the lower Sava do not cause additional river warming relative to conditions before the damming;
- in critical summer conditions with low river flow rates and high air temperatures, HPP reservoirs significantly reduce daily variation in river temperature relative to conditions before damming, while also storing cooler water in the lower layers of the reservoirs due to thermal stratification;

- this is reflected in the Brežice HPP reservoir, where accelerated thermal emission from the reservoir into the atmosphere was detected, compared to the previous state;
- in view of these impacts, HPP reservoirs act as measure for mitigating the effects of climate change in terms of the thermal load on the Sava, which has a further positive effect on Krško NPP operation during periods of reduced river flow and increased water and air temperatures.

A2) Expected impact during operation and the conditions

Surface waters

Cooling (waste) water, which is primarily discharged via a flow cooling system (outlet V7-7), accounts for most of the wastewater that comes from Krško NPP, while the cooling tower system (outlet V7-10) is used when the flow of the Sava is unfavourable with respect to the thermal load on the river. Some of the cooling wastewater comes from the safety supply (outlet V1-1). Cooling water in the cooling tower system accounts for less than 5% of total cooling water.

The operational monitoring of wastewater in the 2015–2020 period shows that the results of analyses rarely exceeded the prescribed limit values. When they did so, this was most often on account of the parameters of undissolved substances and sedimentary matter. Limits were exceeded at the outlet of the main cooling water system, the outlet of the cooling towers and at the outlet of safety water. The power plant does not release substances into these systems which could be the cause of exceeding limit values for undissolved substances and sedimentary matter. In some years, individual readings have indicated exceedances of the emission limits for undissolved substances, sediments and chemical oxygen demand (COD) that were not caused by Krško NPP operation but by the general quality of the Sava.

The fact that the composition of water at discharges depends on the composition of the river water is also shown by the monitoring of COD and BOD_5 (biochemical oxygen demand) values at three measuring points in and around the Krško NPP site, where it is evident that the water contains a certain composition of these indicators before it enters the plant. Under the Decree on surface water status (Official Gazette of RS Nos. 14/09, 98/10, 96/13, 24/16 and 44/22 [ZVO-2]), the BOD_5 limit value (EQS) is 5.4 mg/l for rivers with a good ecological status, while a COD value of 20.9 mg/l indicates a very good status. The concentration of these indicators in emissions from Krško NPP generally meets the criteria for good river status.

Over a period of six years, discharges from the water preparation tank (outlet V7-11) have occasionally exceeded the limit values: once for COD (in 2015), once for BOD_5 (in 2017) and twice for toxicity (in 2016 and 2017). However, the quantities of those wastewaters are very small and amount to 4,000 m^3 annually (the maximum permitted quantity is 6,000 m^3/year). It was determined that Krško NPP does not have a significant negative impact on water, more specifically the Sava Krško–Vrbina water body into which wastewater from the power plant is discharged. This also proves that the status of this water body is good. The assessment of the chemical status of water bodies between 2014 and 2019, which is used for the Management Plan 2022–2027, shows that the chemical status of the water body is good for the water matrix, poor for the biota matrix, and poor for the water and biota matrices together. The "poor" assessment is due to parameters that are not related to Krško NPP emissions; instead, they result from general pollution, namely with mercury and BDE. The ecological status of the water body is good for individual elements of the assessment and very good for "specific pollutants". The construction of wastewater treatment plants,

as well as the treatment of wastewater at Krško NPP's own plants and at the municipal treatment plants of industrial facilities in the

area, have definitely helped that water body to achieve good status. Krško NPP is authorised to use biocides to periodically clean the condensers, but they have not actually been used for many years. The system has been successfully cleaned mechanically by means of the Taprogge system of recycling rubber balls.

As regards the operation of the cooling system, Krško NPP implements measures that have been evaluated in accordance with BREF/BAT guidelines for cooling systems.

The extension Krško NPP's operational lifetime will not result in changes in the discharge of wastewater relative to the current status. There is, however, the possibility of an increase in the proportion of cooling wastewater discharged from the cooling tower system as a result of climate change. Given the current good status of the water body into which wastewater from Krško NPP is discharged, the ministry assesses that the impact will be small and that it will not change the good ecological and chemical status of water in that area.

<u>Groundwater</u>
A small part of the southernmost section of the site of the lifetime extension (in the vicinity of the dam) is located in the Drnovo WPA (protection regime II), as per the Decree on the protection of groundwater in the area of protection zones of the Krško pumping station-water supply system (Official Gazette of SRS, No. 12/85).
Krško NPP's well on the right bank of the Sava cannot affect the quantity of water at the Brege pumping station; this is because the formation of groundwater from the construction of the Brežice HPP reservoir increases the possibility of pumping water from the Brege well at the same installations.
Krško NPP does not potentially pollute the groundwater by releasing harmful materials or polluted water directly into the ground. The lifetime extension will not change the manner in which wastewater is discharged. As all wastewater is already being disposed of in the appropriate manner, there will be no emission of pollutants into the soil during operation. There will be no impact on the water protection area or on stocks of potable water.
Emissions of substances and heat from Krško NPP wastewater into waters are within the legally prescribed limits and will remain so during the power plant's extended lifetime.

The ministry estimates that the impact of the activity and the overall impact on surface waters and groundwater during operation will be (3), i.e. impact not significant, on account of the mitigation measures referred to in point II/1 of the operative part of this environmental protection consent that the developer will be required to implement during the lifetime extension in order to prevent excessive burdens resulting from the discharge of wastewater into the Sava (wastewater parameters below the limit values set out in the environmental protection permit with respect to emissions into water). In point II/1 of the operative part of the environmental protection consent, the ministry has ordered the developer to carry out the mitigation measures set out below.

The ministry has imposed the measures/conditions referred to in points II/1.1 and II/1.2 of the operative part of the environmental protection consent pursuant to the Decree on the emission of substances and heat in the discharge of wastewater into waters and the public collection system, which provides, *inter alia*, that continuous measurements of the flow rate of the watercourse must be carried out if the waste heat emission ratio exceeds 80% of the value of the prescribed limit emission ratio. In Krško NPP's case, the EIA Report and the reports on operational monitoring for the plant obtained by the Slovenian Environment Agency show beyond doubt that this level is exceeded. Pursuant to the provision referred to in the third indent of the first paragraph of Article 8 of the Decree (which also stems from the EIA Report), the limit waste heat emission ratio (WHER) for Krško NPP is "1". According to the EIA Report (Table 62), in its current state Krško NPP achieves a WHER of between 0.1 and 1, which means that the WHER occasionally exceeds 80% of the value of the WHER (because it exceeds 0.8). The developer must therefore ensure continuous measurements of the temperature and flow rate of wastewater and continuous measurements of the temperature and flow rate of the watercourse. The measures/conditions referred to in points II/1.1 and II/1.2 of the operative part of the environmental protection consent have also been set for the purpose of demonstrating compliance with the conditions set out in points II/1.10 and II/1.11 of the operative part of the environmental protection consent, as data on the flow rate of the watercourse, in addition to other data such as watercourse temperature and the flow rate and temperature of wastewater, is vital for establishing the average daily waste heat emission ratio and the average daily temperature increase of the Sava (ΔT).
The measure referred to in point II/1.1 of the operative part of the environmental protection consent has been determined for cases where the Krško NPP dam is not operating and Brežice HPP is operating, while the measure referred to in point II/1.2 of the operative part of the environmental protection consent has been determined for cases where Brežice HPP is not operating and Krško NPP dam is operating.

In order to monitor Krško NPP operations and their impact on the environment and nature, including cumulative and remote impact, the ministry has also set down an obligation to maintain records of these continuous measurements of the Sava flow rate and forward them to the Slovenian Environment Agency (ARSO). This data must be sent to ARSO at least once a day.

The obligation to install measuring equipment to enable the continuous establishment of the actual quantity of water abstracted at the offtake point on the Sava is set out in partial water permit no. 35536-31/2006-16 of 15 October 2009. However, because that water permit is only valid until 31 August 2039 and an assessment of the environmental impacts has been drawn up for the period up to 2043, the ministry has imposed the condition that continuous measurements be taken of the flow rate of the offtake of Sava water for Krško NPP (point II/1.3 of the operative part of the environmental protection consent). Within the measure/condition, the ministry has therefore set the coordinates as determined in the above-mentioned water permit. Using the online application at http://sitranet.si/sitrik.html, it converted the coordinates from the Gauss-Krüger system (D48/GK) to the new coordinates system, the transverse Mercator projection (D96/TM). The developer was informed of this change in letter no. 35428-4/2021-2550-94 of 19 December 2022 and made no comments in response. In determining the parcel number of the land indicated by the coordinates at which these continuous measurements of flow rate are to be carried out, the ministry followed the suggestion made by the developer in statement no. ING.DOV-460.22 of 23 December 2022. In that document, the developer stated that it agreed with the coordinates e=539923 and n=88683, but explained at the same time that, in accordance with Supreme Court's historical extract from the Land Registry (from May 2011), the location of the property in cadastral municipality 1321 Leskovec had changed from land parcel no. 1249/1 to land parcel no. 1249/4. The ministry therefore followed the developer's suggestion and set the measuring point in land parcel no. 1249/4, cadastral municipality 1321 Leskovec. For the purposes of the monitoring of Krško NPP operations, its offtake of Sava water and the impact on the water regime, the ministry also determined that the measurements must be continuous and consistent, with data recorded at least once an hour and the results entered in the Slovenian Environment Agency's online database. This data must be sent to ARSO at least once a day.

The ministry has imposed the measures/conditions referred to in point II/1.4 of the operative part of the environmental protection consent pursuant to the fourth paragraph of Article 31 of the Decree on the emission of substances and heat in the discharge of wastewater into waters and the public collection system, which provides, *inter alia*, that continuous measurements of the temperature of the watercourse must be carried out if the waste heat emission ratio exceeds 80% of the value of the prescribed limit emission. In Krško NPP's case, this limit ratio is exceeded, as explained in the reasoning supplied for the measures/conditions referred to in points II/1.1, II/1.2 and II/1.5 of the operative part of the environmental protection consent. The measures/conditions have also been imposed for the purpose of demonstrating compliance with the conditions referred to in points II/1.10 and II/1.11 of the operative part of the environmental protection consent.

Regarding the requirements to ensure and implement continuous measurements of the temperature of the watercourse (Sava) prior to its arrival at Krško NPP, the EIA Report states that those measurements are being performed at the site defined by the Gauss-Krüger coordinates Y=540222 and X= 88200, i.e. measuring point MM1 from environmental protection permit no. 35441-103/2006-24 of 30 June 2010. In the document titled "Third Supplement to the Application for an Environmental Protection Consent for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years: presentation of evidence", no. ING.DOV-178.22/2022 of 6 May 2022, which contains four appendices, the developer explains, in Appendix 1, that Krško NPP measures the temperature of the Sava at this measuring point using two mutually independent PT100 resistance thermometers. Both are located at the same measuring point in front of the offtake for the essential service water system (small coolant circuit) and therefore function as a representative source of measurements of the temperature of the Sava prior to its arrival at the plant. The developer also explained that the intake for measurements of the temperature of input water and the discharge from the small cooling system are sufficiently distant from each other that industrial

wastewater from the SW does not lead to a rise in the temperature of the Sava at the intake, as the discharge from the SW system is physically located approx. 10 m downstream on the left bank.
Within the measure/condition, the ministry has therefore set the coordinates as determined in the EIA Report. Using the online application at http://sitranet.si/sitrik.html, it converted the coordinates from the Gauss-Krüger system (D48/GK) to the new coordinates system, the transverse Mercator projection (D96/TM). The developer was informed of this change in letter no. 35428-4/2021-2550-94 of 19 December 2022 and made no comments in response.
In determining the parcel number of the land indicated by the coordinates at which these continuous measurements of the temperature of Sava water at the offtake for Krško NPP are to be carried out, the ministry followed the suggestion made by the developer in statement no. ING.DOV-460.22 of 23 December 2022. In that document, the developer stated that it agreed with the coordinates e=539851 and n=88685, but explained at the same time that, in accordance with Supreme Court's historical extract from the Land Registry (from May 2011), the location of the property in cadastral municipality 1321 Leskovec had changed from land parcel no. 1249/1 to land parcel no. 1249/4. The ministry therefore followed the developer's suggestion and set the measuring point in land parcel no. 1249/4, cadastral municipality 1321 Leskovec. The ministry also determined that measurements must be continuous and consistent, with data recorded at least once an hour and the results entered in the Slovenian Environment Agency's online database. This data must be sent to ARSO at least once a day.

The ministry has imposed the measures/conditions referred to in point II/1.5 of the operative part of the environmental protection consent pursuant to the fourth paragraph of Article 31 of the Decree on the emission of substances and heat in the discharge of wastewater into waters and the public collection system, which provides, *inter alia*, that continuous measurements of the flow rate/quantity of wastewater must also be carried out if the waste heat emission ratio exceeds 80% of the value of the prescribed limit emission. In Krško NPP's case, this limit ratio is exceeded, as explained in the reasoning supplied for the measures/conditions referred to in points II/1.1 and II/1.2 of the operative part of the environmental protection consent. The measures/conditions have also been imposed for the purpose of demonstrating compliance with the conditions referred to in points II/1.10 and II/1.11 of the operative part of the environmental protection consent.
When determining which wastewater is to be subject to continuous temperature and flow rate measurements, the ministry took into account the position expressed by the developer in statement no. ING.DOV-460.22 of 23 December 2022. The measure/condition is worded in such a way as to make it unambiguously clear that the measurements must be implemented for the wastewater that is discharged into the Sava, i.e. for at least the wastewater: a) from the SW cooling system, b) from the CT surge tank that discharges into the Sava and c) from the CW cooling system that discharges into the Sava (some of the cooling water from the cooling towers can be recycled, which means that the recycled part is not discharged into the Sava).

In response to the failure to comply with the obligation referred to in the second indent of the first paragraph of Article 11 of the Rules on initial measurements and operational monitoring of wastewater (Official Gazette of RS, Nos. 94/14, 98/15 and 44/22 [ZVO-2]), which lays down the obligation to measure the flow rate of wastewater during sampling, the ministry imposed this obligation as a measure in point II/1.6 of the operative part of the environmental protection consent. The EIA Report does not indicate whether this obligation (for wastewater at measuring points MM1, MM3 and MM4) has been met and, moreover, according to the report on the operational monitoring of wastewater for Krško NPP for 2020 (NLZOH, no. 2172-72-172/20, 24 March 2021), no steps have been taken to ensure that measurements are taken of the flow rate of that wastewater at the time it is sampled by an authorised operational monitoring contractor, as "there are no technical conditions in place for the implementation of measurements of flow rate at the time of sampling using mobile devices". In essence, this means that the measuring points are not properly set up at all. In the measure/condition referred to in point II/1.6 of the operative part of the environmental protection consent, and pursuant to point 4 of Article 4 of the Rules, which provides that the operational monitoring of wastewater shall also cover the measurement of the temperature of wastewater during sampling (where the first paragraph of Article 21 of the Rules

provide that operational monitoring shall be performed by a certified operational monitoring provider that is obliged to draft a report on periodic or continuous measurements for each calendar year), the ministry imposed the obligation on the certified operational monitoring provider to take measurements of the temperature of wastewater when sampling wastewater (as part of the implementation of operational monitoring). One precondition for this is that the measuring points are adequately laid out, as required by the ministry in the measure/condition referred to in point II/1.7 of the operative part of the environmental protection consent.
The ministry also imposed the measure referred to in point II/1.7 of the operative part of the environmental protection consent in response to the failure to comply with the requirements referred to in Article 14 of the Rules on initial measurements and operational monitoring of wastewater (which provide, *inter alia*, that flow rate measurements must cover measurements of laminar flow, for which measurements the length of the flat part of the inflow pipe in front of the measuring point must be at least ten times the diameter of the pipe), while a wastewater depth of at least 5 cm must be ensured at the measuring point so as to enable the use of submersible measuring probes, while the measuring point must also meet the requirements of the standards for the measurement methods used as referred to in the Rules, etc.), to ensure compliance with the existing obligations determined in point 1.12 of the operative part of the environmental protection consent (obligation to lay out measuring points for operational monitoring) and as a precondition for implementation of the obligations referred to in the measure/condition referred to in point II/1.6 of the operative part of the environmental protection consent.

The EIA Report does not define the quantity of wastewater at discharges V2 (flushing of the rotating rakes), V3 (discharge from fire protection pumps), V4 (essential service water), V5 (flushing of the travelling screens) and V6 (pumping during an outage) into the Sava, while the report on the operational monitoring of wastewater for Krško NPP for 2020 and 2021 states that a total of 190,000 m^3 of wastewater entered the Sava from these discharges in 2020 and a total of 179,000 m^3 in 2021. The second paragraph of Article 31 of the Decree on the emission of substances and heat in the discharge of wastewater into waters and the public collection system provides that if a plant has several discharges with a total annual quantity not exceeding 100,000 m^3 and the total annual quantities of process wastewater from all discharges from the plant do exceed 100,000 m^3, the operator of the plant is obliged to ensure that continuous measurements are taken of the quantity of wastewater for every 100,000 m^3 of process wastewater at one of the discharges with the highest annual quantity of process wastewater released. A total of more than 100,000 m^3 of wastewater was released from discharges V2 to V6 in 2020 and 2021, with neither the EIA Report nor the Report on the Operational Monitoring of Wastewater making it clear that continuous measurements of the flow of wastewater would be performed at discharges V2, V3, V4, V5 and V6, i.e. the discharges from which the highest annual quantity of wastewater was released. As a result of the failure to meet this obligation, the ministry imposed it as a measure in point II/1.8 of the operative part of the environmental protection consent. The ministry also imposed an obligation to maintain records of these continuous measurements of wastewater flow rate and to send the records to the Slovenian Environment Agency. This data must be sent to ARSO at least once a day.

The ministry imposed the measure referred to in point II/1.9 of the operative part of the environmental protection consent for the purposes of monitoring and of demonstration of compliance with the condition referred to in point II/1.11 of the operative part of the environmental protection consent, which provides that the temperature of the Sava at the point of complete mixing may not exceed a daily average of 28°C. The measure is also imposed for the purpose of the monitoring of cumulative impact (that of Krško NPP and the Brežice HPP reservoir), which must also be taken into account and monitored for the implementation and operation of the activity. In addition, continuous measurements of the temperature of the Sava at the point of complete mixing are also required for the purpose of monitoring remote impact in the Natura 2000 protected area of the Lower Sava and the fish species Danube roach, as explained in detail in the reasoning supplied for the condition referred to in point II/1.11 of the operative part of the environmental protection consent. The EIA Report states that the point of complete mixing is located downstream of Brežice HPP, approximately at the location of the old steel bridge in Brežice. In its enclosed statement (no. ING.DOV-460.22 of 23 December 2022), the developer suggested that the point of complete mixing be set at the stilling basin of Brežice HPP, where complete mixing physically occurs. It also stated that the conditions for the performance of continuous online measurements were already in place at the location of the downstream side wall on the left bank (coordinates e = 545686.070 and n = 84534.008, D96/TM system). The ministry therefore followed the developer's suggestion and set the point of complete mixing of the Sava and wastewater from Krško NPP at the proposed coordinates. It also imposed, at the same location, the obligation to lay out a measuring point, ensure that continuous measurements of the Sava are taken and maintain records of the measurement results (with the results recorded at least once an hour and entered into the Slovenian Environment Agency's online database). This data must be sent to the Slovenian Environment Agency at least once a day. The ministry determined the land parcel number and cadastral municipality of the point of complete mixing on the basis of the coordinates supplied by the developer and by using the publicly available online applications http://sitranet.si/sitrik.html and Environment Atlas http://gis.arso.gov.si/atlasokolja/profile.aspx?id=Atlas_Okolja_AXL@Arso and http://sitranet.si/sitrik.html (both accessed 4 January 2023).

The ministry has determined the measure referred to in point II/1.10 of the operative part of this environmental protection consent as a measure for monitoring Krško NPP's impact on thermal load on the Sava, specifically pursuant to the third indent of the first paragraph of Article 8 of the Decree on the emission of substances and heat in the discharge of wastewater into waters and the public collection system, with due regard to point 3 of the first paragraph of Article 11 of the same Decree, as the Sava at the Krško NPP site is, under the Rules on the designation of surface water sections important for freshwater fish species (Official Gazette of RS, Nos. 28/05, 8/18 and 44/22 [ZVO-2]), defined neither as salmonid nor as cyprinid water, which means that a waste heat emission ratio (WHER) of 1 applies to Krško NPP. The measure considers the cumulative impact of all wastewater from Krško NPP and not only the impact of discharges V1 and V7 (as stated in the environmental protection permit).

The ministry imposed the measure referred to in point II/1.11 of the operative part of the environmental protection consent for the purposes of protecting the Sava watercourse and monitoring the cumulative impacts of the operation of Krško NPP and the Brežice HPP reservoir on the river, and of preventing remote impact from Krško NPP operation on the Danube roach (*Rutilus pigus*), which has cyprinid species status and lives downstream of the plant. The thermal load could have an impact on fauna in the watercourse indirectly through the impact on oxygen content or directly due to the impact on organisms, as life processes evolve more rapidly at warmer temperatures, while different organisms function optimally at different temperatures. Maximum temperatures in the summer months have the most significant impact on fish; this is because they could lead to deteriorating oxygen conditions or even the overheating of organisms at extremely high temperatures (in excess of 30°C). Cyprinid fish species, including the qualifying species *Rutilus pigus* (Danube roach), which is found in the Lower Sava SAC Natura 2000 area (SI3000304), are predominant in the Sava downstream of Krško NPP. Regarding the provisions of the Decree on the emission of substances and heat in the discharge of wastewater into waters and the public collection system, the limit for excessive thermal load on cyprinid waters is 28°C. The measure has been imposed with due regard to point 7 of Article 4 in conjunction with the third indent of the first paragraph of Article 8, as well as with the third indent of point 3 of the first paragraph of Article 11, of that Decree.

