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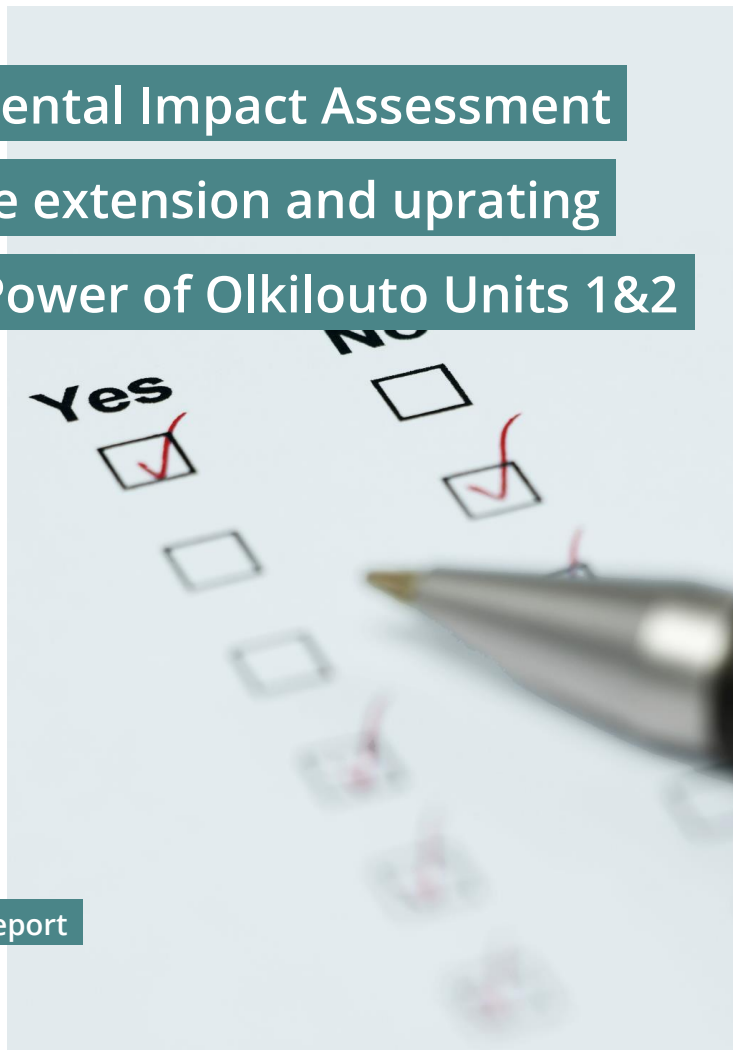
Environmental Impact Assessment for the life extension and uprating thermal Power of Olkilouto Units 1&2



Final Expert Report

umweltbundesamt
ENVIRONMENT AGENCY AUSTRIA

ENVIRONMENTAL IMPACT ASSESSMENT FOR THE LIFE EXTENSION AND UPRATING THERMAL POWER OF OLKILOUTO UNITS 1 & 2

Final Expert Report

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REPORT
REP-0969

VIENNA 2025

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Title photograph © iStockphoto.com/imagestock

Publications For further information about the publications of the Umweltbundesamt please go to: https://www.umweltbundesamt.at/

Imprint

Owner and Editor: Umweltbundesamt GmbH
Spittelauer Laende 5, 1090 Vienna/Austria

This publication is only available in electronic format at https://www.umweltbundesamt.at/.

ISBN 978-3-99004-816-0

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1 SUMMARY

This report presents the findings and the recommendations based on the evaluation of the written answers to the Austrian expert's questions, received as VN/19926/2024-TEM-38 of 31st March 2025, from the Finnish Ministry of Economic Affairs and Employment which is responsible for the implementation of the public consultation process in relation with the EIA for OL 1 and 2.

Being a potentially affected party in case of a radiological release from the Olkiluoto plant, Austria is participating in the OL 1 & 2 lifetime extension/power uprate EIA procedure. In this respect, the Austrian Environment Agency (Umweltbundesamt) engaged an expert team to assess the EIA. The Expert team reviewed the EIA report and assessed the potential impact to the environment and population of Austria. In this, the expert team raised 24 specific questions, covering practically all areas of the EIA. The questions addressed areas where it was felt that the EA did not elaborate in enough detail and/or where clarification might be needed. The competent authority, the Finnish Ministry of Economic Affairs and Employment, provided its answers to the questions raised by the experts in its above quoted communication.

Upon receiving the answers, the experts undertook an evaluation of the answers provided to each of the questions. On that basis, the conclusions were drawn on each of the questions. From an expert's point of view, the following open questions remain to be addressed in the upcoming procedures in Finland, highlighting the following:

While it is true that 100 TBq is established in the Finnish regulation the competent authority seems not to offer any justification as to why not using a higher value, which, as could be read in STUK's own reports on the marginal release values during severe accidents, could be above 100 TBq. It is not just the experts that believe that there is a material justification for using a higher value, some comments from other neighbouring countries reached the same conclusion. Therefore, the answers provided by the competent authority may be insufficient.

It is understandable that extending the lifetime and implementing the power uprate of 2 large nuclear units is a long term and resource-intensive activity. Therefore, having an early EIA to assess whether there are environmental limits or challenges related with such a project is a prudent approach. Nevertheless, it needs to be recognised that the regulatory framework in Finland for the lifetime extension beyond 60 years does not yet exist. Being a highly regarded regulator, STUK will certainly take a deep look into conditions and establish the requirements for the lifetime extension beyond 60 years.

While it is fully plausible that despite of any new conditions and requirements, the final result might be the same, i.e. that the power uprate and lifetime extension is acceptable from the environmental perspective, this does not justify not implementing an update of the EIA when all the regulatory requirements are established. The experts would like to suggest to the competent authority that the

relevant parts (i.e., those being impacted) of the EIA are to be updated and new analyses undertaken when STUK announces its requirements and TVO completes its analyses and studies regarding the safety modifications needed.

