ENVIRONMENT AGENCY AUSTRIA umweltbundesamt

NPP FENNOVOIMA

(HANHIKIVI 1)

Expert Statement to the EIA Program

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SUMMARY

Description of the Project and the Procedure

Fennovoima Ltd. (hereinafter referred to as Fennovoima) plans to construct a 1,200 MW_e nuclear power plant in the Hanhikivi headland (municipality of Pyhäjoki). The proposed plant is a nuclear power plant of the type AES-2006 from the Russian nuclear manufacturer Rosatom.

On 6 May 2010, the Council of State of Finland already granted Fennovoima a Decision-in-Principle for the construction of a nuclear power plant in accordance with the Nuclear Energy Act. The Finnish Parliament confirmed this decision on 1 July 2010.

The Environmental Impact Assessment (EIA) procedure for Fennovoima´s nuclear power plant project – a prerequisite for issuing the Decision-in-Principle – was carried out in 2008 and 2009. This original EIA evaluated the impacts of the nuclear power plant with the electric power of about 1,500–2,500 MW_e, with one or two reactors, in three alternative locations. However, the AES-2006 was not mentioned as one of the plant alternatives in the original Decision-in-Principal application and the original EIA, respectively.

Therefore, the Ministry of Employment and the Economy (MEE) required, among others, an updated EIA. The government will decide on further measures after the assessments of these studies.

The Finnish EIA procedure includes two stages: The EIA program is a study on the current state of the project area, as well as a work program on which impacts shall be studied and how the studies shall be performed.

The actual assessment of the environmental impacts will be carried out on the basis of the EIA program and the coordinating authority's statement relating to it, as well as of other statements and opinions. The results of the assessment work are presented in the EIA report

Since Fennovoima has decided to construct another reactor type as proposed in its application for the Decision-in-Principle in 2009, it is recommended to include into the EIA report an explanation and justification for the choice of the new reactor type, in particular in regard of safety aspects.

Furthermore, it is recommended to provide a comprehensive site evaluation that reflects the international efforts, in particular in the frame of EU stress tests, to enhance the safety margins of nuclear power plants against natural hazards.

It is the general practice in Finland that specific and detailed technical information concerning the reactor type(s) under consideration is not provided in the EIA report. The new nuclear power plant is regarded as a black box, which has to fulfil the regulatory requirements. Several overlapping procedures are ongoing, beside the EIA procedure. After the Decision-in-Principle, a much more detailed assessment of the nuclear power plant project will be performed by STUK, in the course of the nuclear licensing procedure.

This course of action is predetermined and has to be accepted by the Austrian side. However, this does not exclude the possibility to go into somewhat more technical detail already in the EIA report. This is in particular true because the background of this EIA procedure is quite different. The reactor type is chosen by the applicant and its feasibility study has already been provided to the STUK. Thus, it is possible and it is also recommended to include safety analyses and plant-specific severe accident scenarios of the AES-2006 into the updated EIA report.

In the context of the previous EIA procedure, an exchange of information between the competent authorities of Austria and Finland was established. Austria highly appreciates that relevant documents were provided to the Austrian side as an important contribution to keeping the Austrian side well-informed.

It is recommended, in order to follow the ongoing procedures during later stages of the decision making and licensing, that information concerning accident analyses, severe accidents and PSA results should be made available to the Austrian side.

Discussion of the Reactor Type

Design of VVER-1200 plants, the so-called AES-2006, was started after the year 2000 and completed in 2006. However, until now, no nuclear power plant with the AES-2006 design is in operation. Currently, four units are under construction in Russia, which have been subject to construction delays. A few other units are to be built in Belarus and Turkey only.

To gain a comprehensive picture of the functioning and reliability of safety systems of the AES-2006 design, a detailed description of those systems in the EIA report is recommended. Of particular concern are the core catcher and the new passive heat removal systems.

According to the STUK´s assessment in 2009, not all parts of the design objectives and principles of the AES-2006 plant alternative are consistent with Finnish safety requirements. Technical qualification of the new passive heat removal systems is not completed yet; several technical details of the AES-2006 design require further analyses and qualification.

These safety issues include the protection against airplane crashes as well as the protection against internal incidents, such as floods and fires, separation of the I&C systems, lack of filtered containment venting system, and the depressurisation of the primary circuit in severe accidents.

It is recommended that the EIA report should contain a description which parts of the design objectives and principles of the AES-2006 are not consistent with the Finnish safety requirements or with the WENRA´s Safety Objectives for New Nuclear Power Plants. In general, the EIA Report should be made public at the same time, when STUK will have concluded its ongoing review of the AES-2006. STUK is preparing to give the results of the safety assessment to the Ministry of Employment and the Economy during spring 2014.

Accident Analysis

Fennovoima claims without any proof: The nuclear power plant will be designed and operated in such a manner that the quantities of radioactive substances released into the environment remain below the limits set in legislation and in the requirements of the licences.

According to the Regulatory Guide on Nuclear Safety YVL 2.8, the probability for core damage shall be less than 1E-5/a. The probability for a core damage accident exceeding the limit of 100 TBq Cs-137 shall be less than 5E-7/a.

Severe accidents with releases considerably higher than the limit of 100 TBq Cs-137 cannot be excluded for the AES-2006, even if their calculated probability is required to be less than 5E-7/a. Moreover, for rare events the probability of occurrence as calculated by a Probabilistic Safety Analysis (PSA) should not be taken as face value, but as an indicative number only.

Only results of detailed safety assessments for the reactor would permit to exclude a larger source term – in case it can be proven beyond doubt that such a larger source term cannot occur. Such safety assessments, however, are not yet available for the AES-2006.

An INES 6 accident with a release of not more than 100 TBq Cs-137 is supposed to be the most severe accident assessed in the updated EIA report. However, this accident – which was also the most severe accident assessed in the 2008 EIA report – does not constitute a worst-case scenario.

A rough calculation of a severe accident in the AES-2006 at the Hanhikivi site with two different source terms – evaluated in the flexRISK project (54,460 TBq Cs-137) and on behalf of the Norwegian Radiation Protection Authority (2,800 TBq Cs-137) – show possible consequences on Austrian territory, while with the release of 100 TBq Cs-137 such consequences would not be expected.

It is recommended to include a conservative worst case release scenario in the updated EIA report, in addition to the limited release scenario according to Finnish regulation, since their effects can be widespread and long-lasting and even countries not directly bordering Finland, like Austria, can be affected.

Furthermore, it is recommended to present the parameters used for the dispersion calculation and all respective results (in particular including unfavourable weather condition) at different long-range distances.

Radioactive Waste Management

On the basis of the information regarding waste management provided by the EIA program it has to be supposed that Fennovoima has not yet developed a comprehensive nuclear waste management strategy.

For the demonstration of a proper waste management and to evaluate the possible risk due to a possible accident at the interim storage facility, it is recommended that in the updated EIA report Fennovoima should declare the planned type of interim storage, its capacity and the schedule of the construction works. The intended duration of interim storage should also be clarified.

The risk of wet storage facilities compared to dry storage facilities is much higher. Generally, a severe accident in a wet spent fuel storage facility at the Hanhikivi site could affect Austrian territory.

In this regard, a decision about the final disposal strategy of spent fuel is of interest from the Austrian point of view. In particular, in case it is intended to construct an own final disposal by Fennovoima, a time schedule as well as information on the sites envisaged and its timely availability should be provided in the EIA report. This additional information is needed in order to estimate the required duration of interim storage and the subsequent security aspects, and to assess whether the planned sites fulfil the geological requirements.

ZUSAMMENFASSUNG

Beschreibung des Projekts und des Verfahrens

Fennovoima Ltd. (nachstehend als Fennovoima bezeichnet) plant den Bau eines 1.200 MW_e Kernkraftwerks auf der Hanhikivi-Landzunge (Gemeinde Pyhäjoki). Die geplante Anlage ist das Kernkraftwerk vom Typ AES-2006 vom russischen Unternehmen Rosatom.

Bereits am 6. Mai 2010 erteilte der finnische Staatsrat Fennovoima eine „Decision-in-Principle“ (Grundsatzentscheidung) zum Bau eines neuen Kernkraftwerks laut Kernenergiegesetz. Das finnische Parlament bestätigte diese Entscheidung am 1. Juli 2010.

Das Umweltverträglichkeitsprüfungsverfahren (UVP-Verfahren) für Fennovoimas Kernkraftwerkprojekt – eine Voraussetzung für die Erteilung der „Decision-in-Principle“ – wurde in den Jahren 2008 und 2009 durchgeführt. Diese ursprüngliche UVP bewertete die Auswirkungen eines Kernkraftwerks mit einer elektrischen Leistung von etwa 1.500–2.500 MW_e, mit einem oder zwei Reaktoren, an drei alternativen Standorten. Allerdings wurde der Typ AES-2006 im ursprünglichen Antrag auf eine „Decision-in-Principle“ und in der ursprünglichen UVP nicht als mögliche Alternative genannt.

Deshalb hat das Ministerium für Arbeit und Wirtschaft (MEE) unter anderem eine Aktualisierung der UVP gefordert. Die Regierung wird über weitere Maßnahmen nach der Bewertung dieser Studien entscheiden.

Das finnische UVP-Verfahren umfasst zwei Stufen: Das UVP-Programm ist eine Studie über den aktuellen Stand des Projekts sowie ein Arbeitsprogramm darüber, welche Auswirkungen untersucht und wie die Untersuchungen durchgeführt werden.

Die eigentliche Bewertung der Umweltauswirkungen erfolgt auf der Grundlage des UVP-Programms, der entsprechenden Stellungnahme der koordinierenden Behörde sowie weiterer diesbezüglicher Stellungnahmen und Meinungen. Die Ergebnisse der Bewertung werden in dem UVP-Bericht dargestellt.

Da Fennovoima sich für einen anderen Reaktortyp als im Antrag auf die “Decision-in-Principle” in 2009 entschieden hat, wird empfohlen, im UVP-Bericht die Wahl des neuen Reaktortyps, insbesondere in Bezug auf Sicherheitsaspekte, zu erklären und zu begründen.

Außerdem wird eine umfassende Bewertung des Standorts empfohlen, die die internationalen Bemühungen, insbesondere im Rahmen der EU-Stresstests, die Sicherheitsreserven der Kernkraftwerke gegenüber extremen Naturereignissen zu erhöhen, berücksichtigen.

Es ist die allgemeine Praxis in Finnland, dass spezifische und detaillierte technische Informationen über den/die zur Diskussion stehenden Reaktortyp(en) nicht im UVP-Bericht enthalten sind. Das neue Kernkraftwerk wird als „black box“ betrachtet, welche die gesetzlichen Anforderungen zu erfüllen hat. Mehrere sich überschneidende Verfahren werden neben dem UVP-Verfahren durchgeführt. Nach der “Decision-in-Principle” führt die STUK im Laufe des atomrechtlichen Genehmigungsverfahrens eine viel genauere Bewertung des Kernkraftwerk-Projekts durch.

Dieses Vorgehen ist vorgegeben und wird von der österreichischen Seite akzeptiert. Das schließt jedoch nicht die Möglichkeit aus, mehr technische Details bereits im UVP-Bericht darzustellen. Dies ist insbesondere zutreffend, da der Hintergrund dieses UVP-Verfahrens ein ganz anderer ist. Der Reaktortyp wird vom Antragsteller ausgewählt und dessen Machbarkeitsstudie wurde bereits an die STUK übergeben. Es ist also möglich, und wird auch empfohlen, die Sicherheitsanalysen und anlagenspezifischen Szenarien für schwere Unfälle des AES-2006 in den aktualisierten UVP-Bericht aufzunehmen.

Im Rahmen des vorhergehenden UVP-Verfahrens wurde ein Austausch von Informationen zwischen den zuständigen Behörden in Österreich und Finnland etabliert. Österreich begrüßte außerordentlich, dass die relevanten Dokumente der österreichischen Seite zur Verfügung gestellt wurden – als wichtiger Beitrag, um die österreichische Seite gut informiert zu halten.

Es wird empfohlen Österreich Informationen zu Unfallanalysen, schweren Unfällen und PSA-Ergebnissen zur Verfügung zu stellen , um den weiteren Verfahren der Entscheidung und Genehmigung in den weiteren Phasen folgen zu können.

Diskussion des Reaktortyps

Das Design (Auslegung) von Kernkraftwerken mit Reaktoren vom Typ WWER-1200, die sogenannten AES-2006, wurde zwischen 2000 und 2006 entwickelt. Es sind bis jetzt keine Kernkraftwerke vom Typ AES-2006 in Betrieb. Derzeit sind in Russland vier Blöcke im Bau; bei diesen kam es jedoch zu Bauverzögerungen. Weitere Blöcke sollen in Weißrussland und der Türkei gebaut werden.

Um ein umfassendes Bild von der Funktionsweise und Zuverlässigkeit der Sicherheitssysteme des Typs AES-2006 zu erhalten, wird eine ausführliche Beschreibung dieser Systeme im UVP-Bericht empfohlen. Von besonderer Bedeutung sind der "Core Catcher" und die neuen passiven Sicherheitssysteme zur Wärmeabfuhr.

Laut Bewertung der STUK im Jahr 2009 entsprechen nicht alle Auslegungsziele und -prinzipien des Kernkraftwerks AES-2006 den finnischen Sicherheitsanforderungen. Die technische Qualifizierung der neuen passiven Wärmeabfuhrsysteme ist noch nicht abgeschlossen; einige technische Auslegungsdetails des Kernkraftwerks AES-2006 erfordern weitere Analysen und Qualifikation.

Zu diesen Sicherheitsfragen gehören unter anderem der Schutz gegen Flugzeugabsturz sowie der Schutz gegen interne Ereignisse (wie z. B. Überschwemmungen und Brände), die Trennung der I&C-Systeme, das Fehlen eines Systems zur gefilterten Druckabsenkung des Sicherheitsbehälters und die Druckabsenkung des Primärkreises während schwerer Unfälle.

Es wird empfohlen, dass der UVP-Bericht eine Beschreibung beinhalten sollte, welche Teile der Auslegungsziele und -grundsätze des AES-2006 nicht den finnischen Sicherheitsanforderungen oder den WENRA Sicherheitszielen für neue Kernkraftwerke entsprechen. Im Allgemeinen sollte der UVP-Bericht zur gleichen Zeit veröffentlicht werden, wenn die STUK die

laufende Überprüfung des AES-2006 abgeschlossen haben wird. Die STUK beabsichtigt, die Ergebnisse der Sicherheitsbewertung im Frühjahr 2014 dem Ministerium für Arbeit und Wirtschaft zu übergeben.

Unfallanalysen

Fennovoima behauptet, ohne jedoch den Beweis dafür zu erbringen, dass das Atomkraftwerk so ausgelegt und betrieben werde, dass die freigesetzten Mengen von radioaktiven Substanzen in die Umwelt unter den in der Gesetzgebung und den Genehmigungsanforderungen festgelegten Grenzwerten blieben.

Nach dem Regulatory Guide on Nuclear Safety YVL 2.8 muss die Wahrscheinlichkeit für einen Kernschaden geringer als 1E-5/a sein. Die Wahrscheinlichkeit für einen Unfall mit Kernschaden, bei dem mehr als der Grenzwert von 100 TBq Cs-137 freigesetzt wird, muss geringer als 5E-7/a sein.

Schwere Unfälle mit Freisetzungen, die wesentlich höher als der Grenzwert von 100 TBq Cs-137 sind, können für das Kernkraftwerk vom Typ AES-2006 nicht ausgeschlossen werden, auch wenn gefordert wird, dass ihre errechnete Wahrscheinlichkeit geringer als 5E-7/a ist. Im Übrigen sollte die in einer probabilistischen Sicherheitsanalyse (PSA) berechnete Wahrscheinlichkeit für seltene Ereignisse nicht als Nennwert, sondern nur als Anhaltswert verstanden werden.

Nur die Ergebnisse der detaillierten Bewertung der Sicherheit für den Reaktor würden erlauben, einen höheren Quellterm auszuschließen – außer wenn zweifelsfrei nachgewiesen werden kann, dass ein so großer Quellterm nicht auftreten kann. Allerdings ist eine derartige Sicherheitsbewertung für den AES-2006 bislang nicht verfügbar.

Ein INES 6 Unfall mit einer Freisetzung von nicht mehr als 100 TBq Cs-137 wird alsschwerster Unfall angenommen, der im aktualisierten UVP-Berichts bewertet wurde. Jedoch stellt dieser Unfall – der auch der schwerste Unfall im 2008 UVP-Bericht war – nicht ein „Worst-Case-Szenario“ dar.

Eine grobe Berechnung für einen schweren Unfall in einem AES-2006 am Standort Hanhikivi mit zwei verschiedenen Quelltermen – ausgewertet im Rahmen des flexRISK Projekts (54.460 TBq Cs-137) und im Auftrag der norwegischen Strahlenschutzbehörde (2.800 TBq Cs-137) – zeigen mögliche Folgen auf österreichischem Gebiet, während bei einer Freisetzung von 100 TBq Cs-137 diese Folgen nicht zu erwarten sind.

Es wird empfohlen, zusätzlich zu dem begrenzten Freisetzungsszenario laut finnischem Regelwerk, auch ein konservatives “Worst-Case-Freisetzungsszenario“ in den aktualisierten UVP-Bericht aufzunehmen, da die Auswirkungen weitreichend und langanhaltend sein können, und sogar Länder wie Österreich, die nicht direkt an Finnland grenzen, betroffen sein können.

Außerdem wird empfohlen, die Parameter der Ausbreitungsrechnung und alle entsprechenden Ergebnisse (insbesondere bei ungünstigen Wetterbedingungen) bei verschiedenen Reichweiten im UVP-Bericht darzustellen.

Management des radioaktiven Abfalls

Auf Grundlage der Informationen betreffend die Abfallentsorgung im UVP-Programm ist davon auszugehen, dass Fennovoima noch keine umfassende Managementstrategie für radioaktive Abfälle entwickelt hat.

Für den Nachweis einer ordnungsgemäßen Entsorgung und einer Bewertung der möglichen Risiken durch einen möglichen Unfall im Zwischenlager wird empfohlen, dass Fennovoima im aktualisierten UVP-Bericht die geplante Art der Zwischenlagerung, die Kapazität und den Zeitplan der Bauarbeiten darlegt. Die vorgesehene Dauer der Zwischenlagerung sollte ebenfalls erläutert werden.

Die von einem Nasslager ausgehende Gefahr ist im Vergleich zu einem trockenen Zwischenlager viel größer. Im Allgemeinen könnte ein schwerer Unfall in einem Nasslager für abgebrannte Brennelemente am Standort Hanhikivi Auswirkungen auf österreichisches Gebiet haben.

In diesem Zusammenhang ist eine Entscheidung über das endgültige Konzept für die Entsorgung der abgebrannten Brennelemente aus österreichischer Sicht von Interesse. Insbesondere für den Fall, dass die Errichtung eines eigenen Endlagers von Fennovoima geplant ist, sollten ein Zeitplan sowie Informationen über die ins Auge gefassten Standorte und seine rechtzeitige Verfügbarkeit im UVP-Bericht enthalten sein. Diese zusätzlichen Informationen sind nötig, um die erforderliche Dauer der Zwischenlagerung und der folgenden Sicherheitsaspekte abschätzen zu können und zu beurteilen, ob die geplanten Standorte die geologischen Voraussetzungen erfüllen.

1 INTRODUCTION

Fennovoima is preparing to build a 1,200 MW_e nuclear power plant in the Hanhikivi headland (municipality of Pyhäjoki). The proposed plant has an AES-2006 type pressurized water reactor manufactured by the Russian Rosatom Group.

On 6 May 2010, the Council of State of Finland granted Fennovoima a Decision-in-Principle for the construction of a nuclear power plant in accordance with the Nuclear Energy Act (990/1987). The Finnish Parliament confirmed the Decision-in-Principle on 1 July 2010. The Environmental Impact Assessment (EIA) procedure for Fennovoima´s nuclear power plant project – a prerequisite for issuing the Decision-in-Principle – was carried out in 2008 and 2009.

This original EIA procedure evaluated the impacts of the nuclear power plant with the electric power of about 1,500–2,500 MW_e, with one or two reactors, in three alternative locations. However, the current project (the AES-2006) was not mentioned as one of the plant alternatives in the original Decision-in-Principal application.

Therefore, the Ministry of Employment and the Economy (MEE) required an updated EIA, a safety assessment and Pyhäjoki municipality's view on the matter. The government will decide on further measures after the assessments of these studies (MEE 2013).

With reference to the Espoo Convention, the Austrian Federal Ministry of Agriculture and Forestry, Environment and Water Management takes part in the new EIA procedure for Fennovoima´s nuclear power plant project (Hanhikivi 1).

The Finnish EIA procedure includes two stages: The first stage, the EIA program, comprises a study on the current state of the project area, as well as a work program stating which impacts shall be studied and how the studies shall be performed in the second stage, the EIA report.

The Umweltbundesamt (Environment Agency Austria) has assigned Oda Becker, scientific consultant, to elaborate the expert statement at hand assessing the documents presented by Finland, in particular Fennovoima´s *Environmental Impact Assessment Program for a Nuclear Power Plant* published in September 2013 (FENNOVOIMA 2013).

The review of the document is focused mainly on the proposed safety and risk analysis. The aim is to assess if the EIA report will allow making reliable conclusions about the potential impact of transboundary emissions.

The Austrian Federal Ministry of Agriculture and Forestry, Environment and Water Management participated in Fennovoima´s 2008 EIA procedure. The Austrian Institute of Ecology in cooperation with Dr. Helmut Hirsch and Dr. Petra Seibert assessed on behalf of the Umweltbundesamt (Environment Agency Austria) the 2008 EIA report (UMWELTBUNDESAMT 2008).

A bilateral consultation was held in Helsinki on 28 January 2009. During this consultation, the questions of the Austrian side were discussed with the competent Finnish authorities and the applicant Fennovoima. Information presented at the bilateral consultation was assessed in the experts' report on the consultation (UMWELTBUNDESAMT 2010).

In summer 2009, further documents in conjunction with the ongoing decision-making process were made available to the Austrian side as an important contribution to keeping the Austrian side well-informed. The evaluation of these supplements was published in September 2009 (UMWELTBUNDESAMT 2009a).

This expert statement is based on the above-mentioned reports and is structured as follows: After a summary in English and German, a short introduction is given in chapter 1. The project and the EIA procedure are described in chapter 2. In chapter 3, the reactor type (AES-2006) considered for Fennovoima´s nuclear power plant is discussed in detail. Chapter 4 deals with the accident analysis with focus on possible transboundary consequences. In chapter 5, the management of the radioactive waste is shortly discussed. All recommendations are summarised in chapter 6.

2 DESCRIPTION OF THE PROJECT AND THE PROCEDURE

2.1 Treatment in the EIA Program

2.1.1 Description of the Project

Fennovoima Ltd. (hereinafter referred to as Fennovoima) plans to construct a nuclear power plant with about 1,200 MW_e of electric power (FENNOVOIMA 2013, p.18).

Fennovoima was established in 2007. It is owned by Voimaosakeyhtiö SF, under which a total of 60 industrial and commercial enterprises, as well as energy companies, are grouped. At present, the Rosatom Group is negotiating the option to become a minority shareholder in Fennovoima (FENNOVOIMA 2013, p.18).

The purpose and the reasons of the project are described as follows: Nuclear power is an economic way to produce electricity. The price of electricity produced with nuclear power is stable and foreseeable. Electricity produced by Fennovoima will go directly to its owners for cost price. Self-owned electricity production with a stable price supports the competitiveness of Fennovoima's owners and helps them operate and invest in Finland (FENNOVOIMA 2013, p.18).

Increasing the own production of electricity will decrease Finland's dependency on imported electricity. In 2012, approximately 20% of the electricity consumed in Finland was imported. It is also pointed out that nuclear power supports the climate objectives of Finland, because the electricity production is carbon dioxide free (FENNOVOIMA 2013, p.18).

It is stated that the EIA report will present the impacts on the electricity market in the manner presented in the 2008 EIA report, taking into consideration the current estimates on the future status of the electricity market, fuel market, emissions trading and maintenance and supply security in a situation where the new nuclear power plant is in operation (FENNOVOIMA 2013, p.62).

Alternatives and Zero-Alternative

The comparison between alternatives will present the differences between the impacts of the approximately 1,200 MW_e plant that is currently being assessed and the 1,800 MW_e plant presented in the 2008 EIA report. These will be compared with the impacts of the zero alternative (FENNOVOIMA 2013, p.63).

As a zero alternative, the assessment will estimate the situation in which Fennovoima will not implement the nuclear power plant project. The need for electricity in Finland would be covered by increasing the import of electricity or through power plant projects of other parties (FENNOVOIMA 2013, p.31).

It is planned to assess the environmental impacts of the zero alternative on the basis of the 2008 EIA. The assumptions applied in the 2008 EIA will be updated to correspond to the present situation (FENNOVOIMA 2013, p.63).

Site Evaluation

The Hanhikivi site, in the municipality of Pyhäjoki on Finland's western coast, was selected as the location for the plant in 2011.

The coastal waters surrounding the Hanhikivi headland are shallow and the shores are rocky. The influence of waves on the shore zone is significant due to the openness of the coast line. According to model simulations carried out in 2011/2012, wave heights of two to four meters occur regularly in front of Hanhikivi, and single waves can be even larger (FENNOVOIMA 2013, p.49).

In conjunction with the Fennovoima´s application for a Decision-in-Principle in January 2009, STUK has assessed the suitability of the Hanhikivi plant site in Pyhäjoki. Accordingly, there are no such characteristics in the conditions of the site area that would prevent the construction of the nuclear power plant in accordance with the safety requirements (FENNOVOIMA 2013, p.20).

Fennovoima's objective is to make the contract for plant supply by the end of 2013. The construction time period for the nuclear power plant is estimated to be about six years (FENNOVOIMA 2013, p.20).

2.1.2 Description of the Procedure

According to the Finnish Nuclear Energy Act (990/1987), the construction of a nuclear power plant shall require a government Decision-in-Principle to ensure that the project is in line with the overall good of society. The EIA procedure has to be completed before the Decision-in-Principle concerning a new nuclear power plant can be issued. The EIA procedure itself does not involve any project-related decisions, but its objective is to generate information to back up decision-making.

In the original EIA procedure, three sites including the Hanhikivi site were under discussion. Furthermore, three different types of reactors were considered: Areva´s EPR; Toshiba´s ABWR and Areva´s KERENA (FENNOVOIMA 2008).

Since the AES-2006 was not mentioned as one of the plant alternatives in Fennovoima's original Decision-in-Principal application, the Ministry of Employment and the Economy (MEE) has required the following additional studies (FENNOVOIMA 2013, p.67):

- Fennovoima shall update the environmental impact assessments of the project,
- STUK shall assess the safety of the plant alternative,
- the municipality of Pyhäjoki shall make a statement on the issue, and
- the MEE shall arrange a public hearing.

After these contributions, a statement will be made regarding the fact whether the Decision-in-Principle in force will cover this plant alternative as well, or whether the Decision-in-Principle shall be reintroduced to Parliament for new parliamentary proceedings (FENNOVOIMA 2013, p.67).

The EIA procedure officially started in September 2013 when the EIA program was submitted to the Ministry of Employment and the Economy (MEE) that acts as the coordinating authority.

The Finnish EIA procedure includes two stages (FENNOVOIMA 2013, p.24).

The environmental impact assessment program (EIA program) is a study on the current state of the project area, as well as a work program on which impacts shall be studied and how the studies shall be performed. The EIA program presents, among others, the basic data of the project and the alternative to be studied, as well as an estimate on the project schedule.

Table 7-1 of the EIA program presents a preliminary assessment of the environmental impacts on a plant of approximately 1,200 MW_e in comparison with the 1,800 MW_e plant presented in the 2008 EIA, as well as a very short description of the environmental impact assessment methods (FENNOVOIMA 2013, p.58). This overview is presented in Annex 1 of this expert statement.

The actual assessment of the environmental impacts will be carried out on the basis of the EIA program and the coordinating authority's statement relating to it, as well as of other statements and opinions. The results of the assessment work are presented in the environmental impact assessment report (EIA report). Fennovoima plans to submit the EIA report to the MEE in February 2014 (FENNOVOIMA 2013, p.25).

The MEE compiles the statements and opinions expressed on the EIA report, and issues its own statement based on these within two months after the termination of the public display at the latest. The EIA procedure will end when the MEE submits its statement on the EIA report.

The Ministry of the Environment is responsible for the practical arrangements of the international hearing according to the Espoo Convention (FENNOVOIMA 2013, p.23).

2.2 Discussion

2.2.1 Discussion of the Project

Background

In January 2009, Fennovoima submitted its application to the government for a Decision-in-Principle, which was granted in May 2010. Fennovoima presented three site alternatives but, later in 2009, withdrew one site (near Loviisa) and in October 2011 decided upon one of two prospective northern sites: Pyhäjoki municipality, rather than Simo which was close to Outokumpu's Tornio steelworks, the largest electricity consumer in Finland. The Environment Ministry has approved land-use plans and the plant will be built on the Hanhikivi peninsula on the coast of Bothnian Bay, near Pyhäjoki (WNA 2013).

Fennovoima´s new nuclear power plant **Hanhikivi 1** was planned to be a nuclear power plant in a net range of 1,250–1,700 MW_e. The commercial bids were received from Areva and Toshiba in February 2012. As a result of evaluating the bids, in February 2013 Fennovoima decided to terminate that process and proceed with direct negotiations about the 1,600 MW_e EU-ABWR with Toshiba.

At the same time, Fennovoima also started to assess whether a mid-sized unit of 1,000–1,300 MW_e would be a better option. Fennovoima invited Rosatom to engage in direct negotiations, in parallel with Toshiba, concerning its AES-2006 power plant with VVER-1200 reactor. This new approach was prompted by E.ON's departure from the project. In July 2013, Fennovoima announced that it would focus on negotiations with Rosatom and end consideration of the Toshiba option. It signed a project development agreement with Rusatom Overseas, which may also take a 34% share of the project (WNA 2013).

It is recommended to include into the EIA report an explanation and justification for the new choice of the reactor type, in particular in regard of safety aspects.

Alternatives and Zero-Alternative

The 2008 EIA report provided a comparison between the life-cycle CO_2 emissions of nuclear power and fossil fuel / natural gas, but the comparison with renewables is missing. The updated EIA program indicates that the same approach regarding the zero alternative will be applied. To compare alternatives, only the differences between the impacts of the 1,200 MW_e plant and the 1,800 MW_e plant will be presented.

It is recommended to include into the EIA report a comprehensive comparison of all electricity production technologies and the options of saving energy, efficiency enhancement and demand side management. The EIA report should also include information on the cost structure of the project and the technological alternatives.

In May 2010, TVO's application for a Decision-in-Principle to construct a 1,000–1,800 MW_e unit (Olkiluoto 4) was granted (WNA 2013). It is the responsibility of the Ministry of Employment and the Economy (MEE), the Government and the Parliament to decide which capacity will be required to serve the electricity demand, and how many nuclear power plants shall be built. This is even more necessary as the Government stated that nuclear power will not be constructed in Finland for the purpose of permanent export of electricity (UMWELTBUNDESAMT 2010).

It is recommended to include into the updated EIA report a comprehensive justification of the need to construct another new nuclear power plant.

Site Evaluation

According to the Decision-in-Principle of 2010, the Hanhikivi headland in Pyhäjoki (as well as Karsikko in Simo) is suitable as the plant site. This decision is based on the Preliminary Safety Assessment of STUK in October 2009 (STUK 2009c).

It has to be expected that some issues concerning the evaluation of the site have changed compared to the STUK´s assessment in 2009. Changes could be caused by new information (e.g. regarding seismic issues) or new assessment of the situation – for example due to the Fukushima accident 2011.

For example, clogging of the water intake could be a safety issue at the Hanhikivi site. The hazard of the loss of functionality of the ultimate heat sink – highlighted by the Fukushima accident – was a subject in the European stress tests. The peer review team of the Finnish National Stress tests report pointed out that heat sink requirements are addressed through YVL 1.0 in terms of redundancy and diversity although there do not appear to be any specific requirements for an alternative heat sink (ENSREG FI 2012).

Sea level variation is relatively great at the site (STUK 2009c). The above-mentioned peer review team pointed out that the Finnish regulations do not include explicit quantitative requirements on the flood level which shall be considered in the design of NPPs. The design values shall be based on clarifications conducted or contracted by the licensee and reviewed by STUK in cooperation with the appropriate expert organizations, especially the Finnish Institute of Meteorology (ENSREG FI 2012).

It is recommended to provide a comprehensive site evaluation that reflects the international efforts, in particular in the frame of EU stress tests, to enhance the safety margins of nuclear power plants against natural hazards.

2.2.2 Discussion of the Procedure

The Austrian experts assessed the scope of the 2008 EIA report as follow: "Fennovoima's EIA report seems to be complete according to the minimum requirements of the Espoo Convention. However, considering possible transboundary impacts, there is some general lack of information" (UMWELTBUNDESAMT 2010). The EIA program indicates that the updated EIA report will also be in compliance with the minimum requirements of the Espoo Convention. It also indicates a possible lack of information considering transboundary impacts. This issue that is of utmost interest from the Austrian point of view is discussed in chapter 4 of this expert statement.

It is the general practice in Finland, as laid down in the corresponding regulations, that specific and detailed technical information concerning the reactor type(s) under consideration is not provided in the EIA report. Rather, the new nuclear power plant is regarded as a black box, which has to fulfil the regulatory requirements. This approach was also followed in the Fennovoima´s 2008 EIA report.

Several overlapping procedures are ongoing, beside the EIA procedure. Preparation for the Decision-in-Principle includes feasibility studies which have to be provided by the applicant. Based on these documents, the regulatory authority STUK has to assess whether there are safety issues to be foreseen which could prevent the plant meeting the Finnish requirements. After the Decision-in-Principle, a much more detailed assessment of the nuclear power plant project will be performed by STUK, in the course of the nuclear licensing procedure.

This course of action is predetermined and has to be accepted by the Austrian side.[1] However, this does not exclude the possibility to go into somewhat more technical detail already in the course of the EIA procedure (UMWELTBUNDESAMT 2008).

This is in particular true because the background of this EIA procedure is quite different. The reactor type is chosen by the applicant and its feasibility study is already provided to the STUK. Thus, it is possible to present quite more details of the reactor type, in particular concerning safety analysis and a plant-specific severe accident scenario in the EIA report. **It is recommended to include into the updated EIA report safety analyses and a plant-specific severe accident scenario of the AES-2006.**

An exchange of information between the competent authorities of Austria and Finland covering the results of feasibility studies and safety assessments to follow the still ongoing procedures was recommended in the context of the 2008 EIA procedure. Austria highly appreciated that relevant documents[2] made available to the Austrian side as an important contribution to keeping the Austrian side well-informed.

It is recommended, in order to follow the ongoing procedures during later stages of decision making and licensing, that information concerning accident analyses, severe accidents and PSA results should be made available to the Austrian side.

2.3 Conclusions

Since Fennovoima has decided to construct another reactor type as proposed in its application for the Decision-in-Principle in 2009, it is recommended to include into the EIA report an explanation and justification for the new choice of the reactor type, in particular in regard of safety aspects.

Furthermore, it is recommended to provide a comprehensive site evaluation that reflects the international efforts, in particular in the frame of EU stress tests, to enhance the safety margins of nuclear power plants against natural hazards.

It is the general practice in Finland that specific and detailed technical information concerning the reactor type(s) under consideration is not provided in the EIA report. The new nuclear power plant is regarded as a black box, which has to fulfil the regulatory requirements. Several overlapping procedures are ongoing, beside the EIA procedure. After the Decision-in-Principle, a much more

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[1] Note: During the bilateral consultations between Finland and Austria concerning Olkiluoto-4 and Loviisa-3, the Austrian side has proposed considering changes in the licensing process concerning the chronological order because completion of the EIA procedure before the project phase seems to be too early and only few details about the project are available. It was highly appreciated by the Austrian side that the Finnish side considers changes in the EIA process.

[2] (a) Decision-in-Principle application by Fennovoima; b) Statement of MEE on the EIA; c) Decision-in-Principle including STUK´s report on the feasibility study of the reactor types for all applications (UMWELTBUNDESAMT 2009a).

detailed assessment of the nuclear power plant project will be performed by STUK, in the course of the nuclear licensing procedure.

This course of action is predetermined and has to be accepted by the Austrian side. However, this does not exclude the possibility to go into somewhat more technical detail already in the EIA report. This is in particular true because the background of this EIA procedure is quite different. The reactor type is chosen by the applicant and its feasibility study has already been provided to the STUK. Thus, it is possible and it is also recommended to include safety analyses and plant-specific severe accident scenarios of the AES-2006 into the updated EIA report.

In the context of the 2008/2009 EIA procedure, an exchange of information between the competent authorities of Austria and Finland was established. Austria highly appreciates that relevant documents were provided to the Austrian side as an important contribution to keeping the Austrian side well-informed.

It is recommended, in order to follow the ongoing procedures during later stages of decision making and licensing, that information concerning accident analyses, severe accidents and PSA results should be made available to the Austrian side.

3 DISCUSSION OF THE REACTOR TYPE

3.1 Treatment in the EIA Program

Chapter 5.1 of the EIA program starts with a general description of the operational principle of the nuclear power plant. Accordingly, the new nuclear power plant will be used at constant power (base load). The estimated operational lifetime of the plant will be at least 60 years (FENNOVOIMA 2013, p.33).

Table 5.2 of the EIA program presents the comparison of the specifications of the plant of approximately 1,200 MW_e assessed in the current EIA procedure with the plant of approximately 1,800 MW_e assessed in the 2008 EIA report. It is clarified that the data relating to the 1,200 MW_e plant are preliminary estimates (FENNOVOIMA 2013, p.39).

Table 1: Specification of the 1,200 MW_e nuclear power plant in comparison with 1,800 MW_e nuclear power plant

Specification	Nuclear power plant with approximately 1200 MW_e	Nuclear power plant with approximately 1800 MW_e
Reactor	Pressurized water reactor	Pressurized water reactor
Electric power	about 1,200 MWe (1,100–1,300 MWe)	about 1,800 MW_e
Thermal power	about 3,200 MW_{th}	about 4,900 MW_{th}
Thermal efficiency	about 37%	about 37%
Fuel	Uranium dioxide UO2	Uranium dioxide UO2
Thermal load to be discharged to the water system	about 2,000 MW_{th}	about 3,100 MW_{th}
Annual energy production	about 9 TWh	about 14 TWh
Cooling water requirement	about 40–45 m^3/s	about 65 m^3/s
Service water quantity	550–650 m^3/day	550–650 m^3/day
Fuel consumption	20–40 t/year	30–50 t/year
Spent nuclear fuel	1,200–2,400 t (during the entire operating time of the plant)	2,500–3,500 t (during the entire operating time of the plant)
Low and medium-level operating waste	about 5,000 m^3 (during the entire operating time of the plant)	about 6,000 m^3 (during the entire operating time of the plant)

A very short general description of the plant type is provided in chapter 5.2 of the EIA program. It is stated that the pressurized water reactor of the planned new nuclear power plant is of the type AES-2006, which is the newest development stage of the Russian pressurised water reactor (VVER). Similar units have been ordered by several countries, in addition to which this plant type is currently being built in Russia (FENNOVOIMA 2013, p.34).

The “extensive experience in Russian pressurised water reactors” is pointed out, “as the VVER reactors have been operating in the two nuclear power plant units in Loviisa for more than thirty years” (FENNOVOIMA 2013, p.34).

The safety principles of nuclear power plants are described in a general manner; the defence in depth principle is mentioned. Furthermore, the improvements of safety systems of nuclear power plants, in particular equipment and structure to cope with core melt accidents, are highlighted *(*FENNOVOIMA 2013, p.35*)*.

Experience gained from the Fukushima accident is also utilised in the safety design of nuclear power plants: "Passive systems will succeed in cooling down the reactor even in possible cases of electric power loss" (FENNOVOIMA 2013, p.35).

3.2 Discussion

Design of VVER-1200 plants, the so-called AES-2006, was started after the year 2000 and completed in 2006. Besides the increased size of 1,200 MW_e power, the AES-2006 plant has additional safety features when compared with the advanced VVER-1000 plants (ROSATOM 2013.) In the AES-2006 plant, both active and passive systems are used for the implementation of safety functions.

The following chart (figure 1) shows the evolution of the WWER-1000 with different reactors types (GIDROPRESS 2010):

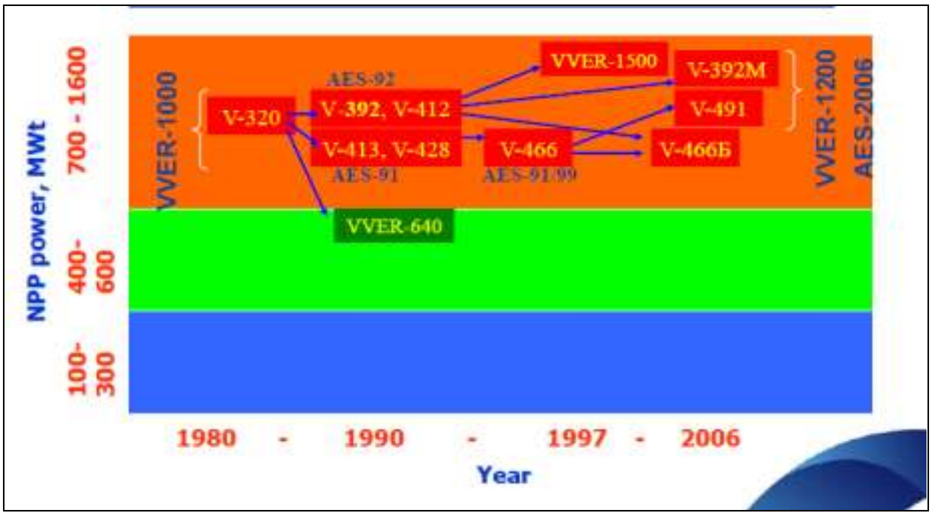

Figure 1: VVER Technology Evolution

Two variants of the AES-2006 have been developed (see figure 1): Passive safety systems prevail in the type VVER-1200/V-392M, whereas the type VVER-1200/V-491 focuses more on active systems (UMWELTBUNDESAMT 2009b). The EIA program does not mention which variant is chosen for Hanhikivi 1. **It is recommended to explain which variant of the AES-2006 is chosen as well as the reason for this choice.**

The claimed Finnish extensive experience with VVER reactor technology is misleading. The units Loviisa 1 and 2 belong to the smaller reactor type VVER-440 with a quite different design compared to the AES-2006.

Today, no nuclear power plant with the AES-2006 design is in operation. Currently, four units are under construction in Russia.[3] They have been subject to construction delays. Novovoronezh II is the lead plant for deploying the V-392M version of the AES-2006 units. Construction of units 1 and 2 began in June 2008 and July 2009, respectively. The units were expected to start up in 2012 and 2013, but commissioning is now expected to take place in 2014 and 2016.

There are two units of the reactor type VVER 1200/V-491 under construction at Leningrad II. Construction of unit 1 started in October 2008, and it was to be commissioned in October 2013. However, a section of outer containment collapsed in 2011 and, among others, set back the schedule. Commissioning is now expected to happen during 2016 at the earliest. The construction of the second unit started in April 2010, commissioning start is envisaged for 2020 (SCHNEIDER 2013; WNA 2013a; WNN 2013b).

Besides the four units in Russia, other units are to be built in Belarus and Turkey only: Belarus launched a tender for the construction of the country's first nuclear power plant. Russia's Atomstroyexport (ASE) was reportedly the only bidder prepared to proceed and provide financing (WNN 2013d). Thus, the AES-2006 design is intended for use for the first nuclear power plant in Belarus. Turkey´s forthcoming first nuclear power plant project comprises four AES-2006 reactors. Environmental approval for this project is expected by the end of 2013 (WNN 2013a).

Special Safety Features of the AES-2006 Design

According to ROSATOM (2013), the strategy for protection of the AES-2006 containment after possible reactor core meltdown is that all physical phenomena that could occur in connection with core meltdown and endanger the containment integrity are taken into account and dedicated means are provided to ensure containment integrity. Protection of the AES-2006 containment integrity against all those physical phenomena is based on passive systems that do not need electrical power. It is emphasised that passive system for decay heat removal is an important advanced feature for ensuring safety of the new VVER plants (ROSATOM 2013).

Passive systems that have previously not been used at nuclear power plants are implemented in the AES-2006 design. To ensure emergency heat removal from the core by passive safety systems, the AES-2006 design includes a passive heat removal system (PHRS) and a system of water tanks ('hydraulic accumulators') in a first and second stage (HA-1 and HA-2).

[3] Construction of the Baltic 1 (VVER-1200/V-491) has started in April 2012, but was suspended in June 2013.

If a loss of all AC power sources at the site causes an active safety system failure – and (only) in case that this failure is not accompanied by a loss of coolant from the reactor circulation circuit – operation of the passive heat removal system alone will be sufficient to cool the reactor. Owing to the use of air as an ultimate heat sink, the PHRS can perform its function for an unlimited period of time in these conditions (NEI 2011).

In a technical publication, the constraints of the capacity of passive safety systems for core flooding and heat removal of the new VVER plants were also pointed out. Regarding safety analysis, it is emphasized that failures of equipment (other than assumed in scenarios) and operator errors are not taken into account (BUKIN 2006). Thus, the capability of passive safety systems for core flooding and heat removal of these safety systems under real accident conditions could be limited.

It is recommended to include into the EIA report a detailed description of the new passive safety systems including their limitations.

An important feature of the AES-2006 is the core melt localisation device (or core catcher). If functioning as planned, this new feature would have the potential to reduce the probability of large releases in case of a severe accident. However, the functioning of a core catcher is beset with a number of problems which have not been sufficiently clarified (for example: interaction between the molten core and concrete, considerable uncertainties regarding heat transfer between the materials involved; occurrence of cracks in the concrete of the device; hydrogen formation).

The core catcher of the VVER-1000/V466 which can be assumed to be similar to that of the VVER-1200 is placed in a concrete shaft below the reactor pressure vessel. It is filled with sacrificial material. The molten reactor core falls into this device after it has penetrated the pressure vessel bottom, and is cooled from above with water. The water from a building sump and the fuel pool is destined for this task.

The steam explosions constitute a severe problem for the core catcher design selected for the VVER-1000/V466. It is not guaranteed that the molten core will reach the core catcher all at once, as a whole. If, at first, only a part gets into the concrete shaft, it is likely that this will trigger flooding. Further molten core material then falls into water and the melt can fragment into small particles. In this way, heat transfer to the water is very fast, with abrupt vaporization as a result. For those steam explosions, it is not possible today to predict the level of potential damage.

To avoid this problem, the core catcher of the EPR is constructed in a different manner: At first, the melt is collected completely in the shaft below the reactor, which is to remain absolutely dry. Then, the melt is to flow to the area where it is cooled with water. This transfer is to be initiated passively by melting through of an aluminium plug. A construction of this kind is complicated and has its own disadvantages – in particular, accurate timing of the accident sequences is required. But the construction selected for the EPR demonstrates that the developers of this reactor type were aware of the steam explosion hazard and attempted to reduce it (UMWELTBUNDESAMT 2009b).

It is recommended to describe the corium localization device (core catcher) in the EIA report in detail. The proof of functioning of this device (test, computer simulations), including the prevention of steam explosions, shall be presented.

STUK´s Preliminary Safety Assessment

Fennovoima explained in 2013, the design of AES-2006 meets current IAEA and European requirements, but it has to be adapted to meet Finnish national standards (WNN 2013c).

On 17 October 2013, Fennovoima has delivered reports to the Finnish Radiation and Nuclear Safety Authority, STUK, for enabling STUK to assess the safety of the Rosatom's nuclear power plant. STUK is preparing to give the results of the safety assessment to the Ministry of Employment and the Economy during spring 2014. Before applying for the construction license, the technical solutions of the plant are designed to fulfil the Finnish requirements (FENNOVOIMA 2013a).

In the framework of Fortum's application for a Decision-in-Principle concerning the construction of a new nuclear power plant unit (Loviisa 3), the Ministry of Employment and the Economy (MEE) requested STUK to draw up a preliminary safety assessment (STUK 2009a, b). In its safety assessment of the AES-2006 in 2009, STUK highlighted facts which indicated that the prerequisites set forth in Section 6 of the Nuclear Energy Act had not been fulfilled.

According to the STUK´s assessment in 2009, not all parts of the design objectives and principles of the AES-2006 plant alternative are consistent with Finnish safety requirements.

- Of particular concern is the structural protection against airplane crashes: Structural protection against collision by a large commercial airplane focuses on the outer containment and on the fresh fuel storage. The safety buildings are not designed to withstand the impact of a large airplane.
- The safety building's structural elements containing safety systems have been placed side by side. They are connected by service corridors and channels for air-conditioning systems. These connections between the parallel subsystems are separated by doors and dampers and call into question the adequate realisation of physical separation. Thus, the protection against internal incidents, such as floods and fires, has not yet been demonstrated.
- The passive systems to be used in transient and accident situations, the reactor circuit cooling residual heat removal system connected to the steam generators (PHRS SG), and the natural circulation based containment building's residual heat removal system (PHRS C) are in the process of testing-based qualification. The correct functioning of the systems can be confirmed only after the test results are ready.
- The design objectives and principles associated with the separation principles of the I&C systems were not found to be consistent with Finnish safety requirements.
- Finnish requirements call for nuclear power plants to be equipped with a filtered containment venting system to mitigate the consequences of severe accidents. A filtered containment venting system is not included in the AES-2006 design.

- Primary circuit depressurisation in severe accidents is not to be independent of the systems designed for the plant's operating stages and postulated accidents. Thus, Finnish safety requirements are not met.

To meet the Finnish requirements, several other technical details of the AES-2006 design require further analyses and qualification based on tests as well as further engineering. These include, among others:

- Reactor pressure vessel material's analysis requirements on the rate of radiation embrittlement
- Integrity of the reactor's inner components in postulated, sudden pipe breaks in the primary circuit
- Technical solutions related to the supply of cooling water for several systems (including PHRS SG and PHRS C) that realise the diversity principle
- Number of redundancy of the alternating current supply equipment
- Electric power supply system of the systems for management of severe accidents
- Separation principles for both electric and automation systems
- Reactivity management (e.g. plans for the sudden dilution of boron concentration in the primary circuit) requires supplementary analyses and/or tests
- Seismic resistance of the plant's fire extinguishing systems.

In STUK's opinion, the required tests, further engineering and modifications can be carried out at later licensing stages in such a manner that the requirements set forth in the Government Decree (733/2008) can be fulfilled.

However, the long list of safety issues shows that a sufficient level of protection against external and internal impacts as well as the functionally of the safety systems had not been demonstrated in a sufficient manner to allow STUK to conclude a positive review. Up to now, a severe accident cannot be excluded due to the design of the AES-2006.

In the 2008 EIA report, the implementation of nuclear safety requirements and principles in the design, construction and operation of a nuclear power plant is discussed in a concise and general manner. It has to be expected that it is intended to be the same in the updated EIA report. However, to gain a comprehensive picture of the functioning and reliability of safety systems of the AES-2006 design, a detailed description of those systems in the updated EIA report is recommended.

It is also recommended to describe which parts of the design objectives and principles of the AES-2006 are not consistent with the Finnish safety requirements and/or with the WENRA´s Safety Objectives for New Nuclear Power Plants.[4]

[4] In 2009, the reactor harmonization working group (RHWG) of the Western European Nuclear Regulator's Association (WENRA) published the "Safety Objectives for New Power Reactors" (WENRA 2009). WENRA´s RHWG was outlining more explicit positions implied by the new safety objectives for some selected important topics. These positions were published by March 2013 (WENRA 2013).

3.3 Conclusions

Design of VVER-1200 plants, the so-called AES-2006, was started after the year 2000 and completed in 2006. Besides the increased size of 1,200 MW_e power, the AES-2006 plant has additional safety features when compared with the advanced VVER-1000 plants. To gain a comprehensive picture of the functioning and reliability of safety systems of the AES-2006 design, a detailed description of those systems in the updated EIA report is recommended. Of particular concern are the core catcher and the new passive heat removal systems.

According to the STUK´s assessment in 2009, not all parts of the design objectives and principles of the AES-2006 plant alternative are consistent with Finnish safety requirements. These safety issues include the protection against airplane crashes as well as the protection against internal incidents, such as floods and fires; separation of the I&C systems; lack of filtered containment venting system; and depressurisation of the primary circuit in severe accidents.

It is recommended that the EIA report should contain a description which parts of the design objectives and principles of the AES-2006 are not consistent with the present Finnish safety requirements or with the WENRA´s Safety Objectives for New Nuclear Power Plants. In general, the EIA Report should be made public at the same time, when STUK will have concluded its ongoing review of the AES-2006.

4 ACCIDENT ANALYSIS

4.1 Treatment in the EIA Program

Chapter 7.4.9 of the EIA program deals with the assessment of impacts in accident situations: It is stated that, according to a preliminary estimate, the impacts of possible abnormal and accident situations of an approximately 1,200 MW_e nuclear power plant being currently assessed will not differ significantly from the impacts caused by a 1,800 MW_e nuclear power plant, since the authority requirements set as the maximum consequences due to these situations are the same for both nuclear power plants.

Without any further explanation it is stated: "The nuclear power plant will be designed and operated in such a manner that the quantities of radioactive substances released into the environment remain below the limits set in legislation and in the requirements of the licences" (FENNOVOIMA 2013, p.37).

The updated EIA report will describe the grounds for the safety design of the new 1,200 MW_e nuclear power plant and present the possibilities to fulfil the statutory nuclear safety requirements (FENNOVOIMA 2013, p.61).

General principles of safety requirements set for nuclear power plants valid in Finland are prescribed in Government Decrees (733–736/2008), and the details are issued in the YVL Guide published by the Radiation and Nuclear Safety Authority (STUK) (FENNOVOIMA 2013, p.35).

Chapter 7.4.10 of the EIA program deals with transboundary environmental impacts. It is emphasised that, according to the preliminary estimate, the impacts of radioactive emissions generated only by a serious nuclear power plant accident could have impact outside of the territory of Finland (FENNOVOIMA 2013, p.62).

Concerning the source term of accidents, it is stated that the EIA report will present an imaginary accident case of a grade 6 accident according to the international INES rating. The accident releases a quantity of radioactive substances that corresponds to the specified limit value for a serious accident according to Section 10 of the Government Decree (733/2008). The impacts of the accident case will be assessed within a radius of at least 1,000 kilometres (FENNOVOIMA 2013, p.62).

The following statement indicates that it is not envisaged to perform new calculations to evaluate possible transboundary impacts: "In conjunction with the 2008 environmental impact assessment and the additional assessment attached to the application for the Decision-in-Principle in 2009, the impacts of a nuclear power plant accident were modelled. The modelling was carried out using general and conservative assumptions which are not plant type specific. Thus the modelling will also apply to the assessment of the nuclear power plant accident of the plant alternative being assessed in this EIA procedure" (FENNOVOIMA 2013, p.62).

The modelling studies carried out in 2008/2009 considered unfavourable weather conditions, as well as emission from a serious accident, containing not more than 100 TBq caesium-137-nuclides. These studies showed that with the assumed emission, the need for population protection measures and long-term restriction on the use of land and water areas would be limited within a radius of 150 kilometres from the site in Pyhäjoki (FENNOVOIMA 2013, p.62).

According the EIA program, other impacts that could reach beyond the Finnish borders have not been identified yet, but these other possible impacts will be studied in more detail in the EIA report (FENNOVOIMA 2013, p.62).

Fennovoima points out that it is unlikely that an accident could occur in a nuclear power plant and lead to the need to take action in the surroundings of the nuclear power plant to protect the population. However, the principle of Defence-in-Depth calls for preparation for emergency operations. The emergency operations are described in more detail in the EIA report (FENNOVOIMA 2013, p.35).

4.2 Discussion

In the context of safety, severe accidents are the issue of foremost interest from the Austrian point of view, since such accidents can potentially lead to adverse effects on Austrian territory.

According to the Government Decree (733/2008)[5] on the Safety of Nuclear Power Plants, mentioned in the EIA program, postulated accidents are divided into the following categories:

- Accidents of Class 1: Postulated accidents with expected frequency of occurrence below 1E-2/a. Annual radiation dose limit for the most exposed person is 1 mSv.
- Accidents of Class 2: Postulated accidents with expected frequency of occurrence below 1E-3/a. Annual radiation dose limit for the most exposed person is 5 mSv.
- Accident caused by a rare external event or a situation where the initiating event of an anticipated operational occurrence or Class 1 postulated accident involves a common-cause failure in safety systems, or a complex combination of failures, in which the facility is required to withstand without severe fuel damage. In this case, the maximum radiation dose permitted for the most exposed individual is 20 mSv.

According to the Regulatory Guide on Nuclear Safety YVL 2.8, the probability for core damage shall be less than 1E-5/a. The probability for a core damage accident exceeding the limit of 100 TBq Cs-137 shall be less than 5E-7/a.

[5] This Decree entered into force on 1 December 2008 and repealed the Decision of the Council of State on the general regulations for the safety of nuclear power plants, issued on 14 February 1991 (395/1991).

An accident with a release of not more than 100 TBq Cs-137, which will be the most severe accident in the updated EIA report (and which was also the most severe accident assessed in the 2008 EIA report), does not constitute a worst-case scenario.[6]

Severe accidents with releases considerably higher than the limit of 100 TBq Cs-137 cannot be excluded for the AES-2006, even if their calculated probability is required to be less than 5E-7/a.

Moreover, for rare events the probability of occurrence as calculated by a Probabilistic Safety Analysis (PSA) should not be taken as face value, but as an indicative number only. The inherent limitations of PSA should not be forgotten – such analyses are beset with considerable uncertainties, and some risk factors are difficult to include in a PSA (UMWELTBUNDESAMT 2009a).

Only results of detailed safety assessments for the reactor would permit to exclude a larger source term – in case it can be proven beyond doubt that such a larger source term cannot occur. Such safety assessments, however, are not yet available for the AES-2006.

The Austrian expert statement to the 2008 EIA report concluded that the information contained in the EIA report did not permit a meaningful assessment of the effects of conceivable accidents at the new Fennovoima NPP on Austrian territory. The analysis of a severe accident scenario which is at least approaching a true worst-case would close this gap and allow a discussion of potential effects on Austria (UMWELTBUNDESAMT 2008).

There is no convincing reason why such severe accidents should not be addressed in the (updated) EIA report; quite to the contrary, it would appear rather evident that they should be included in the assessment since their effects can be widespread and long-lasting and even countries not directly bordering Finland, like Austria, can be affected.

The maximal source term is plant type specific, therefore it is recommended that the updated EIA report should present the maximum release in case of a severe accident and more detailed information on the design and safety features of the AES-2006. 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 and a description of the severe accident sequences envisaged.

To evaluate possible transboundary effects, the Austrian experts used a source term (25,000 TBq of Cs-137) that corresponds to about 5% of the EPR[7] core inventory. The Austrian experts pointed out that even this source term does not constitute the maximum conceivable release. Other accident scenarios (failure of reactor pressure vessel at high pressure or containment bypass via uncovered steam generator tube leakage) can lead to caesium releases of more than 50% of the core inventory (UMWELTBUNDESAMT 2008).

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[6] The release of iodine-131 was estimated to be 1,000 TBq.

[7] European pressurised reactor, which is a Generation III pressurised water reactor

During the bilateral consultation in Helsinki on 28 January 2009, Fennovoima strongly rejected the notion that a source term of 5% Cs-137 inventory, as considered by the Austrian side, would be "realistic" for its plant, due to advanced safety features of the design. Fennovoima argued that even the source term of 100 TBq is an overestimation of the worst case. Fennovoima estimated a probability of less than 5E-9/a for a release of 10,000 TBq Cs-137 (UMWELTBUNDESAMT 2009a).

However, Fennovoima did not deny that according to the present state of knowledge, the probability for a large release could be higher than its own estimate. In any case, Fennovoima was confident that because of technical improvements – for example, counter-measures against containment bypass sequences – in the end they would reach their goal (probability below 5E-9/a for a 10,000 TBq Cs-137 release).

The Austrian side pointed out that published results of current safety studies did not support Fennovoima's claim of a probability below 5E-9/a for a large release. Fennovoima's statement could only be taken as a statement of intent to reach such a low probability. From today's state of knowledge, it remains open whether this can indeed be achieved.

The summarised discussion was related to the plant alternatives, which were under consideration in the 2008 EIA report. However, the statement of Austrian´s experts is also true in regard to the AES-2006 design: A large release exceeding the limit of 100 TBq Cs-137 could not be excluded for the AES-2006. Moreover, from today´s state of knowledge, it remains open whether this can indeed be achieved. This statement is underlined by a recently published report.

In 2012, the Norwegian Radiation Protection Authority published a report concerning the potential consequences in Norway after a hypothetical accident at the nuclear power plant Leningrad II (Russia). The calculation was based on a catastrophic release of VVER-1200$_I$ (AES-2006), i.e. the most severe radiological consequences that could occur as a result of a 'credible' accident scenario in a nuclear power plant of the newest design.

The definition of the release categories and the associated source term data were based on simulations conducted as a part of Level 2 PSA for a VVER-1000/V320 plant. The radionuclide inventory of the core was based on Russian data derived for the original Soviet fuel. The source term was calculated to 2,800 TBq Cs-137 (STATENS 2012). This source term is considerably higher compared to those proposed to be used in the Fennovoima´s 2008 EIA report to calculate transboundary impacts.

Assessment of Transboundary Impact

According to the EIA program, the assessment of transboundary impacts will be based on the assessments presented in the 2008 EIA report.

In the 2008 EIA report, "typical" and "unfavourable" weather conditions were distinguished for the dispersion calculation. Details of these weather conditions were only given with respect to precipitation. Thus, it was not possible to see whether really worst-case meteorological conditions were applied. However, this information as well as further information concerning the dispersion calculations was provided during the bilateral consultation in Helsinki on 28 January, 2009.[8]

For "typical" weather conditions, a Cs-137 deposition of 0.28 kBq/m² was given at the distance of 1,000 km (UMWELTBUNDESAMT 2008). The calculated Cs-137 deposition at the same distance for "unfavourable" weather conditions is about 1.3 kBq/m² (UMWELTBUNDESAMT 2010).

Consequences in other distances, e.g. at 1,500 km, were not provided. It was explained during the bilateral consultation that for long-range transport effects only one point in the distance of 1,000 km was assumed, which is (according to the EIA program) intended to be the same as in the updated EIA report.

It is recommended that the EIA report should present the parameters used for the dispersion calculation and all respective results (in particular including unfavourable weather condition) as well as results at different large distances.

After the evaluation of the provided information, the Austrian experts concluded: the questions concerning the dispersion calculation were answered comprehensively and sufficiently. The use of the model for assessment of transboundary impacts with unfavourable weather conditions as a worst-case is an acceptable approach. But the 2008 EIA report suffers from the fact that the "worst-case" with respect to the emission is rather arbitrarily taken as 100 TBq Cs-137 (UMWELTBUNDESAMT 2010).

Austrian Analyses of Transboundary Impacts

In the framework of the evaluation of the Fennovoima´s 2008 EIA report, Austrian experts analysed the possible transboundary impacts after a severe accident in a nuclear power plant at the Hanhikivi site. The scenario with the most negative consequences for Austria was described as follows: The central part of the country would be contaminated with more than 40 kBq/m² and the whole area to the east of the line Salzburg – Klagenfurt would be contaminated with more than 10 kBq/m² (UMWELTBUNDESAMT 2008). Source term for this calculation was – as mentioned above – 25,000 TBq Cs-137.

The results show that, even if the source term is smaller by one magnitude (as used in the calculation of the Norwegian Radiation Protection Authority) the calculated contaminations (1–4 kBq/m²) are above the threshold that triggered agricultural intervention measures in Austria.

If a contamination of ground beyond a certain threshold can be expected in Austria, a set of agricultural intervention measures is triggered. These measures include earlier harvesting, closing of greenhouses and covering of plants, putting livestock in stables etc. For these measures, Austrian and Ger-

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[8] The following information was given: Short range up to 20 km (Gaussian model); Wind speed (10 m): 2 m/s, Stability class: D; Mixing height: 800 m; Rain: 0.5 mm/h; Long range from 20 km on (Gaussian Puff Model), Wind speed (10 m): 2 m/s; Diffusion coefficient: 6,000 m²/s; Mixing height: 200 m (stable conditions); Rain: 0.5 mm/h.

man authorities defined a threshold for caesium-137 ground deposition of 0.650 kBq/m². These agricultural measures are quite complex and take some time (FLEXRISK 2013; SKKM 2010; SSK 2008).

In the framework of the evaluation of the Fennovoima´s 2008 EIA program, Austrian experts mentioned a study performed in 2004. The study on behalf of the Austrian Federal Ministry of Agriculture and Forestry, Environment and Water Management analysed the probability of weather conditions in Europe that emissions due to severe accidents at NPPs could affect Austrian territory to an extent that would require radiation protection measures. The calculated risk of a release from a Finnish NPP causes a significant impact to Austria is in the range of 1–5 percent (OEOEI 2008).

Although the probability of such weather situations is small, an impact on Austria due to a severe accident at a Finnish nuclear power plant cannot be excluded. The source term of 67,500 TBq Cs-137 was used, which was assumed to be a large release due to a severe accident at a 1,000 MW_e pressurised water reactor.

Additionally, calculations of the recently published FlexRISK project can be used for the estimation of possible impacts of a severe accident at the proposed nuclear power plant Hanhikivi 1 (FLEXRISK 2013). Using source terms and accident frequencies as input[9], for each reactor an accident scenario with a large release of nuclear material was selected.

The accident scenarios are core melt accidents with containment bypass or containment failure. Using the Lagrangian particle dispersion model FLEXPART, both radionuclide concentrations in the air and their deposition on the ground were calculated and visualised in graphs. The total caesium-137 deposition per square-meter (Cs-137 Bq/m²) is used as the contamination indicator.

To estimate the Cs-137 deposition after a severe accident at the Hanhikivi site, a source term of 54,460 TBq Cs-137 is used. This source term was evaluated for a severe accident[10] in an AES-2006 reactor.[11] The results of this estimation are as follows:

For several weather conditions that correspond to nine of 88 real weather situations[12] in 1995, the resulting Cs-137 deposition in Austria is above 1 kBq/m². These values are higher than the threshold that triggered agricultural intervention measures, i.e. Austria would be affected. The maximal value of the Cs-137 deposition is 30 kBq/m².

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[9] Data was collected from plant-specific probabilistic safety analyses (PSA), report of the International Atomic Energy Agency (IAEA), publications in journals, etc.

[10] STGR=steam generator tube rupture

[11] In the flexRISK project, it was assumed that an EPR is in operation at the Hanhikivi site, thus the results were converted.

[12] 1 January; 9 April, 7 May, 11 May, 21 June, 28 July, 29 August, 2 November, 27 November

4.3 Conclusions

Severe accidents with releases considerably higher than 100 TBq Cs-137 cannot be excluded for the AES-2006, even if their probability is below 5E-7/a. Although PSA results are of considerable value for the orientation of designers and regulators, such analyses are beset with considerable uncertainties, and some risk factors are difficult to include in a PSA.

Therefore, for rare events the probability of occurrence as calculated by a PSA should not be taken as face value, but as an indicative number only. Only results of detailed safety assessments for the reactor would permit to exclude a larger source term – in case it can be proven beyond doubt that such a larger source term cannot occur. Such safety assessments, however, are not yet available for the AES-2006 reactor.

Rough calculation of a severe accidents in the AES-2006 at the Hanhikivi site with source terms evaluated in framework of the flexRISK project (54,460 TBq Cs-137) and on behalf of the Norwegian Radiation Protection Authority (2,800 TBq Cs-137) show possible consequences in Austria, while with the release of 100 TBq Cs-137 such consequences would not be expected.

It is recommended to include a conservative worst case release scenario in the updated EIA report, in addition to the limited release scenario according to Finnish regulation, since their effects can be widespread and long-lasting and even countries not directly bordering Finland, like Austria, can be affected.

5 RADIOACTIVE WASTE MANAGEMENT

5.1 Treatment in the EIA Program

In addition to the nuclear power plant, the project comprises the storage of spent nuclear fuel at the site area, the handling of low and medium-level operating waste, storage and disposal, as well as the dismantling of the nuclear power plant, and handling and disposal of dismantling waste (FENNOVOIMA 2013, p.31).

In chapter 7.4.3 of the EIA program it is stated that the quantities of spent nuclear fuel and operating waste generated in an approximately 1,200 MW_e nuclear power plant currently being assessed will be smaller than those generated in an approximately 1,800 MW_e nuclear power plant. Thus, the impacts can preliminarily be estimated as being at the most of the same magnitude as the impacts assessed in the 2008 EIA (FENNOVOIMA 2013, p.60).

Management of Operating Waste

Low- and medium-level operating waste will be disposed in the final repository for operating waste. The repository will be constructed in the bedrock of the power plant site, and the construction was approved of by the Council of State in Finland by the Decision-in-Principle granted on 6 May 2010 (FENNOVOIMA 2013, p.37).

In the solidification plant to be built adjacent to the nuclear power plant, wet medium-level waste shall be dried or solidified into e.g. concrete and disposed of in the operating waste repository (FENNOVOIMA 2013, p.37).

Very low-level operating waste can be disposed of in a repository to be built separately in the ground, from which they can later be released from supervision once the radioactivity has been reduced to an adequately low level (FENNOVOIMA 2013, p.37).

To assess the impacts of waste and their treatment, the EIA report will describe the quantities, qualities and treatment methods for waste, as well as present the related environmental impacts on the basis of assessment presented in the 2008 EIA, and additional studies, when necessary (FENNOVOIMA 2013, p.60).

Decommissioning Waste

The environmental impacts of the decommissioning of a nuclear power plant will in due course be assessed in a separate EIA procedure. However, in order to present an overall picture of the lifecycle of a nuclear power plant, the EIA report will describe, on a general scale, the various stages of decommissioning and their duration, waste to be generated and waste treatment methods, as well as impact relating thereto. According to a preliminary estimate, the impact of the decommissioning of the 1,200 MW_e nuclear power plant will not differ significantly from the impacts presented in the 2008 EIA (FENNOVOIMA 2013, p.62/63).

Interim Storage of Spent Nuclear Fuel

After removing fuel from the reactor, the spent fuel will be stored in the intermediate storage for spent fuel to be built next to the power plant (FENNOVOIMA 2013, p.37).

The regional land use plan for a nuclear power plant in Hanhikivi does not allow disposal of spent nuclear fuel in the Hanhikivi region, thus the spent nuclear fuel can be only temporarily stored in the area until it can be transported to the final disposal site (FENNOVOIMA 2013, p.44).

The quantity of the spent fuel (approximately 1,200–2,400 tons, during the entire operating time of the plant) and the interim storage time (approximately 20 to 40 years) are only estimated imprecisely (FENNOVOIMA 2013, p.40, 44).

Moreover, the type of intermediate storage is not chosen yet: The intermediate storage can either be a dry storage or water pool storage. In the dry storage, spent fuel will be stored in capsules that have been designed for this particular use and that are cooled down passively by utilising the circulation of air. The water pool storage consists of approximately 15 metre-deep water pools where water acts as a radiation shield and cools down the spent fuel (FENNOVOIