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Fennovoima Oy
Scoping Phase of the EIA Program for a NPP

Expert Statement
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Introduction

The Finnish energy company Fennovoima Oy submitted its Environmental Impact Assessment (EIA) Programme to the Ministry of Employment and the Economy concerning a new nuclear power plant (NPP). The NPP shall have an electric capacity of 1500 to 2500 MW.

According to the Finnish law the construction of a new NPP is subject to a decision-in-principle issued by the Government and ratified by the Parliament. The EIA process must be completed before submitting any application for a decision-in-principle concerning a new nuclear power plant.

With reference to the Espoo-Convention the Austrian Federal Ministry of Agriculture and Forestry, Environment and Water Management has been notified by the Environmental Ministry of Finland of the transboundary EIA. The Austrian Institute of Ecology was assigned by the Federal Ministry of Agriculture and Forestry, Environment and Water Management to elaborate an expert statement on the EIA program for this new NPP in Finland.

The expert statement analyzes the comprehensiveness of the proposed content of the EIA compared to the European Commission's EIA Directive [97/11/EC] and the Espoo-Convention [Espoo 1997], respectively.

The task is to evaluate whether the information proposed to be provided by the EIA will allow to assess the safety of the new NPP concerning emissions into the environment in a transboundary context, both during normal operation and accidents (design basis and beyond design basis accidents). For Austria mainly airborne emissions could be relevant, in particular emissions due to severe accidents could contaminate not only the vicinity of the plant but, depending on the climatological conditions at the time of a large accidental release, also regions far from the NPP could be affected. The Expert statement formulates information requirements which allow the assessment of the significance of accidents with a large release of radioactive substances.

A team from the Institute of Meteorology of the University of Natural Resources and Applied Life Sciences, Vienna and the Austrian Institute of Ecology analyzed the climatological risk that emissions due to severe accidents at NPPs in Europe could affect Austrian territory to an extent that would require radiation protection measures for risk groups (children and young people, expecting and nursing mothers) and normal population, respectively. 'Climatological risk for the NPPs in Finland' means the probability of weather conditions in Europe which lead to transport and deposition of emissions released from Finland to Austrian territory, expressed as percentage under consideration of all weather situations. As a result of this study carried out on behalf of the Austrian Federal Ministry of Agriculture and Forestry, Environment and Water Management, the climatological risk that an accidental release from a NPP in Finland causes a significant impact to Austria lies in the range of 1-5% [SEIBERT et al. 2004]. Although the probability of such weather situations is small, an impact on Austria due to a severe accident at the NPP cannot be excluded. Depending on the amount of radioactive substances released during an accident, the impact could be significant, i.e. protection measures could be required for people living in Austria. Therefore, Austria has an interest in the planning of this large new NPP in Finland.

This Experts Statement refers to the following document Austria has received from the Environmental Ministry of Finland:

> **Fennovoima Oy - Environmental Impact Assessment Program for a Nuclear Power Plant**, by Pöyry Energy Oy Consulting, 2008.
> Hereinafter referred to as [EIA, page].

This expert statement concerns the scoping phase of the EIA procedure. Therefore, it will formulate requests for information. The statement consists of two parts:

The first part 'Summary and Conclusions' presents the most important findings and recommendations for the content of the EIA report. The following chapters deal with the issues presented in the EIA program and relevant from the Austrian point of view, in more detail.

The Assessment Program was issued in January 2008. Comments to the EIA program by authorities and public in Finland are to be submitted until April 7, 2008, notified parties to the Espoo-Convention have to respond until April 14, 2008. For the international participation the responsible authority is the Finnish Ministry of Environment.

The Finnish Ministry of Employment and the Economy is responsible for coordination of the EIA process. This Ministry compiles all comments to the EIA program and issues its own statement. Based on all inputs the EIA report will be elaborated. The EIA report is scheduled to be finished in summer 2008. After that citizens and interested partners in the Espoo-Convention will have the opportunity to comment on the EIA report. This phase is scheduled for October to December 2008, and shall be finished with the statement of the coordinating authority in February 2009.

Summary and Conclusions

The EIA program presents the content of the EIA report in a comprehensive manner. Aspects of particular interest from an Austrian point of view are stressed in this statement. Our assessment of the EIA program deals with issues of general interest like the discussion of the options for electricity production or the management of nuclear fuel. On the other hand, all issues relevant for the assessment of environmental impact caused by airborne emissions of radioactive substances are treated and in particular the question of accidents and transboundary emissions is discussed.

Options under Assessment

The main part of this EIA program provides information on the state of the environment in the four areas chosen as options for the plant's siting. We recommend that the EIA report presents a justification for each of the locations, why this area should be suitable for a large NPP.

The NPP planned by Fennovoima Oy is the third NPP project under consideration at present in Finland. EIA procedures are on their way concerning large NPPs in Olkiluoto and in Loviisa. Therefore, we recommend including a comprehensive justification of the need to construct another large NPP in the EIA report. We emphasize that a comprehensive comparison of all electricity production technologies and the options of saving energy, efficiency enhancement and demand side management has to consider the total life cycle of all these options, equally. The EIA report should also include information on the cost structure of the project and its alternatives, provided that all options will be considered.

Nuclear Fuel

The information presented in the EIA report should contain an assessment of all environmental burdens and hazards connected with the total nuclear fuel chain. The EIA report should provide these data for comparison with the environmental and health impacts of other power generation technologies.

Environmental and Health Impacts

The release of large amounts of heat by the NPP is an important impact on the environment which must be considered in the EIA in the context of the existing environmental burden from NPPs and other industrial pollutants around the Baltic Sea and the Bothnian Bay. The additional impact on the environment affects not only the marine ecosystem but also coastal regions and should be evaluated from a holistic point of view.

The description of the areas in the EIA report indicates that there are different ecosystems to consider. Therefore, the impact of radioactive emissions will be site-specific. In particular, impacts on sensitive ecosystems should be assessed carefully.

Regarding the assessment of health impacts due to radioactive emissions, the results of recent studies in Germany should be considered, which show that children living near to NPPs, compared to others, have a higher risk developing leukemia.

Safety and Risk Analysis

Since a detailed safety review can only be conducted during the construction licensing phase a substantial debate of the impacts of accidents on the environment seems hardly possible in the EIA process.

Therefore, as a minimum more detailed information on safety and design requirements for Light Water Reactors (LWRs) must be provided by the EIA report. Otherwise, it is impossible to evaluate the potential impact of severe accidents on Austrian territory.

We expect that the EIA report describes the design objectives and the provisions for limitation of emissions due to accidents with sufficient details to make it plausible that the limits will not be exceeded.

Influences of the different facilities onto each other at the site (LILW storage, interim fuel storage), and common cause failures (e.g. due to external events) should be discussed in the EIA report as well as the potential challenge on the NPP's safety due to global climate change.

We expect that the EIA report contains detailed information on the postulated initiating events (internal and external) for the design basis, as well as on targets for DBA and BDBA frequencies and related source terms to be met by the new reactor. Also parameters which are relevant for the assessment of potential source terms should be given in the EIA report, e.g. the radioactive core inventory.

According to chapter 7 of the EIA program for the assessment of transboundary impacts an INES level 6 accident will be assumed; it is not explained whether this assumption represents the maximum possible release due to a severe accident in the planned NPP.

To allow a reliable assessment of the potential impact of an accident in a NPP in Finland on Austria the maximum release of radioactive substances due to an accident in this NPP should be presented, even if its probability of occurrence is assumed to be very small. This information should be part of a risk assessment of the NPP options under consideration.

Besides that we recommend that the EIA report includes a description of the function of the emergency information system in case of an accident with a potential transboundary impact.

The Proposed Project and Options under Assessment

The proposed project consists of the construction of a NPP. For this two options will be assessed:

- 1. NPP of 1500- 1800 MWe with one unit and reactor
- 2. NPP of 2000-2500 MWe with two units and reactors of 1000-1200 MWe, each.

In addition to the NPP, the project includes the storage of spent nuclear fuel in the plant area, the handling, storage and disposal of low and intermediate level nuclear waste (LILW) and the decommissioning of the power plant, as well as the handling and disposal of the decommissioning waste. [EIA, 29]

According to the stage of the project information on the plant itself is scarce. However, it is said that the plant will be either a Pressurized Water Reactor (PWR) or a Boiling Water Reactor (BWR).

Preliminary technical information is given in Table 5.1 [EIA, 34]:

	Option 1	Option 2
Electrical power	1500-1800 MW	2000-2500 MW
Thermal power	4500-4900 MW	5600-6800 MW
Efficiency	about 37%	37%
Fuel	Uranium oxide UO_2	Uranium oxide UO_2
Thermal power released in cooling (to the water system)	about 3000 – 3100 MW	about 3600 – 4300 MW
Cooling water need	60-70 m³/s	90-100 m³/s

Alternative Locations

For the project the EIA assesses the construction of the NPP at locations in four alternative areas:

- Option 1: Kristinestad: Norrskogen and Kilgrund
- Option 2: Pyhäjoki: Hanhikivi
- Option 3: Ruotsinpyhtää: Kampuslandet and Gäddbergsö
- Option 4: Simo: Karsikkoniemi and Laitakar

[EIA, 29]

The main part of this EIA program provides information on the state of the environment in these four areas. This information is limited because: *'There has been no previous industrial activity at the alternative plant sites explored in this project or their immediate vicinity*.' [EIA, 41]

Therefore, during the course of the EIA process more detailed surveys will be carried out. The description of the four regions in the EIA program gives a compilation of data on land use, population density, regional development plans, economic activities, vegetation and fauna, climate and water systems. All four areas are along the shore, therefore seawater will be used for the turbine cooling system. Only preliminary sites are presented in the EIA.

Further assessments are needed for the EIA:

If all four locations are situated along the shore the potential impact of climate change should be considered for the final siting of the NPP. The suitability of the bedrock for the storage of LILW at the site should be assessed in the EIA, too.

We recommend that the EIA report presents a justification for each of the locations, why this area should be suitable for a large NPP.

The Zero Option

As zero option the EIA program defines that the NPP will not be constructed. In this case the demand of electricity would be covered by increasing import or by other power plants in Finland. Therefore, the environmental impact of the zero option will be illustrated by presenting a review of public assessments of the environmental impacts of different electricity production techniques. [EIA, 30]

The NPP planned by Fennovoima Oy is the third NPP project under consideration at present in Finland. EIA procedures are on their way concerning large NPPs at Olkiluoto and in Loviisa. Therefore, we recommend including into the EIA report a comprehensive justification of the need to construct another new large NPP. We emphasize that a comprehensive comparison of all electricity production technologies and the options of saving energy, efficiency enhancement and demand side management, has to consider the total life cycle of all these options, equally.

The EIA report should also include information on the cost structure of the project and the technological alternatives provided that all options mentioned above will be considered.

Options Excluded from the Investigation

The four selected areas have been chosen from a larger list based on the investigation of their suitability as a location for a NPP. [EIA, 30]

'*The total need for electricity in Finland depends on the general economical and social development, on which Fennovoima has no influence. Fennovoima does not have the energy saving means available that make the amount of electricity produced by the planned power plant unnecessary*. *Thus energy savings will not be reviewed as an alternative of the nuclear power plant project.*' [EIA, 30]

However, the EIA program announces that the EIA report will present *'existing programs and decisions related to energy saving and improved energy efficiency, and their significance for the demand of electrical energy will be assessed.'* [EIA, 30]

Nuclear Fuel

40 to 60 tons of fuel will be consumed by the new NPP. Uranium mining, processing of the ore, enrichment and fuel fabrication have a significant impact on the environment.

'Fennovoima will acquire the services, including the afore mentioned stages, from the market using longterm agreements with producers'. [EIA 37] *'The manufacturing stages of the nuclear fuel used by Fennovoima will be carried out outside of Finland and the environmental impact of the related projects and operations have been identified as required by the legislation in the countries in question. Thus they will not be identified in this EIA procedure but they will be described based on typical production methods to provide an overall picture.'* [EIA, 31]

We want to emphasize that the impact of fuel production is an integral step of the total fuel chain and has to be considered as an impact of electricity production by the NPP. Depending on the region where the uranium is excavated and the grade of uranium in the ore, the CO_2 emissions of the fuel production can be substantial.

After removing the fuel from the reactor it will be stored in an interim storage consisting of 15 meter deep water pools. This interim storage will be built next to the power plant. After several years of storage in the pool spent fuel will be transported to the future final disposal. Transport and disposal of spent fuel will be managed by the company Posiva Oy. The producer of nuclear waste is obliged to pay for all the nuclear waste management expenses. In order to cover the expenses a charge is added to the price of nuclear electricity. It is debited by the producer to the nuclear waste fund, which is administered by the Ministry of Employment and the Economy.

'For spent fuel, the impact of temporary storage over several dozens of years and the transportation of spent fuel to the disposal site will be assessed. The environmental impact of the disposal of spent fuel will be assessed in a separate EIA procedure. To provide an overall picture, this EIA procedure will, however, describe the technical solution of the disposal planned in Finland and its environmental impact.' [EIA, 31]

The information presented in the EIA report should contain an assessment of all environmental burdens and hazards connected with the total nuclear fuel chain. The EIA report should provide these data for comparison with the environmental and health impacts of other power generation technologies.

The EIA process for the final repository for spent fuel will start in 2008. For the disposal of spent fuel from the new NPP a separate decision-in-principle by the government and confirmation by the parliament will be required. [EIA, 14]

Environmental and Health Impacts

Chapter 7 of the EIA program explains in short which environmental impacts will be assessed and which methods will be used for this assessment. From this description we expect that the EIA will present a comprehensive overview on the environmental impacts of the new NPP, as far as this will be possible without knowledge of the specific features of the new NPP.
The ultimate heat sink (cooling the steam in the turbine condenser) is seawater from the local water system. The cooling water is led back to the sea with a temperature increased by 10-12°C. *'The extent of the water area, where the surface is heated by more than one centigrade because of the discharge of the cooling water depends highly on the weather conditions but it is estimated to be approximately 25 km².'* [EIA, 39]

The release of large amounts of heat is an important impact on the environment which must be considered in the EIA in the context of the existing environmental burden from NPPs and other pollutants around the Baltic Sea and the Bothnian Bay. The additional impact on the environment affects not only the marine ecosystem but also coastal regions and should be evaluated from a holistic point of view.

'The radioactive and other airborne releases arising from the operation of the planned power plant will be presented. Their impact on the environment and people will be assessed based on existing research findings. The observed area for radioactive emissions will extend to approximately 10 to 20 kilometers from the power plant site.' [EIA, 72]

The description of the areas in the EIA report indicates that there are different ecosystems. Therefore the impact of radioactive will be site specific. In particular impacts to sensitive ecosystems should be assessed carefully.

'The increase in radiation dosages for residents in the surrounding area caused by radioactive releases from the power plant will be assessed. Health impacts and risks will be assessed using calculations based on radiation exposure.' [EIA, 74]

'The bases for the safety planning of the planned power plant with regard to limiting radioactive substance releases and environmental impacts will be presented in the EIA report. It will also present the estimate of possibilities to meet safety requirements currently in force. [...] The consequences of exceptional situations will be assessed based on the extensive research data on the health and environmental impacts of radiation.' [EIA 77]

In the assessment of health impacts due to radioactive emissions, the results of recent studies in Germany which show that children living near to NPPs, compared to others, have a higher risk developing leukemia should be considered. [KIKK Studie 2007]

Safety and Risk Analysis

For Austria the safety and risk analysis of the new NPP is the most important issue of the transboundary EIA process. Accidents with a large release of radioactive substances into the atmosphere could also affect Austria. Whether Austria could be significantly affected by a nuclear accident in Finland depends on a) the climatological conditions at the time of the accident and b) on the amount of radioactive substances released. The maximal source term is plant specific, therefore the EIA report should present either the maximal release in case of a severe accident or more detailed information on the design and safety features of the NPP.
A team from the Institute of Meteorology of the University of Natural Resources and Applied Life Sciences, Vienna and the Austrian Institute of Ecology analyzed the climatological risk that emissions due to severe accidents at NPPs in Europe could affect Austrian territory to an extent that would require radiation protection measures for risk groups (children and young people, expecting and nursing mothers) and normal population, respectively. 'Climatological risk of a specific NPP site' means the probability of weather conditions in Europe which lead to transport and deposition of emissions released from this NPP site to Austrian territory, expressed as percentage of all weather situations. As a result of this study the climatological risk was assessed for all NPP sites in Europe. Moreover an interpolation was carried out between existing sites in order to assess the risk for other locations. This interpolation results in a climatological risk of 1 to 5 % that Austria could be affected by an accident in a NPP in Finland. [SEIBERT et al. 2004]

Transport, diffusion and deposition of the released substances were calculated with the Lagrangian particle dispersion model FLEXPART. FLEXPART is a model suitable for the meso-scale to global-scale calculations, which is freely available and used by many groups all over the world. The calculations were made for 88 different dates in the year 1995 as a part of the RISKMAP study. This year has been shown to be climatologically representative at least for the Alpine region. [SEIBERT et al. 2004]

The source term assumed for this study is a worst-case scenario for the release due to a severe accident at a PWR 1000 MW reactor. Only the source term for Cs-137 of 6.75 E16 Bq, as a characteristic nuclide, was considered in the dispersion model. A simple conversion factor to derive dose estimates from the total Cs-137 depositions was applied, which is based on results of previous calculations carried out with mainframe COSYMA.
In order to make a comprehensive assessment appropriate information on potential source terms caused by a potential severe accident in the new NPP is required.

Chapter 5.3. of the EIA program dealing with nuclear safety, explains: *'The general principles of safety requirements for nuclear power plants valid in Finland are prescribed in the Finnish Government Decisions 395-397/1991 and 478/1999, and their details are issued in the YVL Guide published by the Radiation and Nuclear Safety Authority (Nuclear Power Plant Guide).'* [EIA, 35] *'Currently, the design of nuclear power plants prepares for the worst possible accident – the melting of the fuel core. Even though a serious reactor accident is highly improbable, plants must be designed to endure the effects so that there are no significant environmental impacts.'* [EIA, 36]

'The EIA report will also describe those safety assessments that will be carried out for the purpose of applying for a construction and operating licence. [...] In the EIA report an imaginary accident situation for each plant site, a level 6 accident according to the international INES scale (in the nuclear event scale of 1 to 7, level 6 corresponds to "serious accident"), is reviewed. Further, the accident would result a release of radioactive emissions into the environment corresponding to the limits of a serious accident set in the Government resolution 395/1991 section 12. The dispersal of the radioactive emissions released into the environment will be modeled case-by-case, under either the most probable or the least favorable conditions in terms of impacts. The immediate radiation impact of an accident will be

assessed in the environment of the plant within a 20 kilometer radius and radiation impact of long-range transportation within 1000 kilometer.' [EIA, 75]

But it is still unclear how a comprehensive safety assessment can be carried out without a clear decision on the plant. The description of how the safety assessment will be carried out for the construction and operating license is no substitution of the safety assessment itself.

We expect that the EIA report contains detailed information on the postulated initiating events (internal and external) for the design basis, as well as on targets for DBA and BDBA frequencies and related source terms to be met by the new reactor. Also parameters which are relevant for the assessment of potential source terms should be given in the EIA report: the radioactive core inventory, the average and maximum burn-up of the fuel.

Influences of the different facilities to each other at the site (LILW storage, interim fuel storage) as well as common cause failures (e.g. due to external events) should be discussed in the EIA report as well as the potential challenge on the NPPs safety due to global climate change.

An explanation of the objectives for the limitation of radioactive emissions and the feasibility of meeting the safety requirements should be presented in the EIA report.

In Finland radiation exposure of the general public is limited by the general regulations of the government [STATE (395/91)] for the safety of NPPs, which are as follows:

The limit for the dose commitment of an individual of the population according to [STATE 395/91)]:

- arising from **normal operation** of a nuclear power plant in any period of one year is 0.1 mSv
- arising from an **anticipated operational transient** in the period of one year is 0.1 mSv
- the limit for a **postulated accident** in the period of one year is 5 mSv
- and for **a severe accident** an atmospheric release of cesium-137 should not exceed 100 TBq. (The combined fall-out consisting of nuclides other than cesium-isotopes shall not cause, in the long term, starting three months from the accident, a hazard greater than would arise from a cesium release corresponding to the above-mentioned limit.)
  The possibility that, as the result of a severe accident, the above mentioned requirement is not met, shall be *'extremely small'*, which is <5E-7 according to STUK YVL2.8.

This probabilistic objective for the limited release due to a severe accident set by Finland's nuclear regulatory authority STUK is more ambitious than the limited release target defined by the European Utilities [EUR 2001].
We expect that the EIA report describes the design objectives and the provisions for limitation of emissions due to accidents with sufficient details to make it plausible that the limits will not be exceeded.

To allow a reliable assessment of the potential impact of an accident in a NPP in Finland on Austria the maximum release of radioactive substances due to an accident in this NPP should be presented. This information should be part of a risk assessment of the NPP options under consideration.

In a transboundary context severe accidents are of particular interest. Therefore we recommend that a worst case scenario concerning the amount of radioactive release will be analyzed even if the applicant thinks that this scenario will have a very low probability of occurrence.

Besides that, we consider that the EIA report includes a description of the function of the emergency information system in case of an accident with a potential transboundary impact.

References

[97/11/EC]: Council Directive 97/11/EC of 3 March 1997 amending Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment

[EIA, page]: Fennovoima Oy - Environmental Impact Assessment Program for a Nuclear Power Plant, by Pöyry Energy Oy Consulting, 2008.

[ESPOO 1997]: Convention on environmental impact assessment in a transboundary context, Bundesgesetzblatt für die Republik Österreich, Jahrgang 1997, Teil III, 201, published November 28, 1997

[EUR 2001]: European Utility Requirements for LWR Nuclear Power Plants (Generic Nuclear Island Requirements)

[KIKK Studie 2007]: Epidemiologische Studie zu Kinderkrebs in der Umgebung von Kernkraftwerken (KIKK-Studie), Im Auftrag des Bundesministeriums für Umwelt, Naturschutz und Reaktorsicherheit und des Bundesamtes für Strahlenschutz, Deutschland 2007

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[STATE (395/91)]: Decision of the Council of State on the general regulations for the safety of nuclear power plants

[STUK YVL2.8]: Probabilistic Safety Analysis in Safety Management of Nuclear Power Plants, 2003

Glossary

BDBA	Beyond Design Basis Accident
BWR	Boiling Water Reactor
DBA	Design Basis Accident
EIA	Environmental Impact Assessment
EU	European Union
LILW	Low and Intermediate Level (radioactive) Waste
HLW	High Level (radioactive) Waste
IAEA	International Atomic Energy Agency
LILW	Low and Intermediate Level (radioactive) Waste
LWR	Light Water Reactor
MW	Megawatt
MWe	Megawatt electric
NPP	Nuclear Power Plant
PWR	Pressurized Water Reactor
SNF	Spent Nuclear Fuel