The ministry imposed the measures referred to in points II/1.12 and II/1.13 of the operative part of the environmental protection consent in order to ensure compliance with the requirements referred to in points II/1.10 and II/1.11 of the operative part of the environmental protection consent. The EIA Report states that if the flow rate of the Sava is less than 100 m^3/s, Krško NPP shall activate the cooling towers, which employ circulation to cool some of the condenser water. In the document titled "Third Supplement to the Application for an Environmental Protection Consent for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years: presentation of evidence", no. ING.DOV-178.22/2022 of 6 May 2022,

which contains four appendices, the developer explained in Appendix 1 that by adhering to the limits referred to in point 12 of the draft environmental protection consent from the public presentation, it covered all the requirements for the operation of the cooling towers under the applicable prescribed conditions in the environmental protection and water permits and that this indirectly includes a flow rate 100 m^3/s. It states that Sava flow rates of slightly below 100 m^3/s cause the difference/delta temperatures to exceed a daily average of 3°C when Krško NPP is at full power. A Sava flow rate of 100 m^3/s is therefore an internal parameter that tells Krško NPP operators to begin the procedure of preparing the cooling towers for use. According to the developer, the Sava flow rate is an indirectly limiting variable as Krško NPP operation is conditional upon ensuring that thermal load on the river is kept below the permitted level. It is frequently the case that the Sava flow rate is less than 100 m^3/s but that the thermal load on the Sava (3°C) still does not require activation of the cooling towers.
The ministry has taken into account the developer's explanation in the measure/condition referred to in point II/1.12 of the operative part of the environmental protection consent by requiring Krško NPP to activate the cooling towers, regardless of the Sava flow rate, in order to ensure compliance with the requirements of the measures/conditions referred to in points II/1.10 and in II/1.11 of the operative part of the environmental protection consent.
In response, the ministry stated, in the measure/condition referred to in point II/1.13 of the operative part of the environmental protection consent, that if the developer was unable to meet the requirements referred to in the measures/conditions referred to in points II/1.10 and II/1.11 of the operative part of the environmental protection consent by operating the cooling towers, it had to reduce electricity generation at the plant.

In point II/1.14 of the operative part of the environmental protection consent, the ministry imposed the measure of the sampling of Sava water at the Krško NPP offtake point and determining the parameters for undissolved substances and sedimentary matter on the basis of the findings in the EIA Report: that on days when the Sava flow rate is very high or it increases quickly, Krško NPP excessively pollutes the river by discharging wastewater with excessively high levels of these two parameters, which could be the result of turbidity or the high levels of undissolved substances and sedimentary matter at the Krško NPP offtake. By sampling Sava water at the offtake and analysing the undissolved substances and sedimentary matter, with the simultaneous sampling of these parameters in wastewater at the discharge from Krško NPP into the Sava, the developer will be able to demonstrate that the excessive levels of these two parameters at the discharge from Krško NPP is not the fault of the plant, but the consequence of the presence of the parameters at the Krško NPP offtake, thereby showing that Krško NPP does not affect the quality of the Sava with regard to these two parameters. In determining the parcel number of the land indicated by the coordinates at which the sampling of Sava water for the purpose of establishing the presence of undissolved substances and sedimentary matter is to be carried out, the ministry followed the suggestion made by the developer in statement no. ING.DOV-460.22 of 23 December 2022. The developer stated in that document that it agreed with the coordinates e=539923 and n=88683 (ministry's note: which is set at the same place as determined for the implementation of continuous measurements of the Sava flow rate at the offtake for Krško NPP; the determination of these coordinates is explained in the reasoning supplied for the measure/condition referred to in point II/1.3 of the operative part of the environmental protection consent). It explained at the same time that, in accordance with Supreme Court's historical extract from the Land Registry (from May 2011), the location of the property in cadastral municipality 1321 Leskovec had changed from land parcel no. 1249/1 to land parcel no. 1249/4. The ministry therefore followed the developer's suggestion and set the measuring point in land parcel no. 1249/4, cadastral municipality 1321 Leskovec.

As the EIA Report envisages steps to ensure that the limit values are preserved for the wastewater parameters as set out in the environmental protection permit, but not the monitoring of the presence of boron in wastewater from Krško NPP (boron does not have a set limit value in the environmental protection permit), even though this requirement is included in point 1.3 of the operative part of the environmental protection permit, the ministry has imposed the obligation on Krško NPP to perform its own measurements of boron in the wastewaters in which it could appear and to keep records of the results of these measurements as a measure in point II/1.15 of the operative part of the environmental protection consent.

The ministry imposed the measure referred to in point II/1.16 of the operative part of the environmental protection consent pursuant to Article 8 ZUOKPOE, with due regard to the restrictions resulting from remote impact on the Danube roach (explained in the reasoning supplied for point II/1.11 of the operative part of the environmental protection consent). Here the ministry also imposed in the measure/condition a requirement regarding the method by which temperature increase in the Sava is to be calculated using the results of the continuous measurements of the river's temperature.

Regarding the additional water protection measures set out in the EIA Report in relation to the expansion of the cooling tower system with the aim of reducing the abstraction of water from the Sava, reducing thermal load and increasing resilience to climate change, the ministry explains that it has not set them as a condition in the operative part of this environmental protection consent as these cooling towers have already been constructed. Four new cooling cells (a new cooling tower – CT3) were installed and all the electrical cooling tower equipment replaced. The expansion that took place in 2008 increased the power of the cooling towers by 36%.

After Krško NPP ceases operating, the use of water will decrease significantly relative to regular operation. The spent fuel pool will still have to be cooled, as will a number of other safety components, and water will be abstracted and returned to the Sava at a rate of approx. 1.6 m^3/s. Pumping from the well on the right bank of the Sava and from the BB2 well will decrease. Wells that maintain the level of groundwater will remain operational. Areas where wet works may be done will be equipped with drainage pits. Sampling will be carried out before the pits are emptied. If the limit values for discharges are exceeded, wastewater will be purified, solidified or processed in some other appropriate way, while the radioactively contaminated portion will be disposed of as LILW. The ministry estimates that the impact of the activity and the overall impact on surface waters and groundwater will be (4), i.e. impact not significant, if the activity is terminated. After Krško NPP ceases operating, there will be no more need for cooling water to be used for the technological process of electricity generation. Abandoning the proposed activity would therefore result in significantly reduced thermal pollution of the Sava from Krško NPP. The ministry estimates that the impact of the activity and the overall impact on thermal pollution of the Sava will be (4), i.e. impact not significant, if the activity is terminated.

B) Impact of climate change on the lifetime extension

B1) Present state of the environment

Krško is located in a temperate continental climate zone. The wider Krško area is characterised by relatively hot summers and mild winters. Average January temperatures are below zero and average July temperatures are almost 20°C.

The future course of climate change depends on actual greenhouse gas emissions. We can attempt to describe these emissions by using various RCP (Representative Concentration Pathway) scenarios. The scenarios are based on human activity-related emissions of CO_2, CH_4, N_2O and other air pollutants. The following is a summary of climate scenarios for the first (2011–2040) and second (2041–2070) 30-year period under the moderately optimistic scenario RCP4.5 that assumes significant emission mitigation actions, compared to the 1981–2010 average.

- Changes in air temperature:
  - 2011–2040: On average, Slovenia will warm by 1°C at the annual scale. A temperature rise of approx. 1°C is expected in all seasons except spring, where the projected rise is below 0.5°C;
  - 2041–2070: by the middle of the 21st century, Slovenia will warm by 2°C at the annual scale. As in the previous 30-year period, this period shows a fairly steady rise in summer, autumn and winter temperatures, and a slightly less pronounced rise in spring temperatures;
- Changes in precipitation:
  – 2011–2040: no significant changes in annual precipitation are expected, although there are slightly

more pronounced precipitation change signals at the seasonal scale. The most significant change is projected for winters, when an increase in precipitation is likely;
– 2041–2070: by the middle of the century, changes in precipitation will intensify. At the annual level, precipitation is projected to increase in the eastern half of the country, while for the western half of the country the precipitation increase signal is weaker. Changes at the seasonal scale are expected to be greater than those at the annual scale. The winter precipitation increase signal will continue to strengthen relative to the preceding 30-year period, and the eastern half of the country is also expected to experience more precipitation in the autumn. For summer, the precipitation change signal shows a decrease, particularly in the southern half of the country, whereas in spring, the signal is the least pronounced, indicating a slight increase in precipitation in the western part of the country;

- Changes in potential evapotranspiration:
  – 2011–2040: major changes in potential evapotranspiration are not expected in the near future, with the clearest change signal indicating an increase in potential evapotranspiration in autumn;
  – 2041–2070: by the middle of the century, changes in potential evapotranspiration will be more pronounced. An increase at the annual scale is projected, which will be most pronounced in the southwest of the country. At the annual scale, changes will be primarily driven by the increase in potential evapotranspiration in summer and autumn, while the increase in spring and winter will be less significant.

According to climate projections for the 21st century, the following changes in hydrological conditions can be expected in Slovenia ("Climate change estimates for Slovenia up to the end of the 21st century – Summary of temperature and precipitation averages", Slovenian Environment Agency, http://meteo.arso.gov.si/uploads/probase/www/climate/text/sl/publications/povzetek -podnebnih-sprememb-temp-pad.pdf):

- under all emission scenarios, no major changes in mean annual flow rates are expected in Slovenia compared to the 1981–2010 period, with the exception of the northeast, where flow rates could increase by up to 30% by the end of the century under the moderately optimistic scenario (RCP4.5). Under the pessimistic emission scenario (RCP8.5), the increase in the northeast of Slovenia could reach up to 40% by the middle of the century;
- compared to the 1981–2010 period, mean annual peaks will rise throughout the country, on average between 20 and 30% under all emission scenarios. This increase will intensify from the near future towards the end of the century. The increase in peaks will be most significant in the northeast of the country, reaching up to around 30% under the moderately optimistic emission scenario. Under the pessimistic emission scenario, the increase will range from 20 to 40% at almost all gauging stations at the end of the century. Under the moderately optimistic and pessimistic scenarios, changes in moderately low flow rates are spatially uneven, showing a significant increase of around 20% only in parts of the northern half of Slovenia;
- under all emission scenarios, an increase in annual 100-year-flood levels is expected for all periods in the future relative to the 1981–2010 period, throughout the majority of the country. Under the RCP2.6 emission scenario, the largest increase is projected in the eastern part of the country and the rivers of the Adriatic basin. Under the RCP4.5 and RCP8.5 emission scenarios, the increase in 100-year-flood levels is not as significant as in RCP2.6 scenario. Larger increases are expected in the northeast of the country.

B2) Expected impact of climate change on the lifetime extension

Section 5.6 (Impact of climate change on the lifetime extension) of the EIA Report analyses the impact of climate change on Krško NPP operation in terms of efficiency, total electricity generation, the availability of electricity for users and the associated environmental impacts. The analysis relates to the normal operation of the power plant, which is defined by six possible states: power operation, start-up, hot standby, hot shutdown, cold shutdown and refuelling.

The analysis comprises seven modules:

- Module 1: Sensitivity analysis
- Modules 2a and 2b: Assessment of exposure
- Modules 3a and 3b: Vulnerability analysis (electricity production)

- Module 4: Risk assessment (changes in electricity production and environmental impacts)
- Module 5: Definition of the ability to adapt
- Module 6: Assessment of the ability to adapt
- Module 7: Inclusion of an adjusted action plan in the lifetime extension.

During the impact assessment, it was found that Krško NPP's production of electricity was sensitive to three climatic variables: access to water from the Sava, the temperature of the Sava and extreme outdoor temperatures.

The plant takes water from the Sava to cool its condensers, the turbine cycle and the safety components. In periods of reduced Sava flow rate, the plant activates its cooling towers to discharge some of its heat through the recirculation cycle. The plant is therefore able to maintain a temperature difference of no more than ΔT 3°C regardless of the state of the Sava. This will remain unchanged in the plant's future operation as well.

In 2008 the plant supplemented its cooling capacities with the construction of a third block of cooling towers. This has strengthened the plant's resistance to changes that could be connected with a future reduction in the river's flow rate and a rise in air and water temperatures. The construction of a system of hydropower plants on the lower reaches of the Sava has moderated variations in the river's flow rate and temperature, which has had a favourable effect on the stability of production.

The impact of climate change on safety is analysed in accordance with the legislation and regulations governing nuclear safety and ionising radiation protection. In combination with other natural and other occurrences, extreme weather conditions are an integral part of power plants' safety analyses. The Periodic Safety Review (PSR), which must be conducted every ten years, includes an analysis of the impact of climate change, and the basic document on the operation and safety of power plants, which is the Updated Safety Analysis Report (USAR), is constantly updated to address all the major safety aspects into account.

After studying the impact of climate change on the lifetime extension, the ministry finds that, in view of the existing measures and the standard review of operations carried out as part of the PSR process, the climate changes associated with extreme weather conditions will have no significant impact on the activity (lifetime extension). The ministry assesses that the impact of the activity and the overall impact of climate change on the activity during operation will be (3), i.e. impact not significant, on account of the mitigation measures referred to in point II/1 of the operative part of this environmental protection consent. In line with the SNSA's opinion, the ministry has, in point II/1.17 of the operative part of this environmental protection consent, also ordered the constant monitoring and detailed analysis of extreme weather events. If the effects of extreme weather events exceed the design bases of the plant's structures, systems or components (SSCs), those SSCs must be upgraded on the basis of an analysis, or protected against the effects of such extreme events. In periods not longer than the interval between two consecutive PSRs, the cumulative impact of extreme weather events, including combinations of such events, must be subjected to an in-depth analysis.

Krško NPP is already implementing the following measures (and will be required to continue to do so during its extended operational lifetime):

- if the flow rate of the Sava is less than 100 m^3/s, Krško NPP activates the cooling towers, which employ circulation to cool some of the condenser water;
- the plant's SSCs are dimensioned to withstand extreme weather events and meteorological parameters with a high level of conservatism, as dictated by nuclear legal framework requirements, global practices and the best available techniques (BAT);
- the Periodic Safety Review, which is performed every ten years, includes an in-depth analysis of the impact of extreme weather events on the safety of the plant. Two reviews will be performed in the coming period: 2021–2023 and 2031–2033;
- measures from the environmental protection consent related limiting the thermal load and water capture through the use of a combined cooling system (once-through system and cooling towers). In all Sava flow rate conditions, the power plant maintains a temperature difference of no more than ΔT 3°C, which will not change during the plant's future operation. Krško NPP supplemented its cooling facilities with the construction of a third block of cooling towers in

2008;

- the plant has preparation procedures in place to respond to hydrological conditions that may affect its operation: activation of cooling towers when water levels are high, to guard against the risk of inflow of debris (branches, plastic etc.);
- the plant has procedures in place for cooperating with other energy facilities on the Sava (Agreement on measures and obligations to ensure unchanged, safe and uninterrupted operation of Krško NPP during the operation of hydropower plants on the Lower Sava, with additional monitoring activities 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. The measurements are reported on an annual basis.

The frequency or impact of extreme weather events could increase as a result of the climate changes that the EIA Report predicts will take place during the period leading up to the end of Krško NPP's extended operational lifetime. Krško NPP must therefore monitor such events particularly carefully, analyse them in detail and take the appropriate steps set out as a condition in the operative part of the SNSA opinion. The basis for addressing extreme events and planning power plant SSCs so that they are able to withstand those events are requirements set out in the Rules on radiation and nuclear safety factors, particularly Annex 1, Chapter 5.

Climate change will no longer have any significant impact on production when operations at Krško NPP come to an end. The impact of climate change on the safety of the plant will be lower when the activity is being terminated than it was during the plant's operation. In terms of safety, water will still have to be secured for the cooling of spent fuel. The ministry estimates that the impact of the activity and the overall impact of climate change on the activity will be (4), i.e. impact not significant, when the activity is being terminated.

C) Impact on biodiversity and nature reserves

C1) Present state of the environment

The information on flora and fauna (except fish) and habitat types in the area under consideration is based primarily on the findings of a study carried out in 2008 as part of the background documentation for the development of the Brežice and Mokrice hydropower plants. This study was published as: "Survey of animal and plant species and their habitats and mapping of habitat types with particular regard for species of Europe-wide importance, ecologically important areas, special protection areas, protected areas and valuable natural features in the area of influence of the planned Brežice and Mokrice hydropower plants" (Editors: Govedič, M., A. Lešnik & M. Kotarac). Published by the Centre for Cartography of Fauna and Flora in conjunction with the Lutra Institute for the Conservation of Natural Heritage, the Research Centre of the Slovenian Academy of Sciences and Arts, the National Institute of Biology, VGB Maribor and the Biology Department of the Biotechnical Faculty at the University of Ljubljana (hereinafter: CKFF, 2008).

Flora and habitat types

The area of the lifetime extension comprises the built area inside the Krško NPP complex enclosure, the car park, the access road, the dam on the Sava and the pumping well on the right bank of the river. Located in the immediate surroundings of the Krško NPP complex are areas of intensive orchards (HT 83.22 Shrub and low stem tree orchards). The area on the left bank of the Sava is for the most part under the influence of intensive agriculture (orchards, fields) and the Vrbina industrial zone. There are therefore no habitat types of greater nature conservation significance within the narrower area of controlled use (650 m) on the left bank of the Sava.

In the wider area of controlled use (1,500 m) to the north and east of Vrbina industrial zone, we still find some preserved extensive meadows (HT 34.322 Medio-European moderately dry grasslands with dominant species *Bromus erectus*). Such grasslands were once common on carbonate gravel deposits by rivers, but are almost no longer found today because they have been converted into fields or intensive

meadows. The Decree on habitat types (Official Gazette of RS, Nos. 112/03, 36/09 and 33/13) lists them as one of the habitat types in danger of disappearing in the European Union, and they have been defined as priority natural habitat types by EU regulations governing the conservation of wild fauna and flora. We can identify them by the presence of erect brome (*Bromus erectus*), a characteristic component of turf, while other common grass species include quaking grass (*Briza media*), heath false brome (*Brachypodium pinnatum agg.*), cat grass (*Dactylis glomerata*) and furrowed fescue (*Festuca rupicola*). This habitat type also typically features orchids (*Orchidaceae*).
Riparian woody vegetation (HT 44.132 Eastern European white willow forest with poplars) still survives along the Struga stream. This habitat type is also listed by the Decree on habitat types as one of the habitat types in danger of disappearing in the European Union, and they have been defined as priority natural habitat types by EU regulations governing the conservation of wild fauna and flora.
The Sava flows past the Krško NPP complex on its south side. The banks of the river directly adjoining the Krško NPP complex are covered with tall herbaceous species (HT 37.7 Nitrophilous woodland edge fringes and humid riverside tall herbaceous cover), while upstream and downstream we find HT 44.132 Eastern European white willow forest with poplars and HT 44.42 remnants of medio-European oak-ash-elm groves in a narrow belt along the bank. On the right bank of the Sava, the original riparian woody vegetation has, for the most part, been cleared. In this area, which is also a designated Natura 2000 Special Area of Conservation (known as Vrbina SAC), there is a mosaic of various habitat types. Here we find extensive meadows (HT 34.322 Medio-European moderately dry grasslands with dominant species *Bromus erectus* and HT 34.323 Medio-European moderately dry grasslands with *Brachypodium pinnatum agg.*) and moderately cultivated meadows (HT 38.221 Xero-mesophile medio-European lowland hay meadows on relatively dry soils and slopes with *Arrhenatherum elatius* the dominant species). In places the area is overgrown with tree and shrub species (HT 31.8121 Medio-European *thermophilous basiphilous* thickets with wild privet and blackthorn, HT 31.8D Shrubby deciduous forests and areas overgrowing with deciduous tree species). Also present is the black locust (*Robinia pseudoacacia*), a non-native tree species – HT 83.324 Locust tree populations and stands.
Numerous orchid species thrive in medio-European moderately dry grasslands with *Bromus erectus* the dominant species. Species recorded in this area include the green-winged orchid (*Orchis morio*), bug orchid (*Orchis coriophora*) and early spider-orchid (*Ophrys sphegodes*). All three species are included as vulnerable species in the Red List of Vascular Plants (Rules on the inclusion of endangered plant and animal species in the Red List, Official Gazette of RS, Nos. 82/02 and 42/10). *Pulsatilla nigricans*, which is likewise included in the Red List as a vulnerable species (Bioportal, 2020, http://www.bioportal.si/, February 2020), is also recorded in the wider area. According to data from 2008, a further nine orchid species occur in the wider area, including, from the Red List, *Phleum paniculatum* (rare species), *Agrostemma githago* (vulnerable species), *Ballota nigra* (little-known species), *Fragaria viridis* (vulnerable species), *Muscari botryoides* and *M. comosum* (both vulnerable species) and *Orobanche teucrii* (little-known species). Some orchid species, the perennial bunchgrass *Chrysopogon gryllus*, the sedge *Carex liparocarpos* and the flowering plant *Seseli annuum* have very large populations in the wider area of Vrbina SAC (CKFF, 2008).

Fauna
Mammals (*Mammalia*)

Bats (*Chiroptera*)
The immediate surroundings of the Krško NPP complex also include habitats suitable for bats. Humid forest or forest fringe areas maintaining large numbers of arthropods, particularly insects, are particularly important feeding areas for bats. Insects are the principal source of food for the bats present in the area. Other favourable bat-feeding areas are riverbanks with old-growth tree cover such as the banks of the Sava and the surroundings of the Struga stream, as well as the overgrown area on the right bank of the Sava. Many bat species (e.g. Kuhl's pipistrelle, serotine bat) roost in cracks and crevices in buildings. Tree bats (e.g. noctule bats, Daubenton's bat) roost in tree hollows and cracks in older deciduous trees, which in the area in question can be expected to be found in habitat types such as Eastern European white willow forest with poplars and remnants of medio-European oak-ash-elm

groves. Many bat species in Slovenia hibernate in caves and other underground spaces. All bats are classified as endangered species (Rules on the inclusion of endangered plant and animal species in the Red List) and are protected by the Decree on protected wild animal species (Official Gazette of RS, Nos. 46/04, 109/04, 84/05, 115/07 [Constitutional Court Decision, 13 March 2008], 96/08, 36/09, 102/11, 15/14 and 62/19). Within the wider surroundings of the area in question, bats have been observed in St Anne's Church in Leskovec (greater horseshoe bat – *Rhinolophus ferrumequinum*) and the bell tower of St Rupert's Church in Krško (Greater mouse-eared bat – *Myotis myotis*). The calls of the long-eared bat (*Plecotus* sp.) have been recorded in Krško, while calls of Daubenton's bat (*Myotis daubentonii*) are particularly numerous by the Sava. Calls of the common noctule (*Nyctalus noctula*) have been recorded here in the autumn. The common pipistrelle (*Pipistrellus pipistrellus*), soprano pipistrelle *(Pipistrellus pygmaeus*), Kuhl's pipistrelle (*Pipistrellus kuhlii*) and serotine bat (*Eptesicus serotinus*) have been recorded on the banks of the Sava and in settlements in the wider area. Individual specimens of the Mediterranean horseshoe bat (*Rhinolophus euryale*) can be expected on the bank of the Sava in the surroundings of Krško, while Geoffroy's bat (*Myotis emarginatus*) can likewise be expected in the vicinity of bodies of water (CKFF, 2008).

<u>Otter *(Lutra lutra)*</u>
The otter maintains a constant presence in the area of the Sava. Its tracks or other signs of its presence have been recorded in riverside and riparian habitats. Gravel pits also constitute an important part of its habitat. Tributaries, particularly their mouth sections, are an extremely important part of the otter's habitat since they provide a sufficient variety of fish species for the otter's diet and also an adequate quantity of food. The area of the Krško NPP complex and its immediate surroundings do not represent a favourable otter habitat, and signs of otter presence have not been observed in the surroundings of the plant (CKFF, 2008).

<u>European beaver (*Castor fiber*)</u>
The area of the Sava in the immediate vicinity of Krško NPP does not represent a suitable beaver habitat, although the Sava, particularly its lower course, is an important corridor for the recolonisation of past beaver habitats across Slovenia (CKFF, 2008). Traces of beaver activity have already been observed near Krško, although these probably do not indicate the presence of a family.

<u>Large carnivores</u>
Owing to human settlement and traffic impact, the role of the Krško/Brežice Basin is limited to that of a transitional microhabitat (albeit an important one) for the wolf (*Canis lupus*) and brown bear (*Ursus arctos*). Both species maintain a permanent presence in the hills of the Gorjanci range, and also occasionally appear in the Krško/Brežice Basin. It is assumed that wolves pass from the Gorjanci through the forest of Krakovski Gozd and the Krško/Brežice Basin to Bohor and Orlica, and then continue on towards the northeast. Individual bears moving towards the north cross the Sava near Sevnica and continue on towards Bohor and Orlica. In order to cross the river, they need a natural riverside area with banks that are at least partly accessible and passable (CKFF, 2008).
<u>Red deer (*Cervus elaphus*)</u>
The Krško/Brežice Basin represents a passage or functional connection between the Gorjanci in the south and the Posavje Hills and Bohor and Orlica in the north. Today's habitat conditions are favourable for deer, above all because of the state of conservation of riparian vegetation and other habitat types offering ample food and protection (surviving islands of forest of various sizes, field boundaries, etc.). At present, the area between Krško and Brežice is still permeable enough to allow deer to pass between the Gorjanci and Bohor and on towards the Pohorje, which ensures gene flow among population units in its margins. While deer are good swimmers, they prefer to cross running waters in shallows, in places with suitably shaped banks and riverbank vegetation, in which they generally remain for a short while after crossing the watercourse. Owing to relatively natural river flow dynamics, there are still sufficient shallows, banks, isolated rocks and overgrown riverbank areas between Brežice and Obrežje to allow deer to cross and provide them with cover (CKFF, 2008).

Other mammals

The Krško/Brežice Basin represents a central optimal habitat type for the European hare (*Lepus europaeus*). The wild boar (*Sus scrofa*) is another occasional presence here, crossing from the SE parts of the Gorjanci to agricultural land (fields). Thanks to the presence of stands of forest, other mammals present in the Krško/Brežice Basin include roe deer (*Capreolus capreolus*), badger (*Meles meles*), beech marten (*Martes foina*), European pine marten (*Martes martes*) and fox (*Vulpes vulpes*). Riverside habitats along the Sava are a very important feeding area for the European polecat (*Mustela putorius*) The stoat (*Mustela erminea*) is also likely to be present in fields, meadows and humid habitats, while the least weasel (*Mustela nivalis*) is probably present in open flat plains (CKFF, 2008). Numerous species of shrew and other small mammals are found across the wider area (Kryštufek, B. 1991. *Sesalci Slovenije* (Mammals in Slovenia), Natural History Museum of Slovenia, Ljubljana, 294 pp.).

Birds

The Sava is a habitat for numerous bird species, with the common sandpiper (*Actitis hypoleucos*) and common kingfisher (*Alcedo atthis*) among the species that nest here. The commonest species in the agricultural cultural landscape of the wider area are the Eurasian skylark (*Alauda arvensis*), the house sparrow (*Passer domesticus*) and the Eurasian blackcap (*Sylvia atricapilla*), while the area is also an important feeding ground for the rook (*Corvus frugilegus*) and a nesting area for vulnerable species such as the common nightingale (*Luscinia megarhynchos*), the Eurasian skylark (*Alauda arvensis*), the crested lark (*Galerida cristata*) and the northern lapwing (*Vanellus vanellus*). In areas of alternating dry meadows and shrubland, the commonest species besides the Eurasian blackcap are the great tit (*Parus major*) and the common pheasant (*Phasianus colchicus*), while the barred warbler (*Sylvia nisoria*) and European turtle dove (*Streptopelia turtur*) populations are important from a nature conservation perspective. Of the owls, the long-eared owl (*Asio otus*) and the tawny owl (*Strix aluco*) have been recorded in the wider area (CKFF, 2008).

Amphibians

The site of the lifetime extension itself and the areas of intensive orchards in the immediate vicinity of the Krško NPP complex do not represent a suitable habitat for amphibians. Suitable habitats for amphibians are located above all in the surroundings of the Struga stream, oxbows, channels, gravel pits and the mosaic of forest habitats on the left and right banks of the river. The European tree frog (*Hyla arborea*), the agile frog (*Rana dalmatina*), the common frog (*Rana temporaria*), the common toad (*Bufo bufo*), the Eurasian water frog (*Pelophylax* sp.), the Italian crested newt (*Triturus carnifex*), the smooth newt (*Lissotriton vulgaris*), the alpine newt (*Ichthyosaura alpestris*) and the European green toad (*Bufotes viridis*) are all found in the wider surrounding area (CKFF, 2008).

Reptiles (*Reptilia*)

Only the common wall lizard (*Podarcis muralis*) can be expected within the anthropogenic habitats of the site of the lifetime extension. We can expect to find the sand lizard (*Lacerta agilis*) in humid areas near water that are partly overgrown by shrubs or tall herbaceous cover. Large numbers of European green lizards (*Lacerta viridis*) have been recorded in the area of shrubland on the right bank of the Sava opposite Krško NPP. The river itself and the riparian zone are an important habitat for the dice snake (*Natrix tessellata*), while we can also expect the grass snake (*Natrix natrix*) to be present by bodies of water (especially standing water). We can expect the slow worm (*Anguis fragilis*) to be generally distributed across extensively cultivated areas of farmland and shrubland, where we can also expect the rarer Aesculapian snake (*Zamenis longissimus*). Shrubland also provides a habitat for the smooth snake (*Coronella austriaca*).

Fish (Pisces) and crustaceans (Crustacea)

The Struga stream is not subject to fishery management and is not entered in the fisheries register. The section of the Sava that flows past the Krško NPP area belongs to the Sava 19 fishing district (the Sava from the mouth of the Blanščica to Turški Brod). The Fishing Registry (2018), maintained by the Fisheries Research Institute of Slovenia, gives 40 species of fish for the Sava 19 fishing district

(https://webapl.mkgp.gov.si/apex/f?p=136:62:10783274489156::NO:RP:P62_ID_REVIR:41, May 2019).
An ichthyological study of the Brežice HPP reservoir in 2019 confirmed the presence of 27 fish species, of which 24 were native and three were non-native species (stone moroko (*Pseudorasbora parva*), pumpkinseed (*Lepomis gibbosus*) and Prussian carp (*Carassius gibelio*)) ("Monitoring of fish in the Brežice HPP reservoir and its tributaries in 2019", Fisheries Research Institute of Slovenia, Spodnje Gameljne, May 2020).

<u>Invertebrates (*Invertebrata*)</u>
Molluscs (*Mollusca*)
Of the mollusc species important from a nature conservation perspective, specimens of the narrow-mouthed whorl snail (*Vertigo angustior*) have been found in the upper course of a tributary of the Struga stream. The big-ear radix (*Radix auricularia*) has been observed at the Stari Grad gravel pit. No other protected or endangered species of mollusc have been observed in the immediate vicinity of Krško NPP. The area of grassland and shrubland on the right bank of the Sava is also important for molluscs, and the variety of mollusc species here is extremely high (CKFF, 2008).

Butterflies and moths (*Lepidoptera*)
Inventories of butterflies have been carried out in the area of dry meadows and shrubland on the right bank of the Sava, although we can also expect the observed species of butterflies in dry meadows and shrubland in the area around the Vrbina industrial zone and the Struga stream. The large copper (*Lycaena dispar*) was recorded in meadows on the right bank of the Sava in 2001, while studies carried out in 2008 recorded 58 species there, including the southern festoon (*Zerynthia polyxena*), Nickerl's fritillary (*Melitaea aurelia*), Assmann's fritillary (*Melitaea britomartis*), the southern small white (*Pieris mannii*), the northern blue (*Plebeius idas*), the mallow skipper (*Carcharodus alceae*), the feathered footman (*Spiris striata*) and the small bagworm moth (*Ptilocephala plumifera*). The area is also important as a favourable habitat for a number of other grassland and shrubland xerothermophilous species of diurnal lepidoptera such as the scarce swallowtail (*Iphiclides podalirius*), the black hairstreak (*Satyrium pruni*), the sloe hairstreak (*S. acaciae*) and the spotted fritillary (*Melitaea didyma*) (CKFF, 2008). Caterpillars of the eastern eggar (Eriogaster catax) were also observed there in 2018 (Bioportal, 2020. http://www.bioportal.si/ February 2020).

Dragonflies and damselflies (*Odonata*)
The exuvia of a green snaketail (*Ophiogomphus cecilia*) has been found in the riparian vegetation of the Sava 800 m below the Krško NPP dam. The green snaketail is a lowland river species and its larvae live on quieter stretches, buried in the sandy bottom. It is protected by the Decree on protected wild animal species as a species whose members are protected and habitats safeguarded. It is classified as a vulnerable species on the Red List of dragonflies and damselflies of Slovenia. The Sava is also a habitat of the common clubtail (*Gomphus vulgatissimus*), which also appears as a vulnerable species on the Red List of dragonflies and damselflies of Slovenia. Since there are no waterways apart from the Sava and the Struga stream in the direct vicinity of the site of the activity, the species variety of dragonflies and damselflies in this area is considerably lower than in more distant gravel pits and oxbow lakes. The goblet-marked damselfly (*Erythromma lindenii*) has been observed at the Stari Grad gravel pit, while the eastern willow spreadwing (*Chalcolestes parvidens*), southern emerald damselfly (*Lestes barbarus*), variable damselfly (*Coenagrion pulchellum*) and dainty damselfly (*Coenagrion scitulum*) have been observed at the abandoned gravel pit by the Močnik stream in Vrbina (CKFF, 2008).

Beetles (*Coleoptera*)
The surviving natural arboreal vegetation along the Struga stream represents a habitat for the European stag beetle (*Lucanus cervus*), where medium-large densities of this beetle were identified during a study in 2008 (CKFF, 2008). A potential habitat for this species is also represented by the arboreal vegetation along the Sava. Individual older trees along the Struga and Sava represent a potential habitat for the hermit beetle (*Osmoderma eremita*) and the marbled rose chafer (*Liocola lugubris*). Gravel beds in the

Sava are a potential habitat for the carabid beetles *Bembidion friebi* and *Lionychus quadrillum* (CKFF, 2008). Specimens of the weaver beetle (*Lamia textor*), a rare non-flying species that lives predominantly in stands of softwood deciduous trees, were found in overgrown meadows 1.1 km southeast of the Krško NPP dam in 2018 (Bioportal, 2020. http://www.bioportal.si/ February 2020).

Important ecological areas and valuable natural features

The area of the lifetime extension contains one important ecological area (IEA) as defined by the Decree on important ecological areas (Official Gazette of RS, Nos. 48/04, 33/13, 99/13 and 47/18): the Sava River from Radeče to the state border (ID 63700). This IEA comprises a stretch of the Sava that crosses the flat Krško Polje/Brežiško Polje from Krško to the mouth of the Sotla, where the river creates an extensive flood plain. It is an area with a great diversity of habitats in a relatively small space. Surviving gravel beds, sections of eroded walls, occasionally flooded channels, oxbow lakes, water meadows and fragments of lowland floodplain forest provide a habitat for numerous protected and threatened species. The fish species including the asp, the streber, the Danubian longbarbel gudgeon and the Balkan loach. Nine species of amphibians are present and there is also a varied avian fauna. Fragments of softwood floodplain forest connected to the remnants of poplar plantations and zones of riparian vegetation along the Močnik and Struga streams are a habitat for saproxylic beetles (scarlet flat bark beetle, hermit beetle and European stag beetle) and the narrow-mouthed whorl snail. The surviving fragments of once extensive dry grassland on the right bank in the Vrbina area are important orchid sites (Nature Conservation Atlas, ARSO; http://www.naravovarstveni-atlas.si/web/).

Valuable natural features

The nearest valuable natural features, as determined by the Rules on the designation and protection of valuable natural features (Official Gazette of RS, Nos. 111/04, 111/04, 70/06, 58/09, 93/10 and 23/15), are:

- Libna – linden tree next to the church (ID 7860). Linden tree by St Margaret's Church in Libna, east of Krško. A valuable botanical natural feature of local importance situated approx. 1,270 m north of the lifetime extension.
- Stari Grad – gravel pit (ID 7861). Aquatic biotope, stopover site for migrating birds and nesting area for endangered bird species southeast of Krško. A valuable ecological and zoological natural feature of local importance situated approx. 1,415 m east of the lifetime extension.

Protected areas

Within the 2,000-metre area of remote impact under the Rules, there is one Natura 2000 area as defined by the Decree on Special Protection Areas (Natura 2000 sites) (Official Gazette of RS, Nos. 49/04, 110/04, 59/07, 43/08, 8/12, 33/13, 35/13 [corrigenda], 39/13 [Constitutional Court Decision], 3/14, 21/16, 47/18), i.e. Vrbina SAC (SI3000234), which is approx. 350 m from the site of the proposed activity. Under Article 20 of the Rules, the area of remote impact established for the proposed activity affecting the environment may differ at any time from the area of remote impact of an activity affecting the environment referred to in Annex 2 of those Rules if this is based on findings from the field, detailed data on implementation of the activity and other actual circumstances. In addition to the remote impact within a radius of 2,000 m as defined by the Rules, remote impact is also possible downstream along the Sava. It is assumed that the area of remote impact downstream along the Sava stretches 8 km downstream of the discharges from Krško NPP, where the Sava has been declared a Natura 2000 area (Lower Sava SAC, SI3000304).

Vrbina SAC (SI3000234)

Three smaller areas of calcareous dry grasslands with orchid sites are defined on the right bank of the Sava on the flood plain between Krško and Brežice, while on the left bank, in Vrbina, there are fragments of softwood floodplain forest connected to the remains of poplar plantations and zones of riparian vegetation along the Močnik and Struga streams, which are a habitat for saproxylic beetles (scarlet flat bark beetle, hermit beetle and European stag beetle) and the narrow-mouthed whorl snail (Nature Conservation Atlas, ARSO; http://www.naravovarstveni-atlas.si/web/).

Qualifying species:

- Scarlet flat bark beetle – *Cucujus cinnaberinus* (1086)

The scarlet flat bark beetle is a small beetle measuring between 11 and 15 mm with an elongated, parallel, flattened body. The head, prothorax and elytra are bright red, while the legs and antennae are black. The head is wrinkled and the prothorax and elytra are ribbed. The species prefers to live under the rotting damp bark of deciduous trees (oak, poplar, maple and beech) or conifers (spruce, fir and pine). In both developmental phases it feeds predatorily, while the larvae also partly feed on wood detritus. The larvae are frequently found together with larvae of woodboring beetles, on which they also feed. Development lasts two years or more. The species is threatened by the forestry management method in which old and dying trees are removed (Nature Conservation Atlas, ARSO; http://www.naravovarstveni-atlas.si/web/).

- European stag beetle – *Lucanus cervus* (1083)

It is one the largest beetle species in Europe. Sexual dimorphism is very pronounced in this species. The male is usually bigger and grows to between 25 and 75 mm. The female is usually smaller and grows to between 30 and 50 mm. This large size range is the consequence of differences in the quality of food available to the larvae. The body is elongated, broad and partly flattened. The females have small jaws, while male's jaws are transformed into an antler-like formation, which is the origin of the name 'stag beetle'. The head, prothorax and legs are black or dark brown, while the colour of the elytra varies from dark brown to chestnut red. Development is tied to various species of deciduous trees, among which oaks predominate. Female stag beetles lay their eggs on or next to tree stumps or old or fallen trees. The larvae feed on dead or rotting tree roots and pupate in soil (at a depth of 15–20 cm). The full process of development takes place very slowly and can last up to five years. Adult beetles, which only live a few weeks, are mostly active at dusk and feed on a variety of plant secretions. In our assessment, the species is not yet endangered in Slovenia, although it has been placed on the Red List because of the excessive zeal of collectors (particularly for very large specimens of male stag beetles). An unsuitable forestry management intervention from the point of view of the species is cutting trees too low (just above the ground) (Nature Conservation Atlas, ARSO; http://www.naravovarstveni-atlas.si/web/).

- hermit beetle – *Osmoderma eremita* (1084)

The hermit beetle is a relatively large (20–35 mm) species of chafer, dark brown to purple in colour and difficult to confuse with other chafers. Larvae develop in deep tree hollows, for the most part in deciduous trees (oak, willow, fruit trees, lime tree, ash), where there is a larger quantity of decaying wood on which the larvae can feed. Development takes two to three or even four years, depending on the nutritional quality of the decaying wood on which they feed. Adult males only live a few days (10–20), while females can live up to a month or two. They feed on plant material and drink sweet tree sap. They are not very mobile and for the most part stay close to their place of development (hence the name "hermit"). For this reason, the proximity or density of tree hollows is important for their survival. As a result of human activity, this density is greatest in anthropogenic environments such as old tree avenues, riparian willow communities or tall orchards. One threat factor is therefore the abandonment of certain customs – e.g. the removal of large, old willow trees from riverbanks, changes in the method of agriculture and the disappearance of tall orchards. (Nature Conservation Atlas, ARSO; http://www.naravovarstveni-atlas.si/web/).

- narrow-mouthed whorl snail – *Vertigo angustior* (1014)

The shell of this tiny snail is 1.8 mm high and 0.9 mm wide, sinistral, with five whorls, a finely ribbed surface, red-brown in colour and glossy. The species is found in tall herbs in marshy meadows and valley groves, in sedges and among mosses in bogs, and in the leaf litter of waterside shrubs and bushes. It frequently lives on the boundaries of different habitats, for example the boundary between reed beds and marsh or in the transitional zone between grassland and salt marsh. It can also live in completely dry environment such as dry forests. It is sensitive to rapid changes in humidity in its habitat, to changes in grazing conditions (it tolerates grazing to a certain extent) and to physical disturbances. In areas liable to flooding, it is important that higher sections of bogs and reed beds are preserved, since these represent flood refuges. (Nature Conservation Atlas, ARSO; http://www.naravovarstveni-atlas.si/web/).

Qualifying habitat types:

- 621017 Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*)

This habitat type consists of meadows or pastures on limestone, dolomite or, more rarely, flysch, or on sand and old gravel beds. Growing sites are dry, light and warm. The substrate is neutral or slightly basic, with few nutrients. They do not tolerate fertilisation, except on very arid soil, where they also do well with moderate fertilisation. They grow on the slopes of hills (except north-facing slopes) where the soil is shallow and the ground is bare in places. They do not tolerate high levels of moisture or stagnation of water. They need extensive pasture or mowing 1–2 times a year, first after the majority of meadow plants have finished flowering, without fertilisation, with hay drying in the meadow, and are not damaged by pasture at the end of the season (August–October). In Slovenia, this habitat type appears in scattered form on suitable surfaces (unfertilised, particularly calcareous soils, sunny slopes). Threats include fertilisation of meadows, hay baling, conversion of meadows into fields, overgrowing with woody species and, in places, hill walking and infrastructure developments. (Nature Conservation Atlas, ARSO; http://www.naravovarstveni-atlas.si/web/).

– 6510 Lowland hay meadows (*Alopecurus pratensis, Sanguisorba officinalis*) Lowland hay meadows thrive on moderately fertilised, damp to moderately dry soils. They are mown two or three times a year. In the traditional cultural landscape, they usually appear as part of a mosaic that also includes dry and damp meadows. They are found across Slovenia but are rare in the Slovenian part of the Istrian peninsula and on the Karst plateau. They are not present in high mountain areas. Three forms of this habitat type are present in Slovenia: damp, dry and mesophilic. The last of these is, for the time being, least at risk, while dry grassland is most at risk from overgrowing, and damp grassland from drying out and intensification of meadows (conversion into fields, oversowing with grass mixtures, baling, overfertilisation, over-frequent mowing). (Nature Conservation Atlas, ARSO; http://www.naravovarstveni-atlas.si/web/).

Lower Sava SAC (SI3000304) – approx. 8 km from the site of the activity.

The Sava from the mouth of the Krka to the national border represents a connecting habitat for Danube roach populations from the Sotla and Krka rivers. (Nature Conservation Atlas, ARSO; http://www.naravovarstveni-atlas.si/web/). Following the decision of a biogeographical seminar held in Ljubljana in June 2014 to ensure the connectivity of the Danube roach population between the Krka and the Sotla, the section of the Sava between the mouth of the Krka and the national border with Croatia was defined as a new area for the species *Rutilus pigus*. The Danube roach that live in Slovenia actually belong to the species *Rutilus virgo* (common name: cactus roach), once defined as the subspecies *Rutilus pigus virgo*. Today this is defined as a species in its own right that inhabits the Danube basin, unlike *Rutilus pigus*, which naturally inhabits the northern part of the Adriatic basin. Lake populations of *Rutilus pigus* inhabit deep open lakes in Italy, while river populations inhabit tributaries of the Po. The distributions of the two species do not overlap and *Rutilus pigus* does not live in Slovenia. The species *Rutilus pigus* is, however, defined as a qualifying species for all Natura 2000 areas in Slovenia on the reference list of Natura 2000 species, since this name derives from the Habitats Directive and, in the case of Slovenia, covers the species *Rutilus virgo* (interpretation of the ZRSVN).

Qualifying species:

- Danube roach – *Rutilus pigus* (1114)

The cactus roach is 60 cm long with a laterally flattened body that is silver in colour, passing to grey-green on the back. The mouth is inferior. It lives in moderately rapid flowing medium to large watercourses. At spawning time it also finds its way into smaller watercourses with submerged aquatic plants and/or a gravel bed. Even at this time it prefers faster flowing waters. It spawns from April to May in tributaries and backwaters, and usually deposits roe on plants or the stream bed. Males develop large white breeding tubercles on the back and head during spawning. The cactus roach feeds on aquatic plants and aquatic invertebrates. In Slovenia it is found in all watercourses of the Danube basin. The largest populations are in the basin of the Ljubljanica, the lower course of the Sava, the Mirna, the Krka and the Kolpa. It is an endemite of the Danube basin. In terms of ecological characteristics, the Danube roach is classified as a rheophilic, potamic, lithophilic or litho-phytophilic and invertivore fish which, according to some sources, migrates for short distances and, according to others, migrates more than 150 km.

C2) Expected impact during operation and the conditions

Flora and habitat types

During operation, safety requirements will dictate the need to maintain tree and shrub vegetation in the Krško NPP buffer zone (prevention of overgrowth). The impact will be direct, medium-term and localised, and will only entail preserving the current situation. Because Krško NPP will operate with its existing infrastructure, there will be no other direct impacts on vegetation and land habitat types. During operation, Krško NPP does not release ionising radiation into the environment that could have a significant impact on the flora in the area surrounding the plant. Engineered safety features prevent the uncontrolled release of radioactive material into the environment. Engineered safety features have been designed to provide safety functions in all operational states, even in the event of the failure of specific equipment. The release of radioactive material into the environment is prevented by four successive safety barriers. The basic objective of the first three barriers is to prevent radioactive material from passing to the next barrier, while the fourth barrier prevents radioactive material from being released directly into Krško NPP's surrounding environment. As the annual dose at the Krško NPP perimeter fence will not exceed the limit of 200 µSv as a result of the lifetime extension, the ministry estimates an insignificant impact.

A sustained impact on the vegetation and habitat types in the vicinity of Krško NPP could occur in the event of a serious accident resulting in the release of radioactive material into the environment. Numerous safety upgrades have been implemented at Krško NPP. For this reason, the possibility of damage to the core is very small. Krško NPP was designed to withstand design-basis accidents and to manage them using its engineered safety features. Krško NPP can use the DEC-A equipment to prevent reactor core meltdown, while the DEC-B equipment has been provided for the purpose of managing the occurrence of a very unlikely core meltdown, and focuses on protecting the final barrier before release, i.e. the integrity of the containment. The passive filter system serves to relieve the pressure in the containment, while environmentally harmful substances remain trapped in the filters. Direct release into the environment is therefore unlikely. The ministry estimates that the impact of the activity and the overall impact on flora and habitat types during operation will be (4), i.e. impact not significant.

Fauna

Impacts on fauna will not change relative to the current situation. The duration of those impacts will, however, be extended. During operation, Krško NPP does not release ionising radiation into the environment that could have a significant impact on the fauna in the area surrounding the plant. Engineered safety features prevent the uncontrolled release of radioactive material into the environment. Engineered safety features have been designed to provide safety functions in all operational states, even in the event of the failure of specific equipment. The release of radioactive material into the environment is prevented by four successive safety barriers. The basic objective of the first three barriers is to prevent radioactive material from passing to the next barrier, while the fourth barrier prevents radioactive material from being released directly into Krško NPP's surrounding environment. As the annual dose at the Krško NPP perimeter fence will not exceed the limit of 200 µSv as a result of the lifetime extension, the ministry estimates an insignificant impact.

The entire exterior of Krško NPP is illuminated for the purpose of ensuring physical protection, i.e. security. As its external lighting is an integral part of the technical systems for ensuring physical protection, Krško NPP is not bound by the Decree on limit values for light pollution, but by the Rules on the physical protection of nuclear facilities and nuclear and radioactive material, and the transport of nuclear material. Light pollution primarily impacts insects that are active at night, i.e. stag beetles (*Lucanus cervus*), which are attracted by artificial light sources and remain fixated on light instead of searching for food or a mate. The lifetime extension will not lead to a change to Krško NPP's lighting arrangements. A beetle census (CKFF, 2008) revealed that the densest populations of stag beetles were in a wooded area on the left bank of the river, around 2.5 km from the Krško NPP complex. The impact will be insignificant.

Krško NPP uses water from the Sava. It returns used water to the Sava, and therefore has no impact on the river's hydrological regime. Only emissions of substances and heat by Krško NPP could potentially have impacts on the Sava. Such impacts are of a long-term nature (over the entire operational lifetime) and remote. During operation, Krško NPP occasionally discharges liquids from discharge tanks into the environment in a controlled manner. Liquids with low activity levels are discharged into the Sava via the essential service water channel, which is located upstream of the Krško NPP dam. Radioactive liquids from waste monitoring tanks and the steam generator blowdown system are discharged via that channel. Liquid radioactive waste from Krško NPP is treated in a treatment plant that comprises reservoirs, pumps, filters, an evaporator and two demineralisers. Blowdown water from the steam generators is treated separately. Tritium (H-3) is regularly present in liquid effluents discharged by Krško NPP. Tritium is an isotope that emits non-penetrating beta radiation, but it is only slightly radiotoxic (the limit value for tritium in potable water is 100 Bq/l). In 2020 the average monthly activity concentration of H-3 in Krško in front of Krško NPP (natural background) was slightly below 0.6 kBq/m^3. The long-term average (since 2002) of monthly H-3 activity concentrations in Brežice is 4.0 kBq/m^3. The average over several months (since July 2017) of monthly H-3 activity concentrations at the sampling station in front of Brežice HPP dam is 2.9 kBq/m^3. The concentrations of tritium activity in Jesenice na Dolenjskem are lower as a result of the additional dilution of the Sava by the Krka and the Sotla. The long-term monthly average of H-3 activity concentrations in Jesenice na Dolenjskem is 2.4 kBq/m^3. In 2020 it was below 1 kBq/m^3, which is well below the limit value for potable water ("Monitoring of radioactivity in the vicinity of Krško NPP – Report for 2020", Jožef Stefan Institute, IJS-DP-13463, April 2021). The total annual C-14 activity discharge into the Sava was 0.3 GBq in 2020. However, measured C-14 activities in the Sava water and in fish were lower than current atmospheric activities. I-131 was not detected in liquid effluents discharged from Krško NPP in 2020. Average concentrations of I-131 in the Sava at Brežice are similar to those in the Sava at Ljubljana (3.4 Bq/m^3). The presence of I-131 in the Sava is attributed to discharges from hospitals into the rivers that flow into the Sava upstream of the Krško NPP dam (Ljubljanica, Savinja). I-131 was not detected in fish samples in 2020. The annual liquid discharge of Cs-137 from Krško NPP into the Sava in 2020 was 0.9 MBq. This contribution cannot be distinguished from the non-homogeneously distributed global contamination. In 2020 the activity of radioactive strontium (Sr-90) discharged into the Sava was 0.04 MBq. However, Krško NPP's contribution cannot be distinguished from the non-homogeneously distributed global contamination. Other fission and activation products (Co-58, Co-60, Mn-54, Ag-110m, Cs-134, Sb-125) appear regularly in liquid effluents discharged from Krško NPP. The total activity of these radionuclides in 2020 was at least six orders of magnitude lower than for tritium. None of the radionuclides listed have been detected in the environment in the last few years. When Krško NPP is in operation, the concentrations of discharged radionuclide activity in the environment, with the exception of the very low-radiotoxic H-3, are therefore significantly below the limits of detection ("Monitoring of radioactivity in the vicinity of Krško NPP – Report for 2020", Jožef Stefan Institute, IJS-DP-13463, April 2021). A significant impact on the fauna in the Sava is therefore not expected.

The pretreatment of water results in wastewater in the counter-flow rinsing of filters for the mechanical treatment of raw water, and in the cleaning of membranes and the reverse osmosis system. Wastewater accumulates in the wastewater pool (PW wastewater pool) at outlet 11, with final outflow from discharge 7. If the system is rinsed using corrosive chemicals, water from the wastewater pool is pumped into a neutralisation tank where the pH value is continuously measured and pH balanced before water is discharged into the Sava. That path is temporary and only used very occasionally, while water quantities are small. For this reason, a significant impact on the fauna in the Sava is not expected in the future. Before being discharged into the Sava, wastewater from Krško NPP is treated at a small municipal treatment plant (SMTP) with a capacity of 700 PE. The SMTP has primary and secondary treatment systems. A total of 10,000 m^3 of wastewater was treated at the treatment plant in 2020, while the measured values of COD and BOD at the discharge from the SMTP were well below the permitted limit values ("Report on the operational monitoring of wastewater for Krško NPP (for 2020)", NLZOH, Centre for the Environment and Health, Department for the Environment and Health, Novo Mesto, Division for Soil and Water, no. 2172-72-172/20, 24 March 2021, and "Reports on the operational monitoring of wastewater for Krško NPP" (for 2015, 2016, 2017, 2018, 2019 and 2020), NLZOH, Centre for the Environment and Health, Department for the Environment and Health, Novo Mesto, Division for Soil and Water). As there is no plan to connect new users, the annual quantity of and burden from municipal wastewater from Krško NPP will not change as a result of the extension of the plant's operational lifetime. A significant impact on the fauna in the Sava is therefore not expected.

Krško NPP did not introduce biocides into any system in 2020. The quality of water from the Sava has improved significantly since the closure of the VIPAP cellulose plant. For this reason, Krško NPP is not planning to introduce biocides into the tertiary coolant circuit in the future. No impact on the fauna in the Sava is therefore expected.

The thermal load could have an impact on fauna in the watercourse indirectly through the impact on oxygen content or directly due to the impact on organisms, as life processes evolve more rapidly at warmer temperatures, while different organisms function optimally at different temperatures. A change in water temperature could lead to a change in the biocenosis of the river. The impact of temperature on macroinvertebrates is somewhat less on the lower course of the river than it is on the middle and upper courses. Maximum temperatures in the summer months have the most significant impact on fish; this is because they could lead to deteriorating oxygen conditions or even the overheating of organisms at extremely high temperatures (in excess of 30°C). Fish can avoid this impact to some extent by moving to cooler, better-oxygenated parts of the river.

Krško NPP uses water from the Sava for cooling the condensers and turbines, and for cooling safety components. Safety components are cooled via the component cooling system. That system represents an additional safety barrier against the potential release of radioactive material and is cooled by the reserve service water system, which extracts water from the Sava. The discharge from that system is at point V1. The average temperature at discharge V1 in July 2020 was 22.16°C. The impact of that discharge is localised and, because it accounts for a low proportion of transmitted heat, insignificant.

The secondary coolant circuit system (for the condenser and turbine) also uses water from the Sava, which is returned in a heated state at point V7-7 to discharge V7. The most significant impact of the thermal load is localised at discharge V7. The warmer water that flows from discharge V7 primarily remains near the surface due to lower density. Taking into account the temperature scheduling model at Brežice HPP's reservoir ("Analysis of changes in the radiological and thermal impacts of Krško NPP on the environment since the construction of HPP Brežice. Final report", Jožef Stefan Institute, Environmental Sciences Department, Faculty of Civil and Geodetic Engineering, Department of Fluid Mechanics, IBE d.d., September 2007), this is an area several 100 m downstream of discharge V7, but not along the entire width of the riverbed, where the mixing of water occurs. In 2020 the daily average of the proportion of transmitted heat accounted for by discharge V7 never exceeded the limit value set out in the environmental protection permit. Krško NPP routinely carries out measurements that ensure that the requirements from the applicable environmental protection permit are met. The environmental protection permit stipulates that Krško NPP must ensure that the synergistic action of the discharge of industrial cooling waters and other discharged wastewater does not cause the Sava to exceed its natural temperature by more than 3 K at any time during the year. Krško NPP must activate the cooling water recirculation system in a timely manner via the cooling towers to prevent the temperature of the Sava from exceeding 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. According to data from Krško NPP, the average temperature of the Sava at the point of complete mixing in July and August 2020 was 22–23°C. Between 2010 and 2020, the average temperature of the Sava at the point of complete mixing rarely exceeded 27°C in one day (four times in July 2015, once in August 2017 and four times in August 2018), but it never exceeded 28°C, which is the limit for excessive thermal load on cyprinid waters according to the Decree on the emission of substances and heat in the discharge of wastewater into waters and the public collection system. To mitigate the impact of thermal pollution, Krško NPP will be required to continue to comply with the provisions of the environmental protection permit or, in accordance with point II/1.11 of the operative part of this environmental protection consent, to comply with the provision that the average daily temperature of the Sava should not exceed 28°C at the point of complete mixing, in addition to the limit in place up to now, i.e. that Krško NPP may not heat the Sava by more than 3°C above its natural temperature at the point of complete mixing. As has already been stated, thermal load can have an impact on fauna in the watercourse. Cyprinid fish species, including the qualifying species *Rutilus pigus* (Danube roach), which is found in the Lower Sava SAC Natura 2000 area (SI3000304), are predominant in the Sava downstream of Krško NPP. According to the provisions of the Decree on the emission of substances and heat in the discharge of wastewater into waters and the public collection system, the limit for excessive thermal load on cyprinid waters is 28°C. The ministry has therefore introduced an additional condition pursuant to the third indent of point 3 of the first paragraph of Article 11 of the Decree in order to prevent remote impact from Krško NPP operation on the cactus roach, which lives downstream of the plant and is recognised as a cyprinid species.

The foaming of water occurred in the Sava following discharges in 2017. The appearance of foam on the Sava downstream of the point of discharge from Krško NPP was examined in the document "Joint final report on investigations and analysis at the Brežice HPP, Krško HPP, Arto-Blanca HPP and Boštanj HPP reservoirs, and studies of the causes of water foaming, Limnos d.o.o., 10 September 2017". The report found that organic pollution of the Sava upstream of Krško NPP contributed significantly to the appearance of foam, as proved by the high values of BOD_5 and COD at sampling locations upstream of the plant. The result of organic pollution is the increased quantity of bacteria that produce CO_2, which in turn causes the water to foam. Water that is used to cool the condenser and turbine is released into the Sava at discharge V7 unchanged, except that it is warmer. There are therefore no substances in Krško NPP discharges that might contribute to foaming. However, following discharge from Krško NPP, the release of gases (CO_2) is more intense due to the fall and mixing of water. Carbon dioxide is more soluble in cold water and is released into the atmosphere when it comes into contact with warmer water. For this reason, foam can appear on the water's surface. It therefore appears that foam on the Sava is a natural phenomenon and the result of the bioproduction processes of microorganisms in the river. The sampling of algae in foam in discharge from Krško NPP indicated the presence of primarily green algae and diatoms, while traces of cyanobacteria, which can produce toxins, were rare. Foam is therefore not expected to pose a direct danger to aquatic organisms. Certain types of algae that cause algal bloom were also present in samples taken, but this phenomenon did not occur during the study. Since the filling of Brežice HPP reservoir, foaming has not been so evident and has not reoccurred in recent years. According to the results of the assessment of the ecological status of the Sava in the area of the Brežice HPP reservoir, the saprobic condition, which is based on benthic invertebrates, was good in 2018 (HESS website, 2019). As evident from the national monitoring of the ecological status of the Sava at Jesenice na Dolenjskem, the ecological status of the Sava was assessed as good in the 2012–2019 period. The trophic conditions and saprobic conditions for phytobenthos, macrophytes and benthic invertebrates were actually assessed as very good in 2016 and 2018, which leads the ministry to believe that the potential localised appearance of foam has no significant impact on the Sava ecosystem. If foam should reappear on the Sava, an analysis of its content could be performed and its decomposition monitored.

Monitoring of the Sava (Cotman, M., 2020. "Report on the non-radiological monitoring of the Sava in 2019. Final report", National Institute of Chemistry, Centre for Validation Technologies and Analytics, Ljubljana), which is carried out at three points (at the offtake point for cooling water at Krško NPP, upstream of the plant on the right bank of the Sava and in Brežice at the road bridge), indicates that organic pollution was down slightly in 2019 relative to the long-term trend. The highest measured value of COD in 2019 was in November at the sampling location upstream of Krško NPP on the right bank of the Sava (10.63 mg/l). The highest measured value of BOD_5 in 2019 was in March, likewise at the sampling location upstream of Krško NPP on the right bank of the Sava (1.60 mg/l). According to the Decree on surface water status, the limit value of BOD_5 for a "very good" ecological river status is between 1.6 and 2.4 mg/l. According to the Decree on the quality required of surface waters supporting freshwater fish life (Official Gazette of RS, Nos. 46/02, 41/04 [ZVO-1] and 44/22 [ZVO-2]), the recommended value for salmonid waters is less than 3 mg/l, while the value for cyprinid waters is less than 6 mg/l. Cyprinid fish species, for which the measured parameters are completely appropriate, are predominant in the Sava downstream of Krško NPP. According to the Rules on the designation of

surface water sections important for freshwater fish species (Official Gazette of RS, Nos. 28/05 and 8/18), the aforementioned section of the Sava is not designated as important for freshwater fish species. For this reason, monitoring of the quality of water that supports freshwater fish life is not envisaged in this area. According to Article 8 of the Decree on the quality required of surface waters supporting freshwater fish life, that monitoring is the responsibility of the ministry responsible for environmental protection.
Periodic national monitoring of the ecological status of rivers is carried out downstream of discharges from Krško NPP on the Sava–border section water body (SI1VT930), where the measuring point is located at Jesenice na Dolenjskem. The ecological status was assessed as moderate in 2009 and 2011 (the phytobenthos and macrophytes parameter of trophic condition was assessed as moderate in 2009, while the phytobenthos and macrophytes parameter of saprobic condition was assessed as moderate in 2011), while the ecological status was assessed as good in 2010 and in the period 2012–2019. The trophic condition and saprobic conditions for phytobenthos, macrophytes and benthic invertebrates were actually assessed as very good in 2016 and 2018. Krško NPP operation therefore does not have a significant impact on the ecological status of the Sava.
A sustained impact on fauna in the vicinity of Krško NPP could occur in the event of a major accident resulting in the release of radioactive material into the environment. Numerous safety upgrades have been implemented at Krško NPP, making the possibility of core damage very unlikely. The plant was designed to withstand design-basis accidents and to manage them using its engineered safety features. Krško NPP can use the DEC-A equipment to prevent reactor core meltdown, while the DEC-B equipment has been provided for the purpose of managing the occurrence of a very unlikely core meltdown, and focuses on protecting the final barrier before release, i.e. the integrity of the containment. The passive filter system serves to relieve the pressure in the containment, while environmentally harmful substances remain trapped in the filters. Direct release into the environment is therefore unlikely.
The ministry estimates that the impact of the activity on fauna during operation will be (3), i.e. impact not significant, on account of the mitigation measures referred to in point II/1 of the operative part of this environmental protection consent that Krško NPP will be required to implement during the lifetime extension in order to prevent excessive burdens resulting from the discharge of wastewater into the Sava.

A chain of hydropower plants (Vrhovo, Boštanj, Arto-Blanca, Krško and Brežice) has been built on the lower course of the Sava. The completion of that chain is planned with the construction of Mokrice HPP in the Lower Sava SAC. The potential cumulative impact on the temperature of the Sava as a result of heat discharges from Krško NPP and Sava's slower flow rate in HPP reservoirs has been examined in the study "Thermal loads on the Sava – Interactions of energy buildings along and on the Sava from the perspective of the thermal load on the Sava" (Revision A, IBE 2012). The study found that the increase in the Sava's temperature most likely resulted from a natural rise in the temperature of river water and not from the construction of HPPs. As this analysis was completed in 2012, i.e. before Krško HPP was built, another thermal analysis of the Sava was conducted for the extended HPP chain, which also included the above-average warm summer of 2019 ("Energy buildings along and on the Sava – Analysis of river temperatures in the Lower Sava in July and August 2019 and the verification of previous studies" (Revision A, IBE, April 2020). Measurements in this latest study showed that there was a 0.54°C drop in the temperature of the Sava between Krško NPP and the discharge from HPP Brežice in July 2019. The HPP Brežice reservoir therefore has a cooling effect on water that flows into the Lower Sava SAC. According to the latest IBE study, increases in the mean monthly temperatures of the Sava in the Čatež area have been lower over the last 18 years than they were previously. The conclusion is therefore that the chain of HPPs does not increase the mean temperatures of the river. The study also anticipates that the mean monthly temperature in the flow-through reservoir of the planned Mokrice HPP during the summer will only rise by a minimal degree (around 0.1 to 0.2°C) relative to the current situation. No cumulative or synergistic impact is therefore expected on the temperature of the Sava from heat discharges from Krško NPP and the slow flow rate of the Sava in existing HPP reservoirs and the planned Mokrice HPP flow-through reservoir.

The ministry estimates that the overall impact on fauna during operation will be (3), i.e. impact not significant, on account of the mitigation measures referred to in point II/1 of the operative part of this environmental protection consent that Krško NPP will be required to implement during the lifetime extension in order to prevent excessive burdens resulting from the discharge of wastewater into the Sava.

<u>IEAs and valuable natural features</u>
Important ecological area: Sava from Radeče to national border (ID 63700)
One part of the important ecological area is the section of the Sava on the Krško Polje/Brežiško Polje, from Krško to the mouth of the Sotla. The activity physically affects the area in the form of a dam on the Sava. Following the construction of Brežice HPP, the water level in the area of Krško NPP rose by 3 m. As a result, the regulation of the water level at the Krško NPP dam is no longer required and the sluice gates are always raised. The Krško NPP dam is now entirely passable for fish. Krško NPP also discharges wastewater into the Sava. According to national monitoring results, the ecological status of the Sava downstream of Krško NPP is assessed as good. Krško NPP operates in compliance with the environmental protection permit. To mitigate the impact of thermal pollution, Krško NPP will have to continue to comply with the provisions of the environmental protection permit. No significant impact is expected from the extension of Krško NPP's operational lifetime as long as the provisions of the environmental protection permit are observed.

VNF Libna – linden tree next to the church (ID 7860)
During operation, Krško NPP does not release ionising radiation into the environment that could have a significant impact on VNF Libna (linden tree next to the church). Measurements of radioactivity in the vicinity of Krško NPP indicate that the impact is already insignificant in apples harvested in the direct vicinity of the plant. That impact is even less due to the great distance between the VNF in Libna (linden tree next to the church) and Krško NPP.

VNF Stari Grad – gravel pit (ID 7861)
Krško NPP is situated right next to the Sava and uses water from the river for cooling. During operation, it releases some radioactive material in a controlled manner into the Sava, which at least partly feeds the underground aquifers of the Krško Polje/Brežiško Polje. The quantities of synthetic radionuclides from Krško NPP's liquid and atmospheric discharges into the groundwater are negligible compared to the contribution from synthetic radionuclides from general contamination and naturally occurring radionuclides arising from natural radiation ("Monitoring of radioactivity in the vicinity of Krško NPP – Report for 2020", Jožef Stefan Institute, IJS-DP-13463, April 2021). The impact on water at VNF Stari Grad (gravel pit) is therefore insignificant.

The ministry estimates that the impact of the activity and the overall impact on valuable natural features during operation will be (4), i.e. impact not significant. The ministry estimates that the impact of the activity and the overall impact on IEAs during operation will be (3), i.e. impact not significant, on account of the mitigation measures referred to in point II/1 of the operative part of this environmental protection consent that Krško NPP is already implementing and will be required to continue to implement during the lifetime extension to prevent excessive burdens resulting from the discharge of wastewater into the Sava (wastewater parameters below the limit values set out in the environmental protection permit with respect to emissions into water).

<u>Protected areas</u>
For the purposes of assessing the acceptability of impacts on protected areas, the "Supplement Assessing the Acceptability of the Impacts on Protected Areas for the Extension of Krško NPP's Operational Lifetime From 40 to 60 Years – Nuklearna elektrarna Krško d.o.o.", order no.: 1456-20 VO, October 2021, updated January 2022 and 5 May 2022 – after public consultation (AQUARIUS d.o.o. Ljubljana, cesta Andreja Bitenca 68, 1000 Ljubljana) has been drawn up in accordance with the Rules, and is appended to the EIA Report. It contains the following findings:

Vrbina SAC (SI3000234)
During operation, Krško NPP does not release ionising radiation into the environment that could have an impact on Vrbina SAC. Engineered safety features prevent the uncontrolled release of radioactive material into the environment. Engineered safety features have been designed to provide safety functions in all operational states, even in the event of the failure of specific equipment. The release of radioactive material into the environment is prevented by four successive safety barriers. The basic objective of the first three barriers is to prevent radioactive material from passing to the next barrier, while the fourth barrier prevents radioactive material from being released directly into Krško NPP's surrounding environment. The annual dose at the Krško NPP perimeter fence will not exceed the limit of 200 μSv as a result of the lifetime extension. The ministry therefore does not expect impacts from ionising radiation on Vrbina SAC after Krško NPP's operational lifetime is extended.
Light pollution primarily impacts insects that are active at night, as they are attracted by artificial light sources and remain fixated on them instead of searching for food or a mate. That impact is of a long-term nature and far reaching. For the qualifying species of stag beetle (*Lucanus cervus*), the Management Programme for Natura 2000 Areas (MPN) sets the objective of maintaining the current state without permanent light bodies. Krško NPP's illumination arrangements will not change with the extension of its operational lifetime, meaning that current state will be maintained. There will therefore be no impact on the aforementioned conservation objective. A beetle census (CKFF, 2008) revealed that the densest populations of stag beetles in Vrbina SAC were on the left bank of the river, around 2.5 km from the Krško NPP complex. Because of the distance, the impact on stag beetles will be negligible. No impact on other qualifying species from light pollution is expected.
A sustained impact on habitat types and qualifying species in Vrbina SAC could occur in the event of a serious accident resulting in the release of radioactive material into the environment. Numerous safety upgrades have been implemented at Krško NPP, making the possibility of core damage very unlikely. The plant was designed to withstand design-basis accidents and to manage them using its engineered safety features. Krško NPP can use the DEC-A equipment to prevent reactor core meltdown, while the DEC-B equipment has been provided for the purpose of managing the occurrence of a very unlikely core meltdown, and focuses on protecting the final barrier before release, i.e. the integrity of the containment. The passive filter system serves to relieve the pressure in the containment, while environmentally harmful substances remain trapped in the filters. Direct release into the environment is therefore unlikely.

Lower Sava SAC (SI3000304)
The Lower Sava SAC is around 8 km downstream of discharges from Krško NPP. Only emissions of substances and heat into the Sava represent a potential impact from Krško NPP on the Lower Sava SAC and the qualifying species of cactus roach. During normal operation, Krško NPP occasionally discharges liquids from discharge tanks into the environment in a controlled manner. Liquids with low activity levels are discharged into the Sava via the essential service water channel, which is located upstream of the Krško NPP dam. Radioactive liquids from waste measurement tanks and the steam generator blowdown system are discharged via that channel. Liquid radioactive waste from Krško NPP is treated in a treatment plant that comprises reservoirs, pumps, filters, an evaporator and two demineralisers. Blowdown water from the steam generators is treated separately. Krško NPP regularly monitors levels of radioactive material in fish tissue. That monitoring is included in the Programme of Measurements of Radioactivity in the Vicinity of Krško NPP. Those measurements are performed by external contractors (Jožef Stefan Institute, Ruđer Bošković Institute and the Institute of Occupational Safety), and the results are presented in annual reports on the monitoring of radioactivity in the vicinity of Krško NPP. Tritium (H-3) is regularly present in liquid effluents discharged by Krško NPP. Tritium is an isotope that emits non-penetrating beta radiation, but it is only slightly radiotoxic (the limit value for tritium in potable water is 100 Bq/l). In 2020 the average monthly activity concentration of H-3 in Krško in front of Krško NPP (natural background) was slightly below 0.6 kBq/m^3. The long-term average (since 2002) of monthly H-3 activity concentrations in Brežice is 4.0 kBq/m^3. The average over several months (since July 2017) of monthly H-3 activity concentrations at the sampling station in front of the Brežice HPP dam is 2.9 kBq/m^3. The concentrations of tritium activity in Jesenice na Dolenjskem are lower as

a result of the additional dilution of the Sava by the Krka and the Sotla. The long-term monthly average of H-3 activity concentrations in Jesenice na Dolenjskem is 2.4 kBq/m^3. In 2020 it was below 1 kBq/m^3, which is well below the limit value for potable water ("Monitoring of radioactivity in the vicinity of Krško NPP – Report for 2020", Jožef Stefan Institute, IJS-DP-13463, April 2021). The total annual C-14 activity discharge into the Sava was 0.3 GBq in 2020. However, measured C-14 activities in the Sava water and in fish were lower than current atmospheric activities.
I-131 was not detected in liquid effluents discharged from Krško NPP in 2020. Average concentrations of I-131 in the Sava at Brežice are similar to those in the Sava at Ljubljana (3.4 Bq/m^3). The presence of I-131 in the Sava is attributed to discharges from hospitals into the rivers that flow into the Sava upstream of the Krško NPP dam (Ljubljanica, Savinja). I-131 was not detected in fish samples in 2020 ("Monitoring of radioactivity in the vicinity of Krško NPP – Report for 2020", Jožef Stefan Institute, IJS-DP-13463, April 2021). The annual liquid discharge of Cs-137 from Krško NPP into the Sava in 2020 was 0.9 MBq. This contribution cannot be distinguished from the non-homogeneously distributed global contamination ("Monitoring of radioactivity in the vicinity of Krško NPP – Report for 2020", Jožef Stefan Institute, IJS-DP-13463, April 2021). The activity discharge of radioactive Strontium (Sr-90) into the Sava in 2020 was 0.04 MBq in 2020. This contribution cannot be distinguished from non-homogeneously distributed global contamination ("Monitoring of radioactivity in the vicinity of Krško NPP – Report for 2020", Jožef Stefan Institute, IJS-DP-13463, April 2021). Other fission and activation products (Co-58, Co-60, Mn-54, Ag-110m, Cs-134, Sb-125) appear regularly in liquid effluents discharged from Krško NPP. The total activity of these radionuclides in 2020 was at least six orders of magnitude lower than for tritium. In the last few years, none of the radionuclides listed have been detected in the environment ("Monitoring of radioactivity in the vicinity of Krško NPP – Report for 2020", Jožef Stefan Institute, IJS-DP-13463, April 2021). When Krško NPP is in operation, the concentrations of discharged radionuclide activity in the environment, with the exception of the very low-radiotoxic H-3, are therefore significantly below the limits of detection ("Monitoring of radioactivity in the vicinity of Krško NPP – Report for 2020", Jožef Stefan Institute, IJS-DP-13463, April 2021). The impact from radioactive releases on cactus roach and the Lower Sava SAC is therefore assessed as negligible.
The pretreatment of water results in wastewater in the counter-flow rinsing of filters for the mechanical treatment of raw water, and in the cleaning of membranes and the reverse osmosis system. Wastewater accumulates in the wastewater pool (PW wastewater pool) at outlet 11, with final outflow from discharge 7. If the system is rinsed using corrosive chemicals, water from the wastewater pool is pumped into a neutralisation tank where the pH value is continuously measured and pH balanced before water is discharged into the Sava. That path is temporary and only used very occasionally, and the water quantities are small. For this reason, the impact on cactus roach and the Lower Sava SAC is estimated to be not significant even if Krško NPP's operational lifetime is extended.
Before being discharged into the Sava, wastewater from Krško NPP is treated at a small municipal treatment plant (SMTP) with a capacity of 700 PE. The SMTP has primary and secondary treatment systems. A total of 10,000 m^3 of wastewater was treated at the treatment plant in 2020, while the measured values of COD and BOD_5 at the discharge from the SMTP were well below the permitted limit values. As there is no plan to connect new users, the quantity of and burden from municipal wastewater from Krško NPP will not change as a result of the extension of the plant's operational lifetime. For this reason, no impact on cactus roach or the Lower Sava SAC is expected.
Krško NPP did not introduce biocides into any system in 2020. The quality of Sava water has improved significantly since the closure of the VIPAP cellulose plant. For this reason, Krško NPP is not planning to introduce biocides into the tertiary coolant circuit in the future. No impact on cactus roach or the Lower Sava SAC is therefore expected, even if Krško NPP's operational lifetime is extended.
Krško NPP uses water from the Sava for cooling the condensers and turbines, and for cooling safety components. Safety components are cooled via the component cooling system. That system represents an additional safety barrier against the potential release of radioactive material and is cooled by the reserve service water system, which extracts water from the Sava. The secondary coolant circuit system (for the condenser and turbine) uses water from the Sava. However, if sufficient cooling is not possible with water from the Sava, Krško NPP uses cooling cells/towers (two batteries per six cells and one battery per four cells). It therefore only takes a portion of required water directly from the Sava, while

the remaining water is recirculated through the cooling cells, where it is air-cooled. Waste cooling water is not treated before it is discharged into the Sava. Krško NPP routinely carries out measurements that ensure that the requirements from the applicable environmental protection permit are met. The environmental protection permit stipulates that Krško NPP must ensure that the synergistic action of the discharge of industrial cooling waters and other discharged wastewater does not cause the Sava to exceed its natural temperature by more than 3 K at any time during the year. Krško NPP must activate the cooling water recirculation system in a timely manner via the cooling towers to prevent the temperature of the Sava from exceeding its natural temperature by more than 3°C. If the combined cooling system is insufficient to fulfil this condition, the power of the power plant must be reduced accordingly. None of the daily averages of the waste heat emission ratio (WHER) at discharges from the large and small cooling system or of the total WHER exceeded the limit value set out in the environmental protection permit in 2020. To mitigate the impact of thermal pollution, Krško NPP will have to continue to comply with the provisions of the environmental protection permit. Periodic national monitoring of the ecological status of rivers is carried out downstream of discharges from Krško NPP on the Sava–border section water body (SI1VT930), where the measuring point is located at Jesenice na Dolenjskem. The ecological status was assessed as moderate in 2009 and 2011 (the phytobenthos and macrophytes parameter of trophic condition was assessed as moderate in 2009, and the phytobenthos and macrophytes parameter of saprobic condition was assessed as moderate in 2011), while the ecological status was assessed as good in 2010 and in the period 2012–2019. The trophic condition and saprobic conditions for phytobenthos, macrophytes and benthic invertebrates were actually assessed as very good in 2016 and 2018, which indicates that the Sava is not organically polluted at that point. Monitoring of the Sava (Cotman, M., 2020. "Report on the non-radiological monitoring of the Sava in 2019. Final report", National Institute of Chemistry, Centre for Validation Technologies and Analytics, Ljubljana), which is carried out at three points (at the offtake point for cooling water at Krško NPP, upstream of Krško NPP on the right bank of the Sava and in Brežice at the road bridge), indicates that organic pollution was down in 2019 relative to the long-term trend. The highest measured value of COD in 2019 was in November at the sampling location upstream of Krško NPP on the right bank of the Sava (10.63 mg/l). The highest measured value of BOD_5 in 2019 was in March, likewise at the sampling location upstream of Krško NPP on the right bank of the Sava (1.60 mg/l). According to the Decree on surface water status, the limit value of BOD_5 for the very good ecological status of rivers is between 1.6 and 2.4 mg/l. According to the Decree on the quality required of surface waters supporting freshwater fish life, the recommended value for salmonid waters is <3 mg/l, while the value for cyprinid waters is < 6 mg/l. Heat discharges from Krško NPP therefore do not cause any deterioration in the living conditions of cactus roach, which is a cyprinid species, in the Lower Sava SAC. Taking the conditions referred to in point II/1 of the operative part of this environmental protection consent into account, no significant impact is expected even if Krško NPP's operational lifetime is extended.

A sustained impact on the environment and Lower Sava SAC could occur in the event of a serious accident resulting in the release of radioactive material into the environment. Numerous safety upgrades have been implemented at Krško NPP, making the possibility of core damage very unlikely. The plant was designed to withstand design-basis accidents and to manage them using its engineered safety features. Krško NPP can use the DEC-A equipment to prevent reactor core meltdown, while the DEC-B equipment has been provided for the purpose of managing the occurrence of a very unlikely core meltdown, and focuses on protecting the final barrier before release, i.e. the integrity of the containment. The passive filter system serves to relieve the pressure in the containment, while environmentally harmful substances remain trapped in the filters. In the event of the accidents discussed (DBA and DEC-B), there will be no liquid releases into the Sava. All cooling water will be contained inside the containment and auxiliary building, which is designed for systems and components that contain radioactive material (contaminated radioactive water).

A chain of hydropower plants (Vrhovo, Boštanj, Arto-Blanca, Krško and Brežice) has been built on the lower course of the Sava. The completion of that chain is planned with the construction of Mokrice HPP in the Lower Sava SAC. A study by the Jožef Stefan Institute (IJS, 2006, "Analysis of changes in radiological and thermal impact by Krško NPP on the environment after the construction of HPP

Brežice". Jožef Stefan Institute, Faculty of Civil and Geodetic Engineering, Inženirski Biro Elektroprojekt, 2006) stated that eutrophication could occur from an increased concentration of phosphates in the Sava from the construction of Brežice HPP on account of the slowed flow rate of the river and higher temperatures in the surface layer of the water in the HPP Brežice reservoir. This could reduce the quality of the Sava. Krško NPP does not discharge substances that could increase the nutrient content of the Sava and does not represent a source of eutrophication. According to calculations in the IBE study (2019), the containment time in the planned Mokrice HPP reservoir will be the shortest of all reservoirs on the lower course of the Sava, while the flow rates will be highest, which means a reduced possibility of eutrophication in the Lower Sava SAC. The potential cumulative impact on the temperature of the Sava as a result of heat discharges from Krško NPP and Sava's slower flow rate in HPP reservoirs has been examined in the study "Thermal loads on the Sava – Interactions of energy buildings along and on the Sava from the perspective of the thermal load on the Sava" (Revision A, IBE 2012). The study found that the increase in the Sava's temperature most likely resulted from a natural rise in the temperature of river water and not from the construction of HPPs. As this analysis was completed in 2012, i.e. before Krško HPP was built, another thermal analysis of the Sava was conducted for the extended HPP chain, which also included the above-average warm summer of 2019 ("Energy buildings along and on the Sava – Analysis of river temperatures in the Lower Sava in July and August 2019 and the verification of previous studies" (Revision A, IBE, April 2020) (IBE, 2020). Measurements in this latest study showed that there was a 0.54°C drop in the temperature of the Sava between Krško NPP and the discharge from HPP Brežice in July 2019. The HPP Brežice reservoir therefore has a cooling effect on water that flows into the Lower Sava SAC. According to the latest IBE study, increases in the mean monthly temperatures of the Sava in the Čatež area have been lower over the last 18 years than they were previously. The conclusion is therefore that the chain of HPPs does not increase the mean temperatures of the river. The study also anticipates that the mean monthly temperature in the flow-through reservoir of the planned Mokrice HPP during the summer will only rise by a minimal degree (around 0.1 to 0.2°C) relative to the current situation. According to calculations in the IBE study (2019), the containment time in the planned Mokrice HPP reservoir will be the shortest of all reservoirs on the lower course of the Sava, while the flow rates will be highest, which means a reduced possibility of eutrophication. Given that no significant deterioration in the parameters of ecological status has been detected in the Brežice HPP reservoir (HESS, 2019. "Quality of surface water in the reservoirs of hydropower plants on the lower reaches of the Sava", 30 August 2019 https://www.he-ss.si/objava/kvaliteta-povrsinske-vode-v-akumulacijskih bazenih hidroelektrarn-na-spodnji-savi.html (cit. 13 January 2021)) and that it is evident from the national monitoring of the ecological status of the Sava at Jesenice na Dolenjskem that there was also no deterioration in the downstream ecological status of the Sava following the construction of the chain of HPPs, it is possible to conclude that there will be no significant deterioration in the ecological status in the case of the Mokrice HPP reservoir. No significant cumulative impact on the Lower Sava SAC is therefore expected.
The ministry estimates that the impact of the activity and the overall impact on protected areas during operation will be (3), i.e. impact not significant, on account of the mitigation measures referred to in point II/1 of the operative part of this environmental protection consent that Krško NPP will be required to implement during the lifetime extension in order to prevent excessive burdens resulting from the discharge of wastewater into the Sava.

When the activity is being terminated (see Section 2.18), fuel will no longer be in the reactor, but stored safely in the spent fuel pool and/or in spent fuel dry storage. Cooling of the reactor will therefore no longer be required and heat emissions into the Sava will greatly decrease, although the spent fuel pool will still have to be cooled using the essential service water system. The impact of discharge from this system is localised and, in view of the low waste heat emission ratio, negligible. The cooling towers will no longer need to be operated. Krško NPP will still perform surveillance of nuclear materials, although the impact of ionising radiation will be insignificant. The ministry estimates that the impact of the activity and the overall impact on nature will be (4), i.e. impact not significant, if the activity is terminated.

D) Impact on material assets

D1) Expected impact during operation

The extension of Krško NPP's operational lifetime will not have a significant impact in terms of increasing existing burdens on the environment. The situation will remain unchanged. During operation, the annual dose at the Krško NPP perimeter fence from all contributing factors, including the spent fuel dry storage, will not exceed the radiation load that currently applies to the fence, which is 200 µSv for external radiation.

The extension of Krško NPP's operational lifetime is not expected to result in excessive environmental burdens or impacts that could cause a deterioration in living conditions or in the use of buildings and land outside the Krško NPP site. The developer has performed an activity in the Vrbina industrial zone, in which other industrial buildings are present, for decades. It is therefore not the only source of environmental burden in that area, but is one of the most significant. That facility is not classified as an activity or installation that can cause large-scale environmental pollution and does not pose a minor or major threat to the environment. Krško NPP is a nuclear facility. Its presence in the area could therefore pose a direct threat of an environmental or other accident that could impact material assets, i.e. land and buildings in the vicinity. However, on account of the technology used and the implementation of protective measures, the possibility of an accident has been reduced to the lowest possible level. In accordance with the Rules on the physical protection of nuclear facilities and nuclear and radioactive materials, and the transport of nuclear materials, Krško NPP's buildings are classified in categories I, II and III. The facility will therefore be protected in accordance with requirements for physically controlled areas and physically controlled facilities. Reporting on stored fuels will be carried out in accordance with the Decree on the safeguarding of nuclear materials (Official Gazette of RS, Nos. 34/08 and 76/17 [ZVISJV-1]).

The ministry estimates that the impact of the activity and the overall impact on material assets during operation will be (3), i.e. impact not significant, on account of the mitigation measures referred to in point II/1 of the operative part of this environmental protection consent and the other measures referred to in the EIA Report that Krško NPP is already implementing in order to reduce impacts on the surrounding area (and that it will be required to continue to implement during the lifetime extension).

When the activity is being terminated, the environmental burden from emissions of pollutants and other burdens will be significantly reduced relative to regular operation. The ministry estimates that the impact of the activity and the overall impact on material assets will be (4), i.e. impact not significant, if the activity is terminated.

E) Impact on the risk of environmental and other accidents

E1) Expected impact during operation

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

Although Krško NPP was designed for a minimum period of 40 years, the plant has carried out all the necessary analyses and upgrades that ensure that it can operate for another 20 years. On the basis of a series of studies and analyses, the SNSA confirmed, in decision no. 3570-6/2009/32 of 20 June 2012, that the state of equipment at Krško NPP was adequate, despite aging, and that all safety margins and operating functions were 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 with sufficient safety margins;
- all equipment that affects the reliability of operation has been replaced;
- the operation of the power plant is stable;
- a safety upgrade has been carried out to comply with the requirement of the Ionising Radiation Protection and Nuclear Safety Act and the lessons learnt from all major nuclear accidents to date, which is reflected in the Slovenian national post-Fukushima plan (ENSREG);
- Krško NPP 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 Krško NPP's number one priority. Since it began operating, Krško NPP has carried out a series of upgrades that have increased the site's safety and efficiency.

The following missions have taken place at Krško NPP in the last ten years:

- an extraordinary safety review (EU stress tests) in 2012;
- ENSREG – Topical Peer Review Ageing Management in 2018, and OSART (Operational Safety Review Team) organised by the IAEA in 2017; and
- a WANO Peer Review in 2014 and 2018.

Krško NPP operates in accordance with all Slovenian laws and within the operating limits set out in the Ionising Radiation Protection and Nuclear Safety Act (Official Gazette of the RS, Nos. 76/17 and 26/19), the water permits, the environmental protection permit, Krško NPP technical specifications, etc. Operational lifetime extension will enable Krško NPP to remain in operation for a further 20 years, i.e. until 2043, within the exact same limits and without exceeding any existing legal requirements or limits. The continual upgrades and modifications that are being carried out ensure a level of safety that is significantly higher than when the plant was built. As a result of the upgrades and modifications completed and the engineered safety features and safety functions in place, Krško NPP will not pose a risk of environmental or other accidents during its extended operational lifetime.

Krško NPP has built-in systems and components for preventing and mitigating the consequences of accidents, as well as predefined plant statuses. A probabilistic safety assessment has also been drawn up.

Krško NPP has also formulated an emergency classification based on predetermined threat levels, and a methodology and guidance on how to classify an emergency to the appropriate threat level according to its actual or anticipated consequences at the plant and in the environment.

Krško NPP is a nuclear facility. Its presence in the area could therefore pose a direct threat of an environmental or other accident. However, on account of the technology used and the implementation of protective measures, the possibility of an accident has been reduced to the lowest possible level.

The key document for Krško NPP operation is the operating licence, which is directly connected with the Krško NPP Updated Safety Analysis Report (USAR) and contains the conditions and limits for operational safety at the plant.

Krško NPP operates pursuant to the decision/approval to commence operations at Krško NPP, National Energy Inspectorate decision no. 31-04/83-5 of 6 February 1984, to the amended Krško NPP operating licence (SNSA decision no. 3570-8/2012/5 of 22 April 2013) and to the Krško NPP Updated Safety Analysis Report (USAR).

In all operational states, Krško NPP ensures a controlled chain reaction in the reactor, the continuous discharge of thermal energy from the reactor, and safety barriers that prevent the release of radioactive material. Ensuring the comprehensive safety of Krško NPP and "defence in depth" requires numerous safety measures to ensure safe operations and continuous preparedness for conditions that deviate from the power plant's normal operational state.

Krško NPP plans for and maintains preparedness for emergencies in accordance with Slovenia's protection and disaster relief concept, and the principles of ensuring the nuclear safety of the power plant. Krško NPP is responsible for managing emergencies at the plant.

The main purpose of planning and maintaining preparedness is to ensure the protection, health and safety of power plant employees and the population in the surrounding areas by preventing emergencies, eliminating or mitigating the consequences of emergencies, and ensuring conditions for the re-establishment of the normal state of the plant.

The steps taken to ensure preparedness and manage emergencies at the plant are set out in the Krško NPP Protection and Disaster Relief Plan (PDRP, Rev. 38). The PDRP and the protection and disaster relief plans for a nuclear accident drawn up by the municipalities of Krško and Brežice, the Posavje region and Slovenia as a whole represent an organisationally and functionally integrated system that ensures the coordinated management of emergencies at the power plant and in the environment, and between the power plant and the environment.

Measures that will be implemented in the event of an emergency at the power plant include operational-technical measures in the power plant's technological process, notification of the general public, professional and administrative institutions about an emergency, and the proposal of immediate protective measures for the population, if required, and radiological and other protective measures at the site of the power plant. The organisational structure of the plant and the aforementioned measures are set out in the PDRP, which is coordinated with local municipalities, and the national protection and disaster relief plan in the event of a nuclear or radiological accident.
The ministry estimates that the impact of the activity and the overall impact on the risk of environmental and other accidents during operation will be (3), i.e. impact not significant, on account of the mitigation measures referred to in point II/1 of the operative part of this environmental protection consent and the other measures referred to in the EIA Report that Krško NPP is already implementing in order to reduce impacts on the surrounding area (and that it will be required to continue to implement during the lifetime extension).

After Krško NPP ceases operating, nuclear fuel will no longer be in the reactor, but stored safely in the spent fuel pool and/or in spent fuel dry storage. The decommissioned area will still have limited access, and be marked out and considered a radiologically monitored area. All activities associated with termination of the activity will be carried out in accordance with the requirements of regulations, the management system, and written work procedures and instructions. After Krško NPP ceases operating, measurements of radiation parameters and all the protective measures that prevent radiation leakage into the environment will continue to be implemented.
The ministry estimates that the impact of the activity and the overall impact on the risk of environmental and other accidents will be (3), i.e. impact not significant, if the activity is terminated, on account of the statutory mitigation measures Krško NPP is already implementing, the other non-statutory mitigation measures that Krško NPP implements in order to minimise impacts on the surrounding area and prevent accidents, and the mitigation measures implemented for other components of the environment (water, waste, ionising radiation).

F) Impact on the population and human health

F1) Expected impact during operation and the conditions
Krško NPP's current level of production does not exceed the limit values for substance emissions and radiation into the environment. The limit values are not expected to be exceeded even if Krško NPP's operational lifetime is extended. The limit value is the prescribed level. It is set with the aim of facilitating the avoidance, prevention or reduction of harmful effects on human health or the environment as a whole. Krško NPP implements (and will continue to implement after the changes) all the measures set out in the regulations to reduce and prevent burdens on and the pollution of the environment, and to minimise impacts on human health. Regular monitoring is also carried out in keeping with the applicable regulations and permits.
Lifetime extension will not cause changes to natural and other conditions for life and habitation near the site of the extension or further afield.
During the extended operational lifetime, the regular monitoring that is already currently being carried out (measurements of river water pumping for process purposes, measurements and analyses of wastewater discharged into the sewage system, radiation measurements) will continue to be conducted throughout the plant.

The ministry estimates that the impact of the activity and the overall impact on the population and human health during operation will be (3), i.e. impact not significant, on account of the mitigation measures referred to in point II/1 of the operative part of this environmental protection consent and the other measures referred to in the EIA Report that Krško NPP is already implementing in order to reduce impacts on the surrounding area (and that it will be required to continue to implement during the lifetime extension).
When operations at Krško NPP come to an end, emissions of substances and radiation will be

significantly lower than described for the period of operation. Fuel will no longer be in the reactor, but stored safely in the spent fuel pool and/or in spent fuel dry storage. After Krško NPP ceases operating, measurements of radiation parameters and all the protective measures that prevent radiation leakage into the environment will continue to be implemented.
The ministry estimates that the impact of the activity and the overall impact on the population and human health will be (3), i.e. impact not significant, if the activity is terminated, on account of the statutory mitigation measures that Krško NPP is already implementing, the other non-statutory mitigation measures that Krško NPP implements in order to minimise impacts on the surrounding area and prevent accidents, and the mitigation measures implemented for other components of the environment (water, waste, ionising radiation).

G) Seismic safety

The ministry notes that the third Periodic Safety Review (PSR3) is currently under way at Krško NPP in accordance with the provisions of the Ionising Radiation Protection and Nuclear Safety Act (Official Gazette of RS, Nos. 76/17, 26/19 and 172/21) and the Rules on the operational safety of radiation and nuclear facilities (Official Gazette of RS, Nos. 81/16 and 76/17 [ZVISJV-1]). Its aim is to produce a comprehensive and independent review of safety at the plant. In accordance with the approved Third NEK Periodic Safety Review Programme (PSR3), NEK ESD-TR-03/20, Rev. 1, December 2021, this should be completed by the end of 2023. The approved final PSR3 report, which will also contain an action plan for the implementation of changes and improvements, is a precondition for extending the plant's operational lifetime for ten years. Under the Rules on the operational safety of radiation and nuclear facilities, the deadline for implementation of the plan for changes and improvements is five years after approval of the PSR3 report.
The acquisition of an updated PSHA is also a requirement for PSR3 and one that will be carried forward into the PSR3 action plan. It will be completed and approved by the end of 2023 (PSR3-NEK-2.3, Hazard Analyses, PSR3 2.3-04 requirement, updated PSHA). Compliance with the PSR3 2.3-04 requirement will, in accordance with the PSR3 action plan, be adopted and given final approval by the SNSA.
A project is currently under way to update the PSHA for the immediate vicinity of Krško NPP. It began with field studies just over ten years ago. The study covers 12 seismic source lines within a 200 km radius of Krško NPP. In addition to seismic source lines, it also considers planar seismic sources or combinations of different types of seismic source; this increases the complexity of the study and is one of the reasons why it is taking so long. A new non-ergodic ground-motion model for the location has been developed on the basis of the study. Such models typically take account of local earthquake characteristics based on ground displacement measurements; in Slovenia's case, these have been provided by the Slovenian Environment Agency (ARSO) for more than 20 years. An independent review of the new PSHA is currently under way and will be completed in 2023. It will serve as final approval of the new revised version of the PSHA. Based on the preliminary results of the new PSHA, and the report produced by the Faculty of Civil Engineering and Geodesy (FGG) of the University of Ljubljana on the preliminary review of those results ("Overview of the non-ergodic ground motion model for Krško and preliminary PSHA results for the mean return period of 10,000 years", Rev. 0), it is not expected that the final results of the new PSHA will be significantly different from the results of the currently valid PSHA from 2004. After the new PSHA is completed, independently reviewed and approved by the SNSA, it will be used as input data for the updating of the seismic model in the Krško NPP probabilistic safety assessment.
Based on the preliminary results of this study, no significant changes in the results are expected in relation to the currently valid seismic hazard study from 2004.
Regarding the seismic performance of Krško NPP, it should be noted that the seismic impact considered when the plant was being designed is comparable with the seismic impact determined by taking into consideration the design spectrum, scaled to a PGA of 0.6 g at surface, which roughly corresponds to a PGA value with a recurrence interval of 10,000 years (PSHA, 2004). The stress-test report estimated that core damage was unlikely with earthquakes with a PGA of up to 0.8 g at surface.
However, that estimate did not take into account the favourable impact of the new safety equipment

installed at the plant in the last ten years in response to the Krško NPP Safety Upgrade Programme. The new DG3 diesel electricity generator has been qualified for a 50% increased load compared to the original seismic criteria. The seismic design load for new engineered safety features on the main Krško NPP island (including the above-mentioned safety features) was a PGA of 0.6 g at surface. When the new safety features were being designed, the beneficial effect of the dissipation of energy from the interaction of movement between the ground and the structure was limited. The new facilities and systems separated from the foundations of the main island (second reinforced bunkered building, spent fuel dry storage, operational support centre) have been designed for a PGA of 0.78 g at surface (a 30% increase).
The issue of the application of the new PSHA will be addressed in the PSR3 action plan in accordance with Slovenian nuclear legislation. In this context, the probabilistic safety assessment will be updated to take into account the results of the new PSHA. Slovenia will keep Austria abreast of developments at a bilateral meeting; these meetings have become a fixture over the last decade.

The ministry also notes although the suggestion that the new seismic study be incorporated into PSHA 3 makes sense, it could not be included in the EIA in 2022 because the data was not available at the time the EIA was being produced and because the EIA had to be completed by the statutory deadline (at the same time, there was already enough data to enable a decision to be made). As this is material that will be produced in the future and is important for the country, the suggestion is taken into account in the safety inspections conducted every ten years by the SNSA in the form of a Periodic Safety Review, and can be added to this environmental protection consent as a condition. As this is an additional safety issue, the ministry has paid due regard to the suggestion and to point II/1.18 of the operative part of this environmental protection consent, which provides that Krško NPP is required to draft an action plan for the third Periodic Safety Review (PSR3*) that includes an update of the PSHA for the Krško NPP site, submit it for approval to the SNSA no later than by the end of 2023 and, on this basis, carry out any additional measures required to increase the nuclear safety of the plant. The measure is laid down in accordance with the Ionising Radiation Protection and Nuclear Safety Act (ZVISJV-1) and the Rules on the operational safety of radiation and nuclear facilities (Official Gazette of RS, Nos. 81/16 and 76/17 [ZVISJV-1]).

According to Article 1(vii) of the Act Ratifying the Convention on Environmental Impact Assessment in a Transboundary Context (Official Gazette of RS [Mednarodne pogodbe], No. 46/1998), an impact is every environmental consequence, including for human health and safety. Therefore, in addition to impacts on flora, fauna, soil, air, water, climate, landscape and historical monuments, consideration must also be given to safety, even though nuclear power plant safety is regulated separately at the international, European and national levels and the topics are interconnected and have relevance to the EIA and the ten-year Periodic Safety Reviews. While an EIA must be drawn up for the entire proposed lifetime extension period, i.e. 20 years, and not for a shorter period, a Periodic Safety Review is conducted every ten years and takes place in relation to the current operation of the plant. All the measures referred to in Article 112 of the Ionising Radiation Protection and Nuclear Safety Act are therefore laid down within the framework of extension of operational lifetime and must be carried out on a regular basis.
In the operative part of this environmental protection consent (point II/1.19), the ministry has also laid down that neighbouring countries must also be apprised of this through bilateral commissions.

Monitoring the status of impact mitigation factors and measures

Waters
Wastewater collected in the CTF drain sump must be sampled and analysed in the event of leakage from the HI-STORM concrete storage overpack (which also contains glycol in winter). The drain sump is a deepened space in the spent fuel dry storage building that is part of the reception area in which full, multi-purpose containers are moved from one overpack to another. In any HI-STORM leakage event, the water collected in the drain sump should be sampled and analysed in line with the provisions of the

Rules on initial measurements and operational monitoring of wastewater (Official Gazette of RS, Nos. 94/14, 98/15) and the Decree on the emission of substances and heat in the discharge of wastewater into waters and the public collection system.

Use of water for process purposes
Method: measurements of amount of water abstracted*
Methods: in accordance with legislation and water permits
Location: sampling locations specified in water permits
Timetable: continuous
* Partial water permit no. 35536-31/2006-16 of 15 October 2009, and decision amending water permit no. 35536-54/2011-4 of 8 November 2011, decision no. 35536-26/2011-9 of 23 May 2013, decision no. 35530-7/2018-2 of 22 June 2018, water permit no. 35530-100/2020-4 of 14 November 2020, and water permit no. 35530-48/2020-3 of 9 September 2021.

Wastewater
Method: measurements of pollution parameters and wastewater quantities performed by an authorised wastewater monitoring contractor
Methods: in accordance with the Rules*, the Decree**, and the environmental protection permit***
Locations: measuring points in accordance with the environmental protection permit***
Timetable: operational monitoring in accordance with the Decree* and the environmental protection permit**

* Rules on initial measurements and operational monitoring of wastewater (Official Gazette of RS, Nos. 94/14, 98/15 and 44/22 [ZVO-2])
** Decree on the emission of substances and heat in the discharge of wastewater into waters and the public collection system
*** Environmental protection permit concerning emissions into waters issued by ARSO, no. 35441-103/2006-24 of 30 June 2010, which was amended by decision no. 35441-103/2006-33 of 4 June 2012 and decision no. 35444-11/2013-3 of 10 October 2013.

In order to determine whether the concentrations of sedimentary matter and undissolved substances are due to the power plant or to elevated concentrations in the Sava, measurements of parameters at the entrance to the system should be carried out
if the conditions in the Sava at the time of sampling clearly indicate elevated concentrations of sedimentary matter and undissolved substances. The measurements at the inflow must be carried out at the same time as the measurements at outlets V1-1, V7-7 and V-7-10, at the inflow located at coordinates y=540294, x=88198.

Air
Due to the possibility that the auxiliary boilerhouse may operate for more than 300 hours per year, which falls under the regime of monitoring emissions set out in the Decree on the emission of substances into the atmosphere from medium-sized combustion plants, gas turbines and stationary engines (Official Gazette of RS, Nos. 17/18, 59/18, 59/18, 44/22 [ZVO-2] and 99/22), a single measurement of emissions must be performed by an authorised laboratory (dust, smoke number, CO, NOx, SO_2).

Noise
Method: measurements performed by an authorised contractor
Methods: in accordance with the Rules*
Locations: determined by the authorised contractor in accordance with the Rules*
Timetable: once every three years in accordance with the Rules*

* Rules on the initial measurement and operational monitoring of noise from noise sources and on the conditions for implementation (Official Gazette of RS, Nos. 105/08 and 44/22 [ZVO-2])

Electromagnetic radiation
Method: measurements performed by an authorised contractor
Methods: in accordance with the Rules*
Locations: determined by the authorised contractor in accordance with the Rules*
Timetable: once every three years in accordance with the Rules*

* Rules on initial measurements and operational monitoring of sources of electromagnetic radiation and on the conditions for implementation (Official Gazette of RS, Nos. 70/96, 41/04 [ZVO-1] and 17/11 [ZTZPUS-1]).

Ionising radiation
Krško NPP carries out very extensive monitoring of radioactive emissions and immissions as defined in the Radiological Effluent Technical Specification (RETS), Revision 10).
The document describes the systems for monitoring liquid and airborne emissions, the locations and the frequency of monitoring. Krško NPP monitors radioactive emissions in all systems where radioactivity might occur during operation. The sampling points, monitoring frequency and type of analysis for liquid and gaseous emissions are described in Tables 3.11-1 and 3.11.-2, respectively.

Table 6: Programme of measurements of liquid emissions:

Type of discharge	Sampling frequency	Minimum analysis frequency	Type of analysis	LLD(1) (B$_q$/m^3)
1. Occasional single discharges(2) Waste monitor tank (WMT) 1 Waste monitor tank (WMT) 2 Turbine building, condensate transfer tank (CTT) Drain tank in the component-cooling building	P Each individual tank	P Single discharge	Main gamma emitters(3), I-131, H-3	1.9×10^4 3.7×10^4 3.7×10^5
	P Each individual tank	M	Dissolved and captured gases (gamma emitters)	3.7×10^5
	P Each individual tank	M Composite(4)	H-3 Total alpha activity	3.7×10^5 3.7×10^3
	P Each individual tank	Q Composite(4)	Sr-89, Sr-90, Fe-55 C-14	1.9×10^3 3.7×10^4 1.9×10^3
1. Continuous discharges(5) Steam generator blowdown (SGBD) system discharges Essential service water (ESW) discharges	Continuously(5) For ESW P, S – SGBD Sampling	W composite(5) ESW W composite(4) SGBD	Main gamma emitters(3), H-3	1.9×10^4 3.7×10^5
	P-SGBD Sampling	P composite(4) SGBD	Dissolved and captured gases	3.7×10^5
	P-SGBD Sampling	M composite(4) SGBD	H-3 Total alpha activity	3.7×10^5 3.7×10^3
	P-SGBD Sampling	M composite(4) SGBD	Sr-89, Sr-90, Fe-55	1.9×10^3 3.7×10^4

Note: sampling frequencies: S – at least once every 12 hours, P – prior to every discharge, M – monthly, Q – quarterly, Note: for 1.c, 1.d, and 2b, only major gamma emitters and H-3 (for H-3 in ESW composite

samples, the minimum analysis frequency is monthly).
(1) LLD – lower limit of detection
(2) A single discharge is a discharge of liquid waste in a limited quantity. Prior to sampling for analysis, the discharge must be isolated and the contents mixed to ensure a representative sample.
(3) The main gamma emitters to which the LLD refers are: Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, Cs-134, Cs-137, Ce-141. Ce-144 must also be measured; the LLD is 1.85 x 105 Bq/m^3. There are other radionuclides that may occur in addition to the ones listed above; they must also be identified and reported. Such radionuclides are e.g. Cr-51, Zr-95, Ag-110m, Sb-124, I-131, I-133, I-135 and Ba-140.
(4) A composite sample is a sample that is proportional in quantity to the discharged liquid and is obtained using a sampling method that ensures it is representative.
(5) Continuous discharges are discharges of liquid waste that do not have a predetermined volume and flow continuously, e.g. from a system during discharge.
(6) In order for the samples to be representative of the quantities and concentrations in the discharge, they must be collected continuously in proportion to steam flow. Prior to analysis, all samples must be mixed to ensure that the composite sample is representative of the discharge.

Table 7: Programme of measurements of gaseous emissions

Type of discharge	Sampling frequency	Minimum analysis frequency	Type of analysis	LLD(1) (B_q/m^3)
1. Gas decay tank	P Individual tank Single sample	P Individual tank	Main gamma emitters(2)	3.7×10^6
2. Containment	P; W Single sample each discharge and venting(3)	P; W Single sample each discharge and venting(3)	Noble gases Main gamma emitters(2)	3.7×10^6
3a Discharge from the ventilation channel(6) (including FHB and AB)	W(3)(4)	W(3)	Main gamma emitters(2)	3.7×10^6
	Continuously(3) or at a minimum W	W(3) Noble gas spectrometry	Main gamma emitters(2)	3.7×10^4
	Continuously Continuously	M M	H-3 (oxide) C-14	3.7×10^3 3.7×10^1
3b Discharge from the fuel handling building (FHB) ventilation channel	M(5)	M	Main gamma emitters(2)	3.7×10^6
3.c Discharge from the condensate ejector(6)	W Single sample	W	Main gamma emitters(2)	3.7×10^6
4a Ventilation channel (plant vent)(6) 4b Fuel handling building (FHB) 4c Auxiliary building (AB) 4d RW repository 4e Decontamination building(6)	Continuously	W(7) Sampling of charcoal filters	I-131	0.037
	Continuously	W(7) Sampling of particulates	Main gamma emitters(2)	0.37
5a Ventilation channel (plant vent)(6) 5b Decontamination building(6)	Continuously	M Composite, Sampling of particulates	Total alpha activity	0.37
	Continuously	Q Composite, Sampling of	Sr-89, Sr-90	0.37

Type of discharge	Sampling frequency	Minimum analysis frequency	Type of analysis	LLD(1) (B_q/m^3)
		particulates		
Containment	Continuously	P, W Charcoal filter	I-131	0.037
	Continuously	P each discharge W, sampling of particulates	Main gamma emitters(2)	0.37

Note: sampling frequencies: S – at least once every 12 hours, P – prior to every discharge, W – weekly, M – monthly, Q – quarterly.
(1) LLD – lower limit of detection
(2) The main gamma emitters to which the LLD refers are: Kr-87. Kr-88, Xe-133, Xe-133m, Xe-135 and Xe-138 in discharges of noble gases, and Mn-54, Fe-59, Co-58, Co-60, Zn-65, Mo-99, I-131, Cs-134, Cs-137, Ce-141 and Ce-144 in discharges of iodine and particulates. There are other radionuclides that may occur in addition to the ones listed above; they must also be identified and reported.
(3) Sampling and analysis must also be carried out after a forced shutdown, start-up, or a change in thermal power if the change exceeds 15% of the rated thermal power in one hour.
(4) Single H-3 samples from the ventilation system must be taken at least once every 24 hours when the refuelling channel is filled with water or when the containment is being purged.
(5) Single samples must be taken from the spent fuel pool exhaust at least once every seven days when spent fuel is in the pool.
(6) The ratio between the flow of air that is being sampled and the flow of air already sampled must be known for all periods when doses or dose rates are calculated.
Samples should be changed at least once every seven days and analysed no later than 48 hours after replacement or removal from the sampler. Sampling must also be carried out at least once every 24 hours for at least seven days after each shutdown, start-up, or a change in thermal power if the change exceeds 15% of the rated thermal power in one hour. Samples should be analysed no later than 48 hours after sampling. If samples are collected for 24 hours and then analysed, the LLD may be greater by a factor of 10. This requirement does not apply if:
(1) analyses show that the equivalent dose concentration of I-131 in the reactor coolant did not increase by more than a factor of 3 and
(2) noble gas monitors show that the activity in the effluents did not increase by more than a factor of 3.

Extensive monitoring of radioactivity in immissions is carried out in the vicinity of Krško NPP at the same time. All pathways by which a person can receive a dose are monitored:

- 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.

A detailed programme with the sampling locations, sampling frequency and required types of analysis is described in Table 3.12.-1 in RETS. Table 8 refers to a programme of measurements from the existing table in RETS and the additional measurements that will be included in the new revised RETS (request for amendment 21-2, Revision 02, RETS Change package: Modernisation of RETS with valid legislation and harmonisation with the actual sampling state as of 31 August 2021).

Table 8: Radioactivity monitoring programme in the vicinity of Krško NPP – immissions

1. Water, Sava

Type and description of measurement	Sampling point	Type of sample	Sampling frequency	Frequency of measurement	Annual no. of measurements
Isotope analysis using gamma-ray spectrometry	1. Krško – 4 km upstream of Krško NPP	- water + suspended solids - filter residue	composite sample collected over 31 consecutive days	once every 92 days	4
				once every 92 days	4
	2. Above the Brežice HPP dam, 7.2 km downstream of Krško NPP*			once every 31 days	12
				once every 31 days	12
	3. Brežice – 7.8 km downstream of Krško NPP			once every 31 days	12
				once every 31 days	12
	4. Jesenice na Dol. – 17.5 km downstream of Krško NPP			once every 31 days	12
				once every 31 days	12
Tritium (H-3), specific analysis using scintillation spectrometer	1. Krško	aqueous distillate	composite sample collected over 31 consecutive days	once every 31 days	12
	2. Above the Brežice HPP dam*			once every 31 days	12
	3. Brežice			once every 31 days	12
	4. Jesenice na Dol.			once every 31 days	12
Strontium Sr-90/Sr-89, specific analysis (radiochemical isolation of Sr-90/Sr-89, detection with proportional counter)	1. Krško	- water + suspended solids - filter residue	composite sample collected over 31 consecutive days	once every 92 days	4
				once every 92 days	4
	2. Above the Brežice HPP dam*			once every 31 days	12
				once every 92 days	4
	3. Brežice			once every 31 days	12
				once every 92 days	4
	4. Jesenice na Dolenjskem			once every 31 days	12
				once every 92 days	4

* Measurements from the operational radioactivity monitoring programme to account for the construction of Brežice HPP, commenced in July 2017 in the vicinity of Krško NPP.

2. River Sava – water, sediments and aquatic biota

Type and description of measurement	Sampling point	Type of sample	Sampling frequency	Frequency of measurement	Annual no. of measurements
	1. Left bank, 0.5 km upstream of Krško NPP	single samples: - water and suspended	once every 92 days	once every 92 days	12

Type and description of measurement	Sampling point	Type of sample	Sampling frequency	Frequency of measurement	Annual no. of measurements
		solids - sediments, - fish			
Isotope analysis using gamma-ray spectrometry	2. Left bank at Brežice, 4–7.8 km downstream of Krško NPP	single samples: - water and suspended solids - sediments, - fish	once every 92 days	once every 92 days	12
	3. Above the Brežice HPP dam, 7.2 km downstream of Krško NPP	single samples: - water and suspended solids - sediments, - fish	once every 92 days	once every 92 days	12
	4. Right bank at Jesenice, 17.5 km downstream of Krško NPP	single samples: - water and suspended solids - sediments, - fish	once every 92 days	once every 92 days	12
	5. Two samples on both banks of the reservoir between river profiles 120 and 121	single sample: water	once every 31 days	once every 31 days	24
		single sample: sediments	once every 31 days	once every 31 days	24
	6. Replacement habitat RH1	single sample: water	once every 92 days	once every 92 days	4
	7. Brežice HPP reservoir	fish	once every 182 days	once every 182 days	2
	8. Podsused	single sample: sediments fish (2 samples)	once every 92 days once every 182 days	once every 92 days once every 182 days	4 2
Strontium Sr-90/Sr-89, specific analysis	1. Left bank, 0.5 km upstream of Krško NPP	single samples: - water and suspended solids - sediments, - fish	once every 92 days	once every 92 days	12
	2. Left bank at Brežice, 4-7.8 km downstream of Krško NPP				12
	3. Above the Brežice HPP dam, 7.2 km downstream of Krško NPP				12
	4. Right bank at Jesenice, 17.5 km downstream of Krško NPP				12
	5. Two samples on both banks of the reservoir between river profiles 120 and	single sample: water	once every 31 days	once every 31 days	24
		single sample: sediments	once every 31 days	once every 31 days	24

Type and description of measurement	Sampling point	Type of sample	Sampling frequency	Frequency of measurement	Annual no. of measurements
	121				
	6. Replacement habitat RH1	single sample: water	once every 92 days	once every 92 days	4
	7. Brežice HPP reservoir	fish	once every 182 days	once every 182 days	2
	8. Podsused	single sample: sediments	once every 92 days	once every 92 days	4
Tritium (H-3), specific analysis using scintillation spectrometer	1. Left bank, 0.5 km upstream of Krško NPP	aqueous distillate	once every 92 days	once every 92 days	4
	2. Left bank at Brežice, 4–7.8 km downstream of Krško NPP		once every 92 days	once every 92 days	4
	3. Above the Brežice HPP dam, 7.2 km downstream of Krško NPP		once every 92 days	once every 92 days	4
	4. Right bank at Jesenice, 17.5 km downstream of Krško NPP		once every 92 days	once every 92 days	4
	5. Two samples on both banks of the reservoir between river profiles 120 and 121		once every 31 days	once every 31 days	24
	6. Replacement habitat RH1		once every 92 days	once every 92 days	4
	7. Podsused[47]		once every 182 days	once every 182 days	2
C-14	5. Two samples on both banks of the reservoir between river profiles 120 and 121	single sample: - water and suspended solids	once every 92 days	once every 92 days	8
	7. Brežice HPP reservoir	single sample: fish	once every 182 days	once every 182 days	2

Note: Gamma-ray spectrometry and strontium analysis in water and in solid samples. Podsused is a location in Croatia where H-3 in the water is also analysed.
* Measurements from the operational radioactivity monitoring programme to account for the construction of Brežice HPP, started in July 2017 in the vicinity of Krško NPP.

3. Water supply systems, boreholes

Type and description of measurement	Sampling point	Type of sample	Sampling frequency	Frequency of measurement	Annual no. of measurements
Isotope analysis using gamma-ray	1. Krško (water supply system)	individual sample	once every 92 days	once every 92 days	4
	2. Brežice (water				4

Type and description of measurement	Sampling point	Type of sample	Sampling frequency	Frequency of measurement	Annual no. of measurements
spectrometry	supply system)				
	3. Inside the Krško NPP perimeter fence, borehole 0071				4
	4. Medsave borehole (Croatia)[47]	single water sample	once every 31 days	once every 31 days	12
	4. Šibice borehole (Croatia)[47]		once every 31 days	once every 31 days	12
Strontium Sr-90/Sr-89, specific analysis	1. Krško (water supply system)	individual sample	once every 92 days	once every 92 days	4
	2. Brežice (water supply system)				4
	3. Inside the Krško NPP perimeter fence, borehole 0071				4
	4. Medsave borehole (Croatia)[47]	single water sample	once every 31 days	once every 31 days	12
	5. Šibice borehole (Croatia)[47]		once every 31 days	once every 31 days	12
Tritium (H-3), specific analysis using scintillation spectrometer	1. Krško (water supply system)	individual sample	once every 92 days	once every 92 days	4
	2. Brežice (water supply system)		once every 92 days	once every 92 days	4
	3. Inside the Krško NPP perimeter fence, borehole 0071		once every 92 days	once every 92 days	4
	4. Groundwater near Krško NPP on the left bank of the Sava (VOP-4)		once every 31 days	once every 31 days	12
	5. VOP-1/06 borehole (ARAO)		once every 31 days	once every 31 days	12
	6. V-7/77 borehole (Krško NPP)		once every 31 days	once every 31 days	12
	7. V-12/77 borehole (Krško NPP)		once every 31 days	once every 31 days	12
	8. Medsave borehole (Croatia)[47]	single water samples	once every 31 days	once every 31 days	12
	9. Šibice borehole (Croatia)[47]		once every 31 days	once every 31 days	12

4. Pumping stations, catchments

Type and description of measurement	Sampling point	Type of sample	Sampling frequency	Frequency of measurement	Annual no. of measure-ments
Isotope analysis using	1. Pumping station Krško	composite samples	once a day	once every 31 days	6 x 12

gamma-ray spectrometry	– Rore 2. Pumping station Krško – Brege 3. Dolenja Vas catchment 4. Pumping station Brežice VT1 (new) 5. Pumping station Brežice 481 6. Petruševac pumping station (Croatia)				
Tritium (H-3), specific analysis using scintillation spectrometer			once a day	once every 31 days	6 x 12
Strontium Sr-90/Sr-89, specific analysis			once a day	once every 31 days	6 x 12
			once a day	once every 31 days	6 x 12

Comment: In Brežice, sampling is only performed at active pumping stations that supply the water supply network.

5. Precipitation and depositions

Type and description of measurement	Sampling point	Type of sample	Sampling frequency	Frequency of measurement	Annual no. of measurements
Isotope analysis using gamma-ray spectrometry	1. Stara Vas (Krško) 2. Brege 3. Dobova	composite sample collected over 31 consecutive days	once every 31 days	once every 31 days	3 x 12
Tritium (H-3), specific analysis using scintillation spectrometer					3 x 12
Strontium Sr-90/Sr-89, specific analysis					3 x 12

SLD = Straight-line distance

6. Depositions – vaseline slides

Type and description of measurement	Sampling point	Type of sample	Sampling frequency	Frequency of measurement	Annual no. of measurements
Isotope analysis using gamma-ray spectrometry	7 sampling points at iodine pumps and the orchard next to Krško NPP, 3 groups of locations	monthly composite sample from 3 groups of locations, i.e. a month-long sample from an individual location at elevated values	continuous sampling for 31 days	once every 31 days	3 x 12

7. Air

Type and description of measurement	Sampling point	Type of sample	Sampling frequency	Frequency of measurement	Annual no. of measurements
Measurement of I-131 (gamma-ray spectrometry)	1. Sp. Stari Grad SLD = 1.8 km, 4C1 2. Stara Vas (Krško) SLD = 1.8 km, 16C 3. Leskovec SLD = 3 km, 13D 4. Brege SLD = 2.3 km, 10C 5. Vihre SLD = 2 km, 8D 6. Gornji Lenart SLD = 5.9 km, 6E 7. Spodnja Libna SLD = 1.3 km, 2B	continuous pumping through a glass fibre filter and a charcoal filter (15 days)	once every 15 days	once every 15 days	7 x 24
Strontium Sr-90/Sr-89, specific analysis	1. Libna or Stara Vas SLD = 1.4 km or 1.8 km	filter residue continuous pumping through an aerosol filter	once every 92 days	once every 92 days	4
Isotope analysis of particulates and aerosols using gamma-ray spectrometry	1. Sp. Stari Grad SLD = 1.8 km, 4C1 2. Stara Vas (Krško) SLD = 1.8 km, 16C 3. Leskovec SLD = 3 km, 13D 4. Brege SLD = 2.3 km, 10C 5. Vihre SLD = 2 km, 8D 6. Gornji Lenart SLD = 5.9 km, 6E 7. Spodnja Libna SLD = 1.3 km, 2B 8. Dobova SLD = 12.0 km, 6F	continuous pumping through the aerosol filter (filter is changed every 31 days or when clogged)	once every 31 days	once every 31 days	8 x 12
C-14 in CO_2 in air	2 locations inside the Krško NPP perimeter fence	CO_2 absorbed on NaOH as Na_2CO_3	once every 2 months	once every 2 months	2 x 6

8. External radiation dose and dose rate

Type and description of measurement	Sampling point	Type of sample	Sampling frequency	Frequency of measurement	Annual no. of measurements
Dose measured using environmental	67 measuring points in Slovenia: 57	TL dosimeter, at least 2 per measuring	once every 182 days	once every 182 days	134 in Slovenia 20 in Croatia

Type and description of measurement	Sampling point	Type of sample	Sampling frequency	Frequency of measurement	Annual no. of measurements
passive dosimeters in a ring around Krško NPP	arranged in circles at distances of 1.5 to 10 km from Krško NPP, and 9 on the Krško NPP perimeter fence (i.e. 66 measuring points in the vicinity of Krško NPP and one measuring point in Ljubljana); 10 in Croatia	point			
Measurement of gamma radiation dose rate	at least 10 measuring points surrounding the Krško NPP site	network with automatic operation		continuous measurement	continuous monitoring

Note: Krško NPP conducts dose measurements with OSL dosimeters at six points on the plant's perimeter fence. Neutron dosimeters are used at the same locations to measure the neutron dose.

9. Soil

Type and description of measurement	Sampling point	Type of sample	Sampling frequency	Frequency of measurement	Annual no. of measurements
Isotope analysis using gamma-ray spectrometry	1. Amerika, SLD = 3.2 km, flood plain, brown alluvial deposits 2. Trnje (Kusova Vrbina), SLD = 8.5 km, flood plain, grey alluvial soil 3. Gmajnice (Vihre) SLD = 2.6 km, flood plain, brown alluvial deposits	single soil sample from 4 depths 0–5 cm, 5–10 cm, 10–15 cm, 15–30 cm single samples: alluvial deposits, pasture or arable land	once every 6 months	once every 6 months	2 x (3 x 4)
Strontium Sr-90/Sr-89, specific analysis (radiochemical isolation of Sr-90/Sr-89, detection with proportional counter)					2 x (3 x 4)

10. Food – milk

Type and description of measurement	Sampling point	Type of sample	Sampling frequency	Frequency of measurement	Annual no. of measurements
Isotope analysis using gamma-ray spectrometry	1. Pesje 2. Drnovo 3. Skopice	single sample every 31 days	once every 31 days	once every 31 days	3 x 12
Strontium Sr-90/Sr-89, specific analysis		single sample every 31 days			3 x 12
I-131, specific analysis		single samples every 31 days during the grazing period – 8 months			3 x 8

11. Food – fruit

Type and description of measurement	Sampling point	Type of sample	Sampling frequency	Frequency of measurement	Annual no. of measurements
Isotope analysis using gamma-ray spectrometry	selected locations on the Krško Polje/Brežiško Polje, specifically an orchard next to Krško NPP, Sremič, Leskovec	single seasonal samples of various fruits: apples, pears, currants, strawberries, grapes, wine	once every 365 days	once every 365 days	10
Strontium Sr-90/Sr-89, specific analysis					10

12. Food – garden and field crops

Type and description of measurement	Sampling point	Type of sample	Sampling frequency	Frequency of measurement	Annual no. of measurements
Isotope analysis using gamma-ray spectrometry	selected locations on the Krško Polje/Brežiško Polje: Brege, Žadovinek, Vrbina, Sp. Stari Grad, Trnje	single seasonal samples of broad-leaved garden and field crops: lettuce, cabbage, carrots, potatoes, tomatoes, parsley, beans, onions, wheat, barley, corn, hops	once every 365 days	once every 365 days	20
Strontium Sr-90/Sr-89, specific analysis					20

* Dobova is a reference sampling point.

13. Food – meat, poultry and eggs

Type and description of measurement	Sampling point	Type of sample	Sampling frequency	Frequency of measurement	Annual no. of measurements
Isotope analysis using gamma-ray spectrometry	selected locations on the Krško Polje/Brežiško Polje: Žadovinek, Vrbina, Sp. Stari Grad, Pesje	single samples of various meat and eggs	once every 365 days	once every 365 days	6
Strontium Sr-90/Sr-89, specific analysis					6

14. Food – C-14 measurements

Type and description of measurement	Sampling point	Type of sample	Sampling frequency	Frequency of measurement	Annual no. of measurements
Carbon C-14	selected locations on the Krško Polje/Brežiško Polje: the orchard next to Krško NPP, Vrbina, Žadovinek, Brege, Spodnji Stari Grad, Dobova* (up to 17 locations)	Seasonal samples – garden crops, field crops and various fruits	twice every 365 days	twice every 365 days	35

Immission measurements are performed by authorised environmental monitoring contractors in accordance with the Rules on the monitoring of radioactivity (Official Gazette of RS, No. 27/18). A report on radioactivity monitoring in the vicinity of Krško NPP, which includes dose estimations for reference population groups, is compiled every year. The conservatively estimated annual effective dose for the most exposed individuals was less than 0.071 µSv in 2020.

Although C-14 has been the largest contributor to the dose for several years, the monitoring programme in the Rules on the monitoring of radioactivity (Official Gazette of RS, No. 27/18) only requires five measurements of C-14 in cereal samples. In previous years, and most recently in 2019 (I. Krajcar Bronić: "Report on measurements of C-14 activity around Krško NPP in 2019", LNA-5/2020, Ruđer Bošković Institute, Institute for Experimental Physics, Laboratory for Measuring Low-Level Activity, 9 January 2020), Krško NPP has ordered measurements of 34 plant samples (vegetables, fruit) from which a dose estimate can be made. A programme of such measurements should be incorporated into the regular monitoring programme (added to RETS). Since H-3 is also an isotope whose emissions into the environment are measurable and contribute to the dose, it makes sense to determine H-3 (organically bound tritium) in the same samples used to determine C-14.

A single evaluation of the possible impact on the environment or persons based on OBT (organically bound H-3) measurements is an integral part of reporting to administrative bodies and is also envisaged by Krško NPP in 2021. Various expert analyses have already been published in connection with this, for example: “Report on OBT intercomparison from IRB, Ruđer Bošković Institute”, I. Krajcar Bronić workshops on the subject of OBT in Romania 2019; and “Interlaboratory comparison and OBT measurements in biota in the environment of NPP Krško”, a conference about radiation measurements in 2019 in the Czech Republic, R. Krištof, J. Kožar Logar, A. Sironić, I. Krajcar Bronić.

In Croatia, measurements of the Sava are performed at Podsused, while measurements of external radiation are performed at ten locations. In 2018 and 2019, Krško NPP also financed measurements of H-3 in continuous samples from the Petruševec pumping station, which is the largest drinking water pumping station for the city of Zagreb. An article by J. Barešić, J. Parlov, Z. Kovač and A. Sironić (“Use of nuclear power plant released tritium as a groundwater tracer”, Mining-Geology-Petroleum Engineering Bulletin, 2020) notes that H-3 values at Petruševec have increased, which is to be expected. Since this is the largest pumping station for the city of Zagreb, the location should be incorporated into the radioactivity monitoring programme (RETS). In addition to H-3, measurements of Sr-89/90 and gamma emitters should also be performed at the site using high-resolution gamma-ray spectrometry.

As the “Monitoring of radioactivity in the vicinity of Krško NPP” (Report for 2019, Jožef Stefan Institute, IJSDP-12784, March 2020) shows, measurements of fish samples using high-resolution gamma-ray spectrometry are performed at Podsused and Otok (four samples at each site) in Croatia. Measurements of groundwater are also performed in Croatia at the Medsave and Šibice sites (high-resolution gamma-ray spectrometry, Sr, H-3). In addition, sediment (gamma emitters and Sr-90) is measured at Podsused. These measurements are not listed in RETS, although they have been carried out for a number of years. Measurements of sediments and fish at the Podsused site therefore need to be stated in or incorporated into the regular monitoring programme.

The monitoring of radioactive emissions follows the water transport path of the Sava. All sampling points are located under the Krško NPP dam, except for the point near the VIPAP VIDEM KRŠKO cellulose plant. Sporadic measurements of OBT (organically bound H-3) in vegetation on the right bank of the Sava near the Krško NPP dam (above the spillways) indicate increased OBT activity concentrations. It is not clear whether this is caused by airborne or liquid discharges from Krško NPP. It is possible that released radioactivity does not fully drain through the spillways, and that stagnation and even counterflow of surface water occur on the right bank of the river. The study “Tritium in organic matter around Krško Nuclear Power Plant” (R. Krištof et al., J. Radioanal. Nucl. Chem., 2017, 314:675-679) showed that OBT activity concentrations in vegetation along the southwestern perimeter of Krško NPP are higher than at other points along the perimeter. This is the result of airborne transport from Krško NPP, where H-3 predominates in the form of the HTO molecule, which is part of the water cycle. Increased values have been observed after an outage. These observations could be grounds for changes to radioactivity monitoring. Since the model of radioactivity dispersion along the Sava will be defined in the terms of reference for a study titled “Impact of Brežice HPP on Krško NPP and the Environmental Impact Assessment Report for the Extension of Krško NPP’s Operational Lifetime” (public invitation to tender published on the Slovenian public procurement portal on 16 February 2021, public contract no. JN000870//2021-E01), the findings of the study should be included in the radioactivity monitoring programme. The radioactivity monitoring programme for the Sava will have to be reviewed after Mokrice HPP is built.

Spent fuel dry storage

The construction of the spent fuel dry storage will require additional external radiation monitoring to be conducted. Krško NPP is currently measuring the dose rate of ionising radiation using six passive optically stimulated luminescence (OSL) dosimeters at measuring points at the perimeter of the plant. After the spent fuel dry storage is constructed, passive dosimeters will also be installed in the northwestern and southwestern corners of the storage area of the building. The upper dosimeter will be placed just below the roof, the lower dosimeter above the height of the partition wall, and the middle dosimeter midway in height between the upper and lower dosimeter. Three dosimeters will therefore be

installed in each of the two corners, or a total of six dosimeters in the dry storage building. Additional passive dosimeters will be installed at the Krško NPP perimeter: one at a site nearest to the spent fuel dry storage and three more on each side of the first dosimeter at a distance of 10 m from each other. The dosimeters will measure neutron and gamma radiation doses, and will be read or changed at least once every six months. Even before construction starts, baseline monitoring will be conducted using the existing OSL dosimeter closest to the spent fuel dry storage. The proposed scope of monitoring may be changed after a certain measurement period.
According to calculations, the total dose (resulting from the operation of the dry storage and other Krško NPP activities) at perimeter will not exceed the limit value of 200 µSv.
During the transfer of spent fuel from the fuel building to spent fuel dry storage, a temporary controlled area will be established along the transfer route and measurements of radiation parameters carried out.

Monitoring of radioactivity following the construction of Brežice HPP

Since July 2017, Krško NPP has been conducting additional monitoring of the radioactivity of the Sava to study the impact of the construction and operation of 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. The damming of the Sava has led to changes in the flow and dispersion of radioactivity in the river, as additional monitoring has shown. There has, of course, been no increase in radioactive liquid discharges from Krško NPP. The model currently in use is based on the “Exposure of the reference population group to radiation from liquid discharges from Krško NPP into the Sava” study (JSI Working Report no. IJS-DP-10114, January 2009 (authors B. Pucelj, M. Stepišnik)). As mentioned, a study titled “Impact of Brežice HPP on Krško NPP and the Environmental Impact Assessment Report for the Extension of Krško NPP’s Operational Lifetime” is being drafted. The results of this project will show whether it is necessary to change the radioactivity monitoring programme for the Sava.

III. Explanation relating to an assessment of the acceptability of an activity affecting nature

The first paragraph of Article 39 of the Rules provides that, in line with the size and characteristics of an activity affecting nature, an assessment of the acceptability of such activities shall be carried out as part of the procedure for the granting of (1) an environmental protection consent for an activity affecting nature that has an environmental impact, (2) a natural conservation consent for an activity affecting nature that does not have an environmental impact, (3) a permit for an activity affecting nature as defined in Article 43 of these Rules or (4) a permit under other regulations for activities affecting nature for which a consent or permit referred to in the preceding three indents is not required.

In accordance with the Rules, the “Supplement Assessing the Acceptability of the Impacts on Protected Areas for the Extension of Krško NPP’s Operational Lifetime From 40 to 60 Years – Nuklearna elektrarna Krško d.o.o., order no.: 1456-20 VO, October 2021, supplemented January 2022 (AQUARIUS d.o.o. Ljubljana, cesta Andreja Bitenca 68, 1000 Ljubljana) was drawn up for the lifetime extension, and specifically for the requirements of Stage II of the assessment of the acceptability of plans and activities affecting nature in protected areas.
According to the Decree on the classification of buildings, the Krško NPP complex is a built industrial complex. According to the Rules, complex industrial buildings are defined in Chapter II of Annex 2 as: areas of production activities that are areas of direct impact (100 m) for all groups, and areas of remote impact (1,000 m) for birds, bats, aquatic and riparian habitat types, and beetles. The only Natura 2000 area within the area of remote impact is Vrbina SAC (SI3000234). The area is approx. 350 m from the area of the lifetime extension. The stretch of Sava 8 km downstream of Krško NPP has been declared a Natura 2000 area (Lower Sava SAC, SI3000304).

After studying the documentation referred to, the ministry found that the impact of the lifetime extension during operation on Vrbina SAC (SI3000234) would not be significant (impact assessed as “B”), neither would it be significant on the Lower Sava SAC (SI3000304) as long as the mitigation measures were carried out (impact assessed as “C”). The ministry included the measures as conditions in the operative part of this environmental protection consent (conditions set out in Point II/1 Conditions for the protection of surface waters, groundwater and the natural environment, including from the standpoint of climate change).

The seventh paragraph of Article 105 of the Nature Conservation Act (Official Gazette of RS, Nos. 96/04 [UPB], 61/06 [ZDru-1], 8/10 [ZSKZ-B], 46/14, 21/18 [ZNOrg], 31/18, 82/20, 3/22 [ZDeb] and 105/22 [ZZNŠPP]) provides that if an EIA is prescribed for the construction of a structure referred to in the first paragraph of this article in accordance with the regulations governing environmental protection, an environmental protection consent shall be issued in place of a nature conservation consent. The second paragraph of Article 39 of the Rules provides that when an assessment of the acceptability of an activity affecting nature is carried out as part of a procedure for granting an environmental protection consent, a nature conservation consent shall be deemed to have been granted at the same time as the environmental protection consent. The decision was therefore reached as per point III of the operative part of this decision.

Pursuant to the eighth paragraph of Article 61 ZVO-1, an environmental protection consent ceases to be valid if, within five years of its entry into force, the developer fails to begin carrying out construction activities in the area, or fails to obtain a building permit (if a building permit is required pursuant to the regulations on construction). The ministry has therefore decided as per point IV of the operative part of this environmental protection consent.

Costs

Pursuant to the fifth paragraph of Article 213 in conjunction with Article 118 ZUP, it was also necessary to decide on the costs of the procedure in the operative part of this decision. In view of the fact that no costs arose in this procedure, the ministry decided as per point V of the operative part of this environmental protection consent.

According to the second paragraph of Article 230 ZUP, an appeal against a decision issued by the ministry in the first instance is only permitted when the law allows. That law must also determine which authority is competent to decide on the appeal. If no determination is made, the appeal is decided upon by the government. Although the ZVO-1 does not provide for an appeal against the decision, an administrative dispute may be initiated.

Notice of legal remedy:
While this decision admits no appeal, an administrative dispute may be filed at the Administrative Court of the Republic of Slovenia within 30 days of delivery of the decision. The action shall be submitted directly with the competent court or sent by post.

The following took part in the preparation of this decision:

Erna Tomaževič, Secretary

Compiled by:

Ana Kezele Abramović
Secretary

Vesna Kolar Planinšič
Head of the Environmental Assessment Section

Annex 1: List of abbreviations

Abbreviation	English term	Slovenian term
NPP	Nuclear Power Plant	nuklearna elektrarna
SNSA	Slovenian nuclear safety administration	Uprava Republike Slovenije za jedrsko varnost
SNSA	Slovenian nuclear safety administration	Uprava Republike Slovenije za jedrsko varnost
ARSO	Slovenian Environment Agency	Agencija Republike Slovenije za okolje
PSA	Probabilistic Safety Assessment	verjetnostne varnostne analize
CFVS	Containment Filtered Venting System	sistem zadrževalnega filtra
PAR	Passive Autocatalytic Recombiners	pasivne sežigalne peči / pasivni avtokatalitski rekombinatorji
MAAP	Modular Accident Analysis Programme	modularni program za analizo nesreč - računalniški program, ki simulira zaporedja težkih nesreč v jedrskih elektrarnah
CDF	Core Damage Frequency	pogostost poškodbe sredice
LRF	Large Release Frequency	pogostost velikega izpusta
LERF	Large Early Release Frequency	pogostost velikega zgodnjega izpusta
WENRA RL Issue SV	Western European Nuclear Regulators Association Safety Reference Level Issue: Internal Hazards	Združenje zahodnoevropskih jedrskih regulatornih organov, Referenčna varnostna raven: notranje nevarnosti
AFW	Auxiliary feedwater	Sistem pomožne napajalne vode
USAR	Updated Safety Analysis Report	posodobljeno varnostno poročilo
DEC	Design Extension Conditions	razširjeni projektni pogoji
SSC	Systems, Structures and Components	Sistemi, strukture in komponente
ESPOO	Convention on Environmental Impact Assessment in a Transboundary Context	Konvencija o presoji čezmejnih vplivov na okolje
EIA Directive	Environmental Impact Assessment Directive (EU's Environmental Impact Assessment Directive (2011/92/EU as amended by 2014/52/EU))	Direktiva Evropskega parlamenta in sveta o presoji vplivov nekaterih javnih in zasebnih projektov na okolje (Direktiva 2011/92/EU, zadnjič spremenjeno z Direktivo 2014/52/EU)
NEPN	Integrated National Energy and Climate Plan of the Republic of Slovenia	Celoviti nacionalni energetski in podnebni načrt Republike Slovenije
GHG	greenhouse gases	toplogredni plini
RES	Renewable Energy Sources	obnovljivi viri energije

Abbreviation	English term	Slovenian term
UNECE	United Nations Economic Commission for Europe	Ekonomska komisija Združenih narodov za Evropo
DB / DBA	Design Basis Accident	Projektna nesreča
BDB	Beyond Design Basis Accident	Izvenprojektna nesreča
PGA	Peak Ground Acceleration	konični pospešek tal
UHS	Uniform Hazard Spectra	enotni spektri nevarnosti
UHS	Ultimate Heat Sink	končni ponor toplote
AUHS	Alternative Ultimate Heat Sink	alternativni končni ponor toplote
PSHA	Probabilistic Seismic Hazard Analysis	Verjetnostna analiza potresne nevarnosti
BB1	Bunkered Building 1	Bunkerska zgradba 1
BB2	Bunkered Building 2	Bunkerska zgradba 2
EMS	European macroseismic scale	Evropska makroseizmična lestvica
EPRI	Electric Power Research Institute	Inštitut za raziskave na področju elektroenergetike
WENRA RHWG	Western European Nuclear Regulators Association Reactor Harmonisation Working Group	Delovna skupina za usklajevanje reaktorjev Združenja zahodnoevropskih jedrskih regulatorjev
TLAA	Time Limited Aging Analysis	časovno omejena analiza staranja
TEPCO	Tokyo Electric Power Company	Japonsko elektropodjetje iz Tokya (upravljavec nuklearne elektrarne v japonski Fukušimi)
SALTO	Safety Aspects of Long Term Operation	varnostni vidiki dolgoročnega obratovanja
AMP	Aging Management Programme	program upravljanja staranja
GALL	Generic Aging Lessons Learned	splošna spoznanja o staranju v jedrskih elektrarnah, ki jih izdaja Upravni organ Združenih držav Amerike za jedrsko varnost
IGALL	International Generic Ageing Lessons Learned	mednarodna splošna spoznanja o staranju v jedrskih elektrarnah, ki jih izdaja Mednarodna agencija za jedrsko energijo
ENSREG	European Nuclear Safety Regulators Group	Skupina evropskih regulatorjev za jedrsko varnost
PSR	Periodic Safety Review	občasni varnostni pregled
NRC	Nuclear Regulatory Commission	Upravni organ Združenih držav Amerike za jedrsko varnost
SAR	Safety Analysis Report	Varnostno poročilo elektrarne
LOCA	Loss of Coolant Accident	nezgode z izgubo hladila
AOP	Abnormal Operating Procedures	postopki za obvladovanje nenormalnih stanj
EOP	Emergency Operating Procedure	postopki za obvladovanje nezgodnih stanj

Abbreviation	English term	Slovenian term
SBO	Station Blackout	Izguba vsega izmeničnega napajanja elektrarne
PCFVS	Passive containment filtering vent system	prezračevalni sistem pasivnega zadrževalnega sistema
flexRISK	Project: Flexible Tools for Assessment of Nuclear Risk in Europe	Projekt: Prilagodljiva orodja za oceno jedrskega tveganja v Evropi
KBS-3	Swedish method for final disposal of SF (swe. Kärnbränslesäkerhet)	tehnologija za odlaganje visokoradioaktivnih odpadkov razvita na Švedskem
ZVO (EPA)	Environmental Protection Act	Zakon o varstvu okolja
EIA Report	Environmental Impact Assessment Report	Poročilo o vplivih na okolje
CBD	United Nations Convention on Biological Diversity	Konvencija Združenih narodov o biološki raznovrstnosti
POMS	Proactive Obsolescence Management System	Proaktivni sistem upravljanja zastarelosti
MECL	Master Equipment Component List	seznam inštalirane opreme in komponent)
TPR	Topical Peer Review	tematskega strokovnega pregleda
MD bus	Medium Dedicated safety bus	varnostna zbiralka
DG	Diesel generator	Dizelski generator
RWST	Refuelling Water Storage Tank	zbiralnik vode za menjavo goriva
CST	Condensate Storage Tank	zbiralnik kondenzata
ASI	Alternative Safety Injection	alternativnega varnostnega vbrizgavanja
AAF	Alternative Auxiliary Feedwater	alternativni sistem pomožne napajalne vode
SFP	Spent Fuel Pit	Bazen za izrabljeno gorivo
RC	Release category	kategorija izpusta
RHR	Residual Heat Removal System	sistem za odvajanje zaostale toplote
SI	Safety Injection	varnostno vbrizgavanje
CSS	Containment Spray System	sistem za prhanje zadrževalnega hrama
ARHR	Alternative Residual Heat Removal System	alternativni sistem za odvajanje zaostale toplote
SAMG	Severe Accident Management Guidelines	Smernice za obvladovanje težkih nesreč
SUP	Safety Upgrade Programme	Program nadgradnje varnosti
HCLPF	High Confidence of Low-Probability of Failure	nizka verjetnost odpovedi ob visokem zaupanju
PMF	Probable Maximum Flood	maksimalna verjetna poplava
PFDHA	Probabilistic Fault Displacement Hazard Analysis	verjetnostna analiza nevarnosti premika prelomov
EIU	Economist Intelligence Unit	Oddelek za raziskave in analize Economist Grupe
NSI	Nuclear Security Index	indeks jedrskega varovanja

Abbreviation	English term	Slovenian term
NTI	Nuclear Threat Initiative	pobuda za oceno in sledenje razmer jedrske varnosti v državah po vsem svetu
IPPAS	International Physical Protection Advisory Service	Mednarodne svetovalne službe za fizično zaščito
TEDE	Total Effective Dose Equivalent	efektivno dozo celega telesa in dozo ščitnice
ICRP	International Commission on Radiation Protection	Mednarodna komisija za radiološko varstvo
EVND	Ex-Vessel Neutron Dosimetry	Nevtronska dozimetrija izven reaktorske posode
PWROG	Pressurized Water Reactor Owners Group	Združenje operaterjev tlačnovodnih reaktorjev
CFD	Core Damage Frequency	pogostost poškodbe sredice
SLORA (CRS)	Cancer Registry of Republic of Slovenia	Register raka Slovenije
OBT	Organically bound H-3	organsko vezani tritij H-3
OSART	Operational Safety Review Team	Revizijska skupina za operativno varnost pri MAAE
WANO	World Association of Nuclear Operators	Svetovno združenje operaterjev jedrskih elektrarn
IAEA	International Atomic Energy Agency	Mednarodna agencija za jedrsko energijo
CANDU	CANadian Deuterium Uranium	Kanadski težkotlačnovodni reaktor
RW	Radioactive waste	radioaktivni odpadki
SF	Spent (nuclear) fuel	izrabljeno goriv
SPSA	Seismic Probabilistic Safety Assessment	ocena potresne verjetnosti
PSHA	Probabilistic Seismic Hazard Analysis	verjetnostna analiza potresne nevarnosti
ASME	American Society of Mechanical Engineers	Ameriško združenje strojnih inženirjev
PMF	Probable Maximum Flood	Maksimalno verjetne poplave
NGMM	Non-ergodic ground motion model	neergodičen model gibanja tal
SSHAC	Senior Seismic Hazard Analysis Committee	višji odbor za analizo seizmične nevarnosti
GMM	Ground–motion models	model gibanja tal
LTO	Long-term operation	Dolgoročno obratovanje
SSE	Safe Shutdown Earthquake	Projektni potres
IRRS	Integrated Regulatory Review Service	Misija Mednarodne agencije za jedrsko energijo za neodvisen strokovni pregled zakonodajnega in upravnega okvirja jedrske in sevalne varnosti
AIT	Austrian Institute of Technology	Avstrijski inštitut za tehnologijo

Abbreviation	English term	Slovenian term
EES (ES)	electricity system	elektroenergetski sistem
WHER	Waste heat emission ratio	Emisijski delež oddane toplote
HPP	Hydro power plant	hidroelektrarna
ARAO	Agency for Radwaste Management	Agencija za radioaktivne odpadke
FOND	Fund for financing the decommissioning of Krško Nuclear Power Plant and the disposal of Krško NPP radioactive waste and spent fuel	Fond za financiranje razgradnje i zbrinjavanja radioaktivnog otpada i istrošenoga nuklearnog goriva Nuklearne elektrane Krško
WMB	Waste manipulation building	objekt za manipulacijo z opremo in pošiljkami radioaktivnih tovorov
ADR	European Agreement concerning the International Carriage of Dangerous Goods by Road	Evropski sporazum o mednarodnem cestnem prevozu nevarnega blaga
LILW	Low- and intermediate-level waste	Nizko in srednje radioaktivni odpadki
WENRA	Western European Nuclear Regulators Association	Združenje zahodnoevropskih jedrskih regulatornih organov
IRSN	L'Institut de Radioprotection et de Sûreté Nucléaire (French Radioprotection and Nuclear Safety Institute)	Francoski inštitut za zaščito pred sevanjem in jedrsko varnost
BRGM	French geological survey (Bureau de Recherches Géologiques et Minières)	Urad za geološke in rudarske raziskave
GEOZS	Geological Survey of Slovenia	Geološki zavod Slovenije
ZAG	Slovenian National Building and Civil Engineering Institute	Zavod za gradbeništvo Slovenije
HEP	Croatian national power company (Cro. Hrvatska elektroprivreda d.d.)	Hrvaško elektrogospodarstvo
INPO	Institute of Nuclear Power Operations	Inštitut za obratovanje jedrskih elektrarn
EQ	Environmental Qualification of Plant Equipment	kvalificiranje opreme za pogoje obratovalnega okolja
PTS	Pressurised Thermal Shock	tlačno-toplotni udar
ART	Adjusted Reference Temperature	Temperatura krhko-duktilnega prehoda
RCS	Reactor Coolant System	Reaktorski hladilni sistem

To be delivered to:

- the developer: Nuklearna elektrarna Krško, d.o.o., Vrbina 12, 8370 Krško – in person;
- third-party participant: Zveza ekoloških gibanj Slovenije (ZEG, Association of Ecological Movements of Slovenia), Cesta krških žrtev 53, 8270 Krško – in person;
- third-party participant: Focus, društvo za sonaraven razvoj (Association for Sustainable Development), Trubarjeva cesta 50, 1000 Ljubljana – in person;
- third-party participant: Hidroelektrarne na Spodnji Savi, d.o.o., Cesta bratov Cerjakov 33a, 8250 Brežice – in person.

Also to be delivered, pursuant to the eleventh paragraph of Article 61 ZVO-1, to:

- Inspectorate of the Republic of Slovenia for the Environment and Spatial Planning, Environment and Nature Inspection Service, Dunajska 58, 1000 Ljubljana – by email (gp.irsop@gov.si).
- Municipality of Krško, Cesta krških žrtev 14, 8270 Krško – by email (obcina.krsko@krsko.si);
- Slovenian Nuclear Safety Administration, Litostrojska cesta 54, 1000 Ljubljana – by email (gp.ursjv@gov.si);
- Institute of the Republic of Slovenia for Nature Conservation, Novo Mesto Regional Office, Adamičeva ulica 2, 8000 Novo Mesto – by email (zrsvn.oenm@zrsvn.si);
- Fisheries Research Institute of Slovenia, Spodnje Gameljne 61a, 1211 Ljubljana – Šmartno – by email (info@zzrs.si);
- Ministry of Health, Public Health Directorate, Štefanova ulica 5, 1000 Ljubljana – by email (gp.mz@gov.si);
- Slovenian Water Agency, Mariborska cesta 88, 3000 Celje – by email (gp.drsv@gov.si);
- Slovenian Environment Agency, Vojkova 1b, 1000 Ljubljana – by email (gp.arso@gov.si),

To be sent to the countries involved:

- Virag Pomozi, Ministry of Agriculture, Apaczai Csere Janos u.9, H-52 Budapest, Pomozi – by email (virag.pomozi@tim.gov.hu),
- Anamarija Matak, Ministry of the Environment and Energy, Radnička cesta 80, 10000 Zagreb – by email (Anamarija.Matak@mingor.hr),
- Anna Maria Maggiore, Ministry of the Environment, Land and Sea, Director-General for Environmental Assessments and Authorisation, II Division EIA/SEA – by email (anamariamaggiore@minambiente.si),(nocco.gianluigi@minambiente.it)
- Dr Ursula Platzer-Schneider, Republic of Austria, Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology, Directorate General V – Environment and Circular Economy, Department 11 – Plant-Related Environmental Protection, Environmental Assessment and Air Pollution Control – by email (Ursula.Platzer@bmk.gv.at and Waltraud.petek@bmnt.gv.at),
- H Hans Heierth, Referat 81, Bayerisches Staatsministerium für Umwelt und Verbraucherschutz Rosenkavalierplatz 2, 81925 München, Postfach 81 01 40, 81901 München – by email (Hans.Heierth@stmuv.bayern.de),
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