Concerning to all the uncertainties and in particular the fact that the uprate (if agreed) is 3-4 years and the life extension even more, 10-12 years away, it is suggested that an update of the EIA is prepared when all currently unknown issues become known. Assessing the answer received, it has to be said, that while it may appear that now there are ”no unknown issues”, those may well arise when STUK’s requirements are established and ageing degradation mechanisms for beyond 60 years of operation are analysed in depth.

The statement „OL 1&2 would adhere to the requirements“, while the requirements are at present not known is not fully useful.

Apart from indicating that the ageing management procedures are being applied through the maintenance activities, the EIA does not say anything as to how Olkiluoto would assure that the full spectrum of degradation mechanism,s that might be different from those for the initial life extension, would be identified and the ageing management procedures designed.

The total power would be increased by more than 35%, meaning that the plant will be operating far from its original design envelope. This requires particular attention to analyses to be undertaken to assure safety for the plant. While it is correct that (many) other plants increased their power and also that the BWR reactors have larger margins (in the core) than could be used for the power uprate, OL 1&2 will be, with the planned power uprate among the highest (or indeed the highest) relative power increase of all operating NPPs. The answer to experts' question neither provided further clarification, nor raised assurances that the activities that are implemented or planned at OL1&2 would indeed be comprehensive enough to minimise eventual safety impact.

An engineering pass into the accident potentially affecting all units at the Olkiluoto site, i.e. the Fukushima scenario would be a good addition to the EIA. No information on the scope of the PRA (probabilistic risk assessment), its assumptions, the actual results obtained, etc. have been provided neither in the EIA, nor in the answer to specific question raised by experts. It is obvious that STUK would require all the details of the PRA as part of the regulatory submittal. However, from the answer to the Q 19 it appears that the PRA concerning external events already exists. Therefore, there shall be no reason why the details that are being asked for are not released.

2 ZUSAMMENFASSUNG

Dieser Bericht enthält die Ergebnisse und Empfehlungen auf der Grundlage der Auswertung der schriftlichen Antworten auf die Fragen der österreichischen Experten, die mit VN/19926/2024-TEM-38 vom 31. März 2025 vom finnischen Ministerium für Wirtschaft und Beschäftigung, das für die Durchführung des öffentlichen Konsultationsverfahrens im Zusammenhang mit der UVP für Olkiluoto 1 und 2 (OL1 und 2) zuständig ist, übermittelt wurden.

Als potenziell betroffene Partei im Falle einer radioaktiven Freisetzung aus dem Kraftwerk Olkiluoto beteiligt sich Österreich am UVP-Verfahren für die Verlängerung der Laufzeit/Leistungserhöhung von OL 1 und 2. In diesem Zusammenhang hat das österreichische Umweltbundesamt ein Expertenteam mit der Bewertung der Umweltverträglichkeitsprüfung beauftragt. Das Expertenteam hat den Umweltverträglichkeitsbericht überprüft und die potenziellen Auswirkungen auf die Umwelt und die Bevölkerung Österreichs bewertet. Dabei hat das Expertenteam 24 spezifische Fragen gestellt, die praktisch alle Bereiche der Umweltverträglichkeitsprüfung abdecken. Die Fragen betrafen Bereiche, in denen die Umweltverträglichkeitsprüfung als nicht ausreichend detailliert angesehen wurde und/oder in denen Klarstellungen erforderlich sein könnten. Die zuständige Behörde, das finnische Ministerium für Wirtschaft und Beschäftigung, hat die Fragen der Experten in der oben genannten Mitteilung beantwortet.

Nach Erhalt der Antworten haben die Experten die eingelangten Antworten bewertet. Auf dieser Grundlage wurden zu jeder Frage Schlussfolgerungen gezogen. Aus Sicht der Sachverständigen sind in den nachfolgenden Verfahren in Finnland noch folgende offene Fragen zu klären, wobei insbesondere auf Folgendes hingewiesen wird:

Zwar ist in den finnischen Vorschriften im Falle einer radioaktiven Freisetzung ein Wert von 100 TBq festgelegt, doch scheint die zuständige Behörde keine Begründung dafür zu liefern, warum kein höherer Wert verwendet wird, der, wie aus den eigenen Berichten der STUK über die Grenzwerte für die Freisetzung bei schweren Unfällen hervorgeht, über 100 TBq liegen könnte. Nicht nur die Experten sind der Ansicht, dass es eine wesentliche Begründung für die Verwendung eines höheren Wertes gibt, auch einige Stellungnahmen aus anderen Nachbarländern kommen zu dem gleichen Ergebnis. Daher können die Antworten der zuständigen Behörde als unzureichend angesehen werden.

Es ist verständlich, dass die Verlängerung der Laufzeit und die Leistungserhöhung von zwei großen Kernkraftwerken eine langfristige und ressourcenintensive Maßnahme darstellen. Daher ist es sinnvoll, frühzeitig eine Umweltverträglichkeitsprüfung durchzuführen, um zu beurteilen, ob mit einem solchen Projekt Beschränkungen aus Umweltsicht oder Herausforderungen verbunden sind. Dennoch muss anerkannt werden, dass in Finnland noch kein Rechtsrahmen für die Verlängerung der Laufzeit über 60 Jahre hinaus existiert. Als hoch angesehene Regulierungsbehörde wird die STUK die Bedingungen sicherlich eingehend prüfen und die Anforderungen für die Verlängerung der Betriebsdauer über 60 Jahre hinaus festlegen.

Es ist zwar durchaus denkbar, dass trotz neuer Bedingungen und Anforderungen das Endergebnis dasselbe sein könnte, d. h., dass die Leistungserhöhung und die Verlängerung der Betriebsdauer aus Umweltsicht akzeptabel sind, doch rechtfertigt dies nicht, dass die UVP nicht aktualisiert wird, wenn alle regulatorischen Anforderungen festgelegt sind. Die Experten schlagen der zuständigen Behörde vor, die relevanten Teile (d. h. die betroffenen Teile) der UVP zu aktualisieren und neue Analysen durchzuführen, sobald die STUK ihre Anforderungen bekannt gibt und TVO ihre Analysen und Studien zu den erforderlichen Sicherheitsänderungen abgeschlossen hat.

Angesichts aller Unsicherheiten und insbesondere der Tatsache, dass die Leistungserhöhung (sofern genehmigt) erst in drei bis vier Jahren und die Verlängerung der Betriebsdauer sogar erst in zehn bis zwölf Jahren erfolgen soll, wird empfohlen, eine Aktualisierung der UVP vorzunehmen, sobald alle derzeit unbekannten Fragen geklärt sind. Nach Prüfung der erhaltenen Antwort ist festzustellen, dass zwar derzeit „keine unbekannten Probleme“ vorliegen, diese jedoch durchaus auftreten können, wenn die Anforderungen der STUK festgelegt und die Degradationsmechanismen für einen Betrieb über 60 Jahre hinaus eingehend analysiert werden.

Die Aussage, dass „OL 1&2 die Anforderungen erfüllen würde“, ist nicht hilfreich, da die Anforderungen derzeit noch nicht bekannt sind.

Abgesehen davon, dass in der UVP angegeben wird, dass die Verfahren zum Alterungsmanagement im Rahmen der Wartungsarbeiten angewendet werden, enthält sie keine Angaben dazu, wie in Olkiluoto sichergestellt werden soll, dass alle Degradationsmechanismen, die sich von denen bei der ursprünglichen Laufzeitverlängerung unterscheiden könnten, ermittelt werden und das Verfahren zum Alterungsmanagement entsprechend gestaltet wird.

Die Gesamtleistung würde um mehr als 35 % erhöht, was bedeutet, dass die Anlage weit außerhalb ihres ursprünglichen Auslegungsbereichs betrieben würde. Dies erfordert besondere Aufmerksamkeit bei den Analysen, die zur Gewährleistung der Sicherheit der Anlage durchgeführt werden müssen. Zwar ist es richtig, dass (viele) andere Anlagen ihre Leistung erhöht haben und dass die Siedewasserreaktoren über größere Margen im Reaktorkern verfügen, als für die Leistungserhöhung genutzt werden könnten, doch wird OL 1&2 mit der geplanten Leistungserhöhung eine der höchsten (oder sogar die höchste) relative Leistungssteigerung aller in Betrieb befindlichen Kernkraftwerke aufweisen. Die Antwort lieferte weder weitere Klarstellungen noch gab sie Gewähr dafür, dass die in OL1&2 durchgeführten oder geplanten Maßnahmen tatsächlich umfassend genug sind, um eventuelle Auswirkungen auf die Sicherheit zu minimieren.

Eine technische Bewertung des Unfalls, der potenziell alle Blöcke am Standort Olkiluoto betreffen könnte, d. h. das Fukushima-Szenario, wäre eine sinnvolle Ergänzung der UVP. Weder in der UVP noch in der Antwort wurden Informationen zum Umfang der PRA (probabilistische Risikobewertung), ihren Annahmen, den tatsächlich erzielten Ergebnissen usw. bereitgestellt. Es liegt auf der Hand, dass die STUK alle Einzelheiten der PRA als Teil der behördlichen Unterlagen verlangen würde. Aus der Antwort auf Frage 19 geht jedoch hervor, dass die

PRA für externe Ereignisse bereits vorliegt. Daher gibt es keinen Grund, warum die angeforderten Einzelheiten nicht veröffentlicht werden sollten.

3 INTRODUCTION

This report presents the findings and the recommendations based on the evaluation of the written answers to the Austrian expert's questions, received as VN/19926/2024-TEM-38 of 31st March 2025, from the Finnish Ministry of Economic Affairs and Employment which is responsible for the implementation of the public consultation process in relation with the EIA for OL 1 and 2.

The design lifetime of the O1 and O2, when those units were started up in 1978, was set to 40 years. Even before reaching the end of the design life in 2018, the licensed lifetime was extended to 60 years, meaning that the current license to operate the plant is set to expire in 2038. Recognising the contribution and importance to assure low carbon electricity generation for Finland, the operator TVO is considering an extension of the lifetime of the units for an additional 10 or even 20 years. The lifetime extension is said to be possible based on the analyses and maintenance activities that are being continuously performed while operating the Olkiluoto units 1 and 2 (OL 1&2). The decision on the length of the lifetime extension (10 or 20 years) will be made upon obtaining the results of the detailed studies and analyses, including economic impact.

In addition to the lifetime extension, the operator TVO is considering an increase of the power of the OL1 and OL2 units. This would not be the first increase of the units' power. Originally rated at 660 MWe, the units increased power initially to 710 MWe in 1984 and to 840 MWe in 1998. Those two power increases were achieved by increasing the power of the reactor. In the period 2005-6 and then 2010-12, the improvement of the turbine and related systems added to the efficiency of the plant, effectively increasing the power level to 890 MWe per unit. Under consideration now is the third power increase that will bring the units' power to 940 MWe, to be achieved by increasing the effectiveness of the primary circulating pumps, i.e. by having a higher throughput of the circulating water that is removing the heat from the reactor.

For both, the lifetime extension and the power level increase, an Environmental Impact Assessment is required under the prevailing EU legislation and international conventions. In its Statement on the evaluation of the EIA programme, the? established its requirements for the information to be contained as well as the assessments to be undertaken in the EIA analysis. Among those, of the highest interest from the Austrian perspective are the sections focused on "Continuation of operation, power uprating and management of ageing", the "Risks caused by climate change and external threats", and the "Exceptional and accident situations and transboundary impacts".

Being a potentially affected party in case of a radiological release from the Olkiluoto plant, Austria is participating in the OL 1 & 2 lifetime extension/power uprate EIA procedure. In this respect, the Austrian Environment Agency (Umweltbundesamt) engaged an expert team to assess the EIA. The Expert team reviewed the EIA report and assessed the potential impact to the environment and population of Austria. In this, the expert team raised 24 specific questions, covering practically all areas of the EIA. The questions addressed areas where it

was felt that the EA did not elaborate in enough detail and/or where clarification might be needed. The Competent authority, the Finnish Ministry of Economic Affairs and Employment, provided its answers to the questions raised by the experts in its above quoted communication.

Upon receiving the answers, the experts undertook an evaluation of the answers provided to each of the questions. On that basis, the conclusions were drawn on each of the questions.

4 COMPETENT AUTHORITY REQUIREMENTS REGARDING THE EIA

The Finnish regulation specifies that the most severe radioactive release for which the dispersion and consequential impact on the population and environment is to be assessed is 100 TBq of Cs 137. The Competent authority, upon evaluating the EIA programme, concluded that the EIA report "should also examine the plant's safety principles that aim to prevent or reduce major emissions in the event of severe accidents", also suggesting "more realistic emission estimates". The latter in effect establishes the "100 TBq" as the upper limit.

From the experts' perspective, limiting the modelling to a release of 100 TBq or even lower, as suggested by the competent authority, is not just contrary to a comprehensive analysis of severe accidents, but also to the Finnish regulator STUK's own reports that are establishing that releases above 100 TBq are possible, albeit of low probability. It is therefore reasonable to expect that a value which is higher than 100 TBq, in particular given that the analysis shows that such cannot be deterministically excluded, would be used in the transboundary analysis. In this respect, two questions as below were raised by the experts.

Q1) Clarification of the statement that the competent authority suggested "more realistic emission estimates", i.e. being below 100 TBq release. On which basis could such an estimate be made, given that STUK's own report envisages much higher estimates in a worst case?

Answer In the EIA report full English version, Appendix 4, the consideration is given to the coordinating authority's statement on the EIA programme when drawing up the assessment report. Finnish legislation and requirements set a 100 TBq limit for Cs-137, and this has been accepted by the competent authority (Ministry of Economic Affairs and Employment of Finland) to be used for evaluations in the EIA.

Evaluation The answer to the questions reverts to the position that the competent authority already established during the evaluation of the EIA programme, which is that the "100 TBq" is based in the Finnish regulation. While this is true (100 TBq is established in the Finnish regulation), the competent authority seems not to offer any justification as to why not using a higher value, which, as could be read in STUK's own report on the marginal release values during severe accidents, could be above 100 TBq is not to be used in the EIA. It is not just the experts that believe that there is a material justification for using a higher value, some comments from other neighbouring countries reached the same conclusion. Therefore, the answers provided by the competent authority seems to be insufficient.

Q2) Clarification on the fact that the competent authority specifically requires that the "external threats and the risks arising from climate change must be taken into account when assessing the safety", where it appears that external threats have been covered rather superficially. Climate change was covered in the area of sea level rise, but not really in relation to the potential for increased severity of extreme weather.

Answer Preparations for external threats and extreme weather conditions have been discussed in the EIA report full English version, Chapter 6.18.4.3.

Evaluation The competent authority's answer refers to the EIA section that has been reviewed by the experts and which was the basis for raising the question in the first place – because only the sea level rise was considered as a risk from climate change. The answer provided therefore seems to be insufficient.

5 PROCEDURAL ASPECTS OF THE EIA

The EIA process of the Olkiluoto lifetime extension/power uprate follows the steps that are required per the EU Directive 2011/92/EU. For the lifetime extension of nuclear power plants in the EU, the "Commission Notice regarding application of the Environmental Impact Assessment Directive (Directive 2011/92/EU of the European Parliament and of the Council, as amended by Directive 2014/52/EU) has to be followed. The process started with the Scoping EIA, which was opened for comments nationally and internationally. Following the collection of comments and their resolution by the competent authority, the full EIA was prepared. The EIA is again opened for comments nationally and for international participation, with the latter being of specific interest to Austria. In this respect, the EIA programme for the Olkiluoto 1&2 lifetime extension and power uprate comply with the requirements set forth.

In the scoping EIA the experts' comments requested a description of the planned activities that would be implemented during the extended lifetime to assure the safety of the units. Apart from a general statement that the high safety level will be maintained, that the ageing management activities will be implemented and that the plants' safety will comply with applicable regulatory requirements to be verified by STUK, no further details were provided. Given that the Olkiluoto units may be, with the extended lifetime, in operation up to the year 2058, it is prudent to expect that there will be safety upgrades that will assure plant safety in line with the requirements for new reactors, including, e.g. Olkiluoto 3 which is a GEN III facility. Nevertheless, it is felt that the EIA report did not put enough lights on those important aspects.

Q3) It is not fully clear as to why the EIA has been initiated at a stage when a) no real decision has been made in terms of the life extension and power uprate and b) when the analyses that would likely determine whether the power uprate and life extension should proceed or not have not been completed. Completing the analyses but also having clear requirements and conditions by STUK, in particular related with the safety level to be maintained up to 2058, would be essential for an EIA that aims at comprehensively assessing the environmental impact of the facility.

Answer According to Finnish EIA legislation the environmental impacts of a project shall be examined in an environmental impact assessment procedure at the earliest possible stage of planning when the options are still open, taking into account the other processes to prepare the project. TVO made the decision to perform an EIA prior to the decision on lifetime extension and power uprate to produce input for the decision-making process. Through the EIA process, TVO's target is to reach a conclusion on whether the lifetime extension and the power uprate are feasible from the environmental impact perspective.

Evaluation It is understandable that extending the lifetime and implementing the power uprate of 2 large nuclear units is a long term and resource intensive activity. Therefore, having an early EIA to assess whether there are environmental limits or challenges related with such a project is a prudent approach. Nevertheless, it

needs to be recognised that the regulatory framework in Finland for the lifetime extension beyond 60 years does not yet exist. Being a highly regarded regulator, STUK will certainly take a deep look into conditions and establish the requirements for the lifetime extension beyond 60 years. Those are likely to focus on, e.g. the prevention of the degradation mechanisms that at present might not be available or even known. Therefore, it is not really clear as to what kinds of activities, analyses and justifications, safety upgrades and/or equipment and systems replacements might be needed, all of those being factors of relevance for the EIA.

While it is fully plausible that despite of new conditions and requirements in the final result might be the same, i.e. that the power uprate and lifetime extension is acceptable from the environmental perspective, this does not justify not doing an update of the EIA when all the regulatory requirements are established. The experts would like to suggest to the competent authority that the relevant parts (i.e., those being impacted) of the EIA are to be updated and new analyses undertaken when STUK announces its requirements and TVO completes its analyses and studies regarding the safety modifications needed.

Q4) Given all the uncertainties and in particular the fact that the uprate (if agreed) is 3-4 years away and the life extension even more, 10-12 years, it is suggested that an update of the EIA is prepared when all currently unknown issues become known. Furthermore, the EIA will benefit from the results of the PSR due in 2028 (for uprate) and the next PSR due in 2038 for the lifetime extension.

Answer TVO has not identified any unknown issues that would cause an update to the EIA. If such issues arise, TVO will evaluate the need to update the EIA. According to Finnish EIA legislation, the licensing authority must ensure that the reasoned conclusion of the EIA is up to date when deciding on the licensing matter.

Evaluation See Evaluation for Q3). While it may appear that now there are ”no unknown issues”, those may well arise when STUK’s requirements are established and degradation mechanisms for beyond 60 years of operation are analysed in depth. Given the situation where the competent authority, through its reasoned conclusion already closed the matter of the EIA for OL1&2 lifetime extension/power uprate, it is not obvious under which conditions the EIA would be reopened, which, in the view of the experts, might need to be the case, depending on the STUK requirements and analyses undertaken.

6 ALTERNATIVES CONSIDERED IN THE EIA

The EIA scoping document suggested that three different alternatives are to be investigated in the full EIA document to include:

The **ZERO alternative**, within which the OL1 and OL2 units are to be shut down in 2038, after 60 years of operation, on the date of the expiry of the current license.

The **life extension alternative**, with two options, one with 10 years extension (i.e., until 2048) and another with 20 years extension (i.e., until 2058) so an operating lifetime of 70 and 80 years respectively.

The **power uprate alternative**, from the current 2500 MWth reactor power level and 890 MWe electricity generation to a 2750 MWth reactor power level and 970 MWe electricity generation.

For the "zero" option, it is concluded that the "the major positive impacts of extending the power plant's operation on climate, the energy market and the regional economy will end". This point of view could be understood, as continued Olkiluoto operation will contribute to the generation of non-carbon electricity. It is nevertheless a bit unusual, in particular in the view of some other recent EIA studies for the lifetime extension around the EU, that alternative(s) of generating needed electricity from other sources has not been assessed as part of the EIA. The assessment of the alternatives is only mentioned in a short paragraph that concludes that there are limited possibilities to increase hydropower production, and the same applies to biomass ("woodfuel"). The renewables (solar and wind) are said to be constrained by their dependence on the weather. It is further stressed that having nuclear as a baseload source allows for export of electricity to the Baltics and Poland, effectively replacing coal generated electricity thus having a positive impact on the environment.

The EIA assessed the environmental impact of increasing the power level of the reactor from 2500 MWth to 2750 MWth by increasing the flow through the reactor, i.e. by enabling higher removal of thermal energy generated. No structural changes are needed for such an increase. The increase of the thermal power will lead to an increase of the generated electrical power of the generator to reach a level of 970 MWe. Further, the environmental impact of the lifetime extension to 70 or even 80 years (depending on the variant chosen) of the Olkiluoto units 1&2 has been covered. For the lifetime extension, TVO is expected to undertake extensive analysis as well as specific inspection and testing to ascertain that the plant safety level could be maintained for the extended lifetime.

Q5) It is somewhat unusual that the "zero" option, i.e., shutting down Olkiluoto 1 &2 at the time of expiry of the current license has not been addressed in any level of detail, except by concluding that "this would be a loss of generation of carbon free electricity". An overview in what might be available to replace those units could have been made, even if the conclusion might be the same, that power uprate and life extension of Olkiluoto 1&2 is a better alternative than the zero option.

Answer The "zero" option corresponds to the current operating license of OL1/OL2 plants. In the zero alternative, the operation of the plant units will continue until the expiration of the valid operating licenses in 2038. The EIA has been done for the lifetime extension after the current operating license and for the power uprate. A separate environmental impact assessment will be drawn up for the decommissioning of the OL1 and OL2 plant units, according to the legislation in force, once decommissioning becomes relevant.

Evaluation The answer repeated the position that is clearly from the EIA, that the „zero" alternative is to shut down the units when their current licence expires.. No insights were offered as to how the missing power would eventually be replaced.

Q6) The EIA report stated that "STUK regulatory requirements will be adhered to". This is of course obvious, as STUK would not give a license to a plant that does not adhere to the requirements. However, the requirements for the extended lifetime to 80 years are not yet known. On which basis could the EIA then conclude that those would be "adhered to"?

Answer EIA is done according to EIA legislation, which is not directly connected to the STUK regulatory requirements. The complete renewal of the Nuclear Energy Act is ongoing. The work to renew STUK's nuclear safety provisions, i.e., the regulations and guides, is also underway. The preparation of STUK's regulations is done in parallel with the preparatory work for the Nuclear Energy Act and Decrees.

Evaluation The question was not focused on the process of STUK establishing the regulatory requirements for the lifetime extension, but rather on the statement that „OL 1&2 would adhere to the requirements", which are at present unknown. How could adherence be claimed to yet unknown requirements?

Q7) A related issue is which safety level would be required for plants to be in operation in 2058. It should be at least the one that is required for the plants that have come into operation recently, e.g. Olkiluoto 3. The EIA does not add any clarity whether the ultimate goal of the safety uprates that are necessary for the second lifetime extension of Oliklouto 1 and 2 would bring the units to a safety level comparable to Olkiluoto 3.

Answer Over the years, many retrofits and safety improvements have been implemented at Olkiluoto 1 and Olkiluoto 2 units. This is demonstrated by the significant decrease in the core damage frequency that is estimated with the level 1 PRA (probabilistic risk assessment). The safety level of the plants is evaluated frequently by the company and by STUK, especially during license renewals and periodic safety reviews, and whenever new regulatory requirements are intro-

duced. The possible needs for safety improvements are evaluated by the company and by STUK and required actions are agreed upon together with STUK. This work will continue in the future. At present, the core damage frequency for Olkiluoto 1 and Olkiluoto 2 units fulfils the safety criteria set for new NPP units with a good margin.

Evaluation The information that OL1&2 already „fulfils the safety criteria for new NPPs with a good margin" is a valuable insight, though its value would be higher if this would be supported by information on, e.g. which PRA results are being considered (i.e., CDF or LERF), what is the scope of the PRA undertaken (internal vs. external hazards, list of hazards) and specifics of analyses undertaken. Furthermore, the PRA values alone are not complete safety requirements for the new NPP units. Therefore, an elaboration as to how other safety requirements are (or will be) fulfilled at OL 1&2, would be valuable indeed.

Q8) It appears that the EIA expected that the only (hardware) safety upgrade is adding a diesel driven injection pump that is shared between 2 units. On which basis was the conclusion reached that this is enough?

Answer Several improvements have already been implemented during the operation of the power plant. Deterministic and probabilistic safety assessments were performed to evaluate the effects of the power uprate and the effectiveness of possible safety improvements. The diesel-driven injection pump was selected mainly based on its clear positive effect on the core damage frequency. Another hardware safety upgrade is the capacity increase of the residual heat removal pumps.

Evaluation The requirements that STUK will issue for the lifetime extension (and possibly for power uprate) are at present not known. Therefore, there might be additional safety upgrades necessary to assure that the safety of the plant is maintained for the full duration of the extended lifetime. Updating the EIA at the time those requirements as well as solutions are known, remains, from the experts' perspective, a necessity.

Q9) Which systems are expected to be "reparameterized" (reparameterization of existing systems) in order to assure operability and safety for the increased power? How would the margins that might be expected to be reduced be restored or compensated?

Answer The plant's protection and automation system settings will need to be re-parameterized when implementing the reactor power increase. The re-parameterization is based on the safety analyses and the plant's process modelling, and in this way, the safe operation of the plants is ensured even after the reactor power increase. In connection with increasing reactor power, the capacity of certain systems (e.g., the residual heat removal system) is increased in order to maintain sufficient safety margins.

Evaluation The way in which the answer is provided is short on new information. The „plants' protection and automation system" contains numerous subsystems that may or may not be „re-parameterized". Also, giving the RHR system as an example, listing all of the systems (e.g., there will be a new pump in the injection system) that will be re-parameterized and/or whether their capacity would be

increased, is in the experts' view an important addition that is necessary to be in the EIA.

The safety margins are not only those in the, e.g. RHR or injection system, those are also relevant for the reactor control systems that might, due to power uprate, have lower margins in, e.g. temperature or time window for an action. These have neither been discussed in the EIA nor provided in the competent authority's answers.

6.1 Lifetime extension to 70/80 years

Unlike the lifetime extension from 40 to 60 years that has been implemented at NPPs worldwide, further extensions to 70 or even 80 years are still new. No plants in Europe had their lifetime extended (Beznau and Borssele might be expected to go that path) and only a few in the US have been through the life extension process. This is both due to a lack of the regulatory framework but also due to potentially unknown degradation mechanisms. The EIA scoping document did not provide any relevant details as to what the lifetime extension from the current 60 to a future 70 to 80 years would entail, apart from saying that "the facility and its equipment need to fulfil regulatory requirements", and that "the status of equipment, systems and structures needs to be assessed, followed by the implementation of the ageing management programme".

The full EIA report addresses the issue of the lifetime extension of Olkiluoto 1&2, though that is at a much higher level than what is expected. The description is on the "objectives" level, rather than providing concrete details. Only a high level overview of the current ageing management activities at the Olkiluoto 1&2 units is provided. The EIA report fails to provide any clarity in relation with the expected requirements for the life extension beyond 60 years, the critical ageing and degradation mechanisms or at least the investigations planned to determine new degradation mechanisms, in particular those that might be initiated/accelerated by the physical effects of a power uprate.

Q10) Apart from indicating that the ageing management procedures are being applied through the maintenance activities, the EIA does not say anything as to how Olkiluoto would assure that the full spectrum of degradation mechanisms that might be different than those for the initial life extension would be identified and the ageing management procedure designed?

Answer The ageing management programs are updated based on TVO's own and other nuclear power plants' operating experiences, as well as results from research programs covering new ageing phenomena and methods to identify them.

Evaluation The answer did not add any further information regarding actual activities in particular related to assuring that possible additional degradation mechanisms are addressed in the ageing management programmes.

Q11) This is particularly relevant as the total power would be increased by more than 35%, meaning that the plant will be operating very far from its original design envelope. This requires particular attention to analyses to be undertaken to assure safety for the plant.

Answer TVO agrees that the ageing management is an important topic if extending the lifetime and/or uprating the power. The power uprate is planned to have similar main parameters as power uprates carried out in other nuclear power plants in order to be able to utilize their operational experiences. The initial plant design included large design margins. TVO has implemented power increases in two stages in the 80s and 90s and has gained a lot of experience from them. The current power level corresponds to 125% of the original power, and the current planned 10% power increase is based on the power level of similar types of power plants and the main process parameters.

Evaluation While it is correct that (many) other plants increased their power and also that the BWR reactors have larger margins in the core than could be used for the power uprate, OL 1&2 will be, with the planned power uprate among the highest (or indeed the highest) relative power increase of all operating NPPs. The answer neither provided further clarification, nor raised assurances that the activities that are implemented or planned at OL1&2 would indeed be comprehensive enough to minimise eventual safety impact.

Q12) The EIA mentioned that the "plant sections important to safety" and "piping and piping supports" will be addressed in the life extension assessment. It would be appropriate for the EIA to list all the SSC (and maybe particularly structures) that would be assessed as a part of the lifetime extension preparation of the 80 years lifetime.

Answer These assessments will be covered in the operating license application process.

Evaluation While it is obvious that there will be the application of the license for the extended lifetime, as TVO has been studying the feasibility of implementing such, a list of potentially-affected SSCs must be known. Providing such a list in the EIA (and in the absence of that, in answers to the experts' question) would be a prudent step to inform the public.

Q13) The EIA for the lifetime extension, in particular considering that the decision has not been taken and that it is still at least a decade away, to clearly present and justify the criteria that will be adhered to when making a decision on the lifetime extension.

Answer The most important thing is that project is environmentally, technically, and economically feasible and that the use of nuclear energy is safe for people and the environment.

Evaluation If the acceptance criteria for the lifetime extension are not known, how then could the EIA conclude that the lifetime extension is „environmentally, technically and economically feasible". This is clearly connected to the previous statement and information provided in the EIA, where it is obvious that STUK re-

quirements are not known and those requirements will have a direct (and decisive) impact on the technical and economic parameters related with the lifetime extension project.

6.2 Power uprate to 970 MWe

Following upon the previous power uprates, Olkiluoto units 1 and 2 might further increase the power of the reactor to 2750 MWth with a corresponding increase of the generating capacity to 970 MWe. The power uprate is envisaged to be implemented after the year 2028, meaning still within the existing operating license. Then the operation at uprated power will continue in the lifetime extension, regardless of whether this is for 10 or 20 years.

The EIA report states that the concept for the power uprate has been considered "when replacing equipment" at the units. However, apart from the circulating water pumps, the EIA report does not specify which other equipment might have been changed. What is nevertheless stressed is the need to increase the capacity of the residual heat removal pumps, as well as the new source of feedwater.

The EIA mentions that "further improvements and equipment replacements" are required for electrical systems but also "at the turbine plant, increased process flows will require the replacement of some components". It looks like the uprating will in fact necessitate multiple (numerous) component replacements and other adjustments, which is contrary to other statements given in the EIA report.

Q14) The EIA report states that "the power uprate has no effect on service life management". It would be very important to justify such a statement, because higher flow in the reactor and the power conversion system might be expected to have an effect on the service life of various SSCs.

Answer If TVO decides to implement a reactor power increase, the effects of the increased flow will be monitored in an enhanced manner, in addition to the plant's normal inspection program, in the years following the power increase. Based on these inspections, changes can be made to the preventive maintenance and lifetime management programs if necessary.

Evaluation The answer states the obvious, that there will be a monitoring, which will then be acted upon in case of deterioration. This answer indicates that the statement in the EIA that „there is no effect on service life management" is not fully correct. Furthermore, it must be that TVO was studying the effects of increased flow and concluded on the parameters to be monitored, resources for monitoring, the degradation mechanisms of interest, etc. When informing the public on the activities, it would be useful that more clarity is provided on critical mechanisms and the monitoring plans.

Q15) The EIA report states that the concept for the power uprate has been considered "when replacing equipment" at the units. However, apart from the circulating water pumps, the EIA report does not specify which other equipment might have been replaced and when.

Answer This includes components in both the reactor and turbines islands. For example, the reactor steam dryer has been replaced, and TVO has an ongoing project to replace the reactor steam separators. For the turbine island TVO has 4 (5) modernized the high- and low-pressure turbines, condenser, and generator with a design margin that enables the planned power level.

Evaluation While the answer provided more insights, it is still just an example. The experts would appreciate seeing the full list of equipment replacements which is planned (and will be necessary) for the power uprate. That shall include essential elements of the automation and protection (I&C) systems.

Q16) The EIA report indicates that there is a need to increase the capacity of the residual heat removal pumps, but does not say how a higher capacity would be reached, and whether any other modifications (apart from pumps) might be needed

Answer The residual heat removal chain consists of a total of three different systems. The capacity of the heat removal chain will be increased by changing the pumps in one of these systems. The pumps to be replaced were chosen based on the fact that, at present, they are the most limiting in terms of the capacity of the entire chain. TVO has already increased the capacity of the pumps in the other residual heat removal systems as part of lifetime management. After these changes, the new capacity of the residual heat removal chain will enable the reactor's thermal power to be increased.

Evaluation It remains unclear as to which pumps in the RHR chain are to be replaced, nor whether any other elements of the RHR chain would be replaced, re-parameterized, and/or subject to different operating procedures or practices. Full details on the equipment as well as the capacity of the RHR chain would be appreciated.

Q17) The EIA report states that "as a safety improvement related to the power uprating … a new feed water source has been investigated". It is unclear from the EIA report as to what specifically this referred to.

Answer This refers to a diesel-driven injection pump system that is able to serve both units.

Evaluation Answer noted.

Q18) The EIA report states that "further improvements and equipment replacements" are required for electrical systems but also "at the turbine plant, increased process flows will require the replacement of some components". Even if not final (due to analyses needed) a list of SSCs that might require replacement or even further improvement would help in understanding the magnitude of activities needed for the power uprate.

Answer For the turbine island plant, the planned modifications are minor due to an earlier modernization project, the main required modification being the new blades for the high-pressure turbine.

Evaluation Answer noted.

7 EXTERNAL EVENTS AND MULTIPLE UNITS ON SITE

The Olkiluoto island currently houses 3 (operational) units, as well as SNF/radioactive waste facilities. The EIA programme (scoping) mentioned that the joint impact of 3 units in operation at the Olkiluoto site will be assessed in the EIA report, and that was done. However, the assessment focused on the immediate impact from thermal plume (cooling water release) by all 3 units; to visual traffic and even radioactive doses for the population caused by the authorised emissions from all three units.

Possible safety impacts by events/accidents possibly affecting all units at the site have not been addressed, not even mentioned. It is clear that this would be an extremely low probability event (except maybe in a case of an external hazard simultaneously affecting all units, i.e. Fukushima type scenario. The Olkiluoto units are of a robust design and the Olkiluoto site has a lower probability of external hazards (e.g., seismic or tsunami) than many other nuclear sites. Therefore, the overall risk of external events is likely not that large. Also, the human-induced hazards are, due to relative isolation, not that high. However, such a conclusion cannot quite be reached from the EIA report because it introduced the issues at a very high level, and did not provide any details that could support discussions.

Q19) An engineering pass into the accident potentially affecting all units at the Olkiluoto site, i.e. the Fukushima scenario would be a good addition to the EIA.

Answer Possible external hazards and their effects on the Olkiluoto NPP units have been studied extensively with PRA. It can be stated that the effect of external hazards on the core damage frequencies of the Olkiluoto units is small.

Evaluation The answer, as in another question above, refers to the PRA as the source for such a conclusion. No information on the scope of the PRA, its assumptions, the actual results obtained, etc. have been provided neither in the EIA, nor in this answer.

Q20) The list of external hazards, man-made and natural that have been considered and the resulting contribution to CDF and LERF needs to be provided.

Answer If TVO decides to apply for the lifetime extension and/or power uprate, the external hazards and their contribution to PRA results will be covered in the safety analyses conducted as part of the operating license application. The results and their safety implications will be evaluated by the Finnish nuclear safety regulator, STUK.

Evaluation It is obvious that STUK would require all the details of the PRA as part of the regulatory submittal. Nevertheless, from the answer to the Q 19 it appears that the PSA already exists. Therefore, there shall be no reason why the details that are being asked for are not released.

8 TRANSBOUNDARY IMPACT

The EIA report discussed the transboundary impact, providing the expected radiological impact on countries located within a radius of 1000 km from the Olkiluoto site (Austria is about 1400km away). The source term used in the assessment of the transboundary impact is based on Section 22 of the Nuclear energy decree (161/1988), which specified that the amount of radioactive releases is limited to 100 TBq of Cs-137. This corresponds to an accident level of 6 in the international INES scale.

The EIA report concludes that the radiation doses resulting from a radioactive release from the Olkiluoto units in a case of a severe accident "will remain statistically insignificant outside Finland's borders". The maximum radiation dose at a distance of 1000km is said to be 0.43 mSv, so well within the annual background dose. The radiation doses at distances of more than 1000 km have not been calculated but based on expert assessments to be no higher than 0.02–0.03 mSv. Austria would be in that category, with a minimum distance of 1400km.

The distance of 1400km nominally exceeds a suggested radius of the Ingestion and Commodities Planning Distance (ICPD) defined in the IAEA general safety requirements. Those are defined as "Area around a facility for which emergency arrangements are made to take effective emergency response actions following the declaration of a general emergency in order to reduce the risk of stochastic effects among members of the public and to mitigate non-radiological consequences as a result of the distribution, sale and consumption of food, milk and drinking water and the use of commodities other than food that may have contamination from a significant radioactive release.".

Nevertheless, the EIA report is focusing on the doses to an individual, rather than other parameters of specific interest to Austria, which is the deposition of radionuclides (Cs) on the ground. The reason why Austria has interest in this parameter is due to the fact that after the deposition reaches 650 Bq/m2, a threshold above which the protective measures in terms of monitoring and food controls kick in. It is also worth noting that contamination can have different effects depending on the time of year and land use. Even if the doses to the population from a radioactive release are small, the fact that the protective measures will be activated makes a nuclear accident in a plant that is relatively distant from Austrian territory an important event.

Q21) Detailed description of severe accident scenarios and their sequences, and the resulting estimated source terms for each of those (not just Cs-137, but other relevant radionuclides for transboundary impact);

Answer In the EIA report, full English version, Chapter 6.18.3.1, the initial data and assessment methods for the release of a severe accident and severe accident scenarios are described.

Evaluation The information in the specific section of the EIA has been reviewed by the experts. Lack of information herein was the reason for asking specific question, which remain unanswered.

Q22) Detailed description of the assumptions taken when modelling accident sequences addressing source term, including duration of a release, levels of release, energy, etc.;

Answer Duration of the release 7 hours, Elevation of the plume release 100 m

Evaluation Answer noted.

Q23) Thorough presentation of the dispersion modelling, including the weather parameters taken (covering a range of weather situations as well as the determination of radiation impacts deposits, doses to the population, etc.);

Answer Modelling has been done with a program that utilizes methods for which STUK has granted permission to use in the Finnish NPP licensing analyses. In the modelling, 3 years of weather data from the NPP weather monitoring system have been used and the data represents the atmosphere at the NPP site. The weather data includes wind direction, wind speed, rain, and atmospheric stability as inputs to the dispersion modelling.

Evaluation The answer does not expand on what is already available in the EIA report. While it is clear that the weather data for the site has been used, it remains unclear as to the weather used for the distant impact and the approach of calculating the doses and deposition of radionuclides.

Q24) Resulting probability distribution of the radiological impact, covering all cases.

Answer The EIA shows data with 95% fractile, meaning that with a 95 % probability, the doses and fallout will be less than those reported.

Evaluation Answer noted.

9 GLOSSARY

AMP ..... Ageing Management Programme

Bq ..... Becquerel

CDF ..... Core damage frequency

DBA ..... Design Basis Accident

DEC-A/B ..... Design Extension Condition

EIA ..... Environmental impact assessment

EU ..... European Union

IAEA ..... International Atomic Energy Agency

LERF ..... Large early release fraction

LTE ..... Lifetime Extension

MW ..... Megawatt

MWe ..... Megawatt electric

MWth ..... Megawatt thermal

NPP ..... Nuclear power plant

PBq ..... Petabecquerel

PRA ..... Probabilistic risk assessment

SSC ..... System Structures & Components

STUK ..... Säteilyturvakeskus – Finnish nuclear regulator

TBq ..... Terabecquerel

TVO ..... Teollisuuden Voima Oyj – Betreiberfirma von O1 & 2

WENRA ..... Western European Nuclear Regulators' Association

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ISBN 978-3-99004-816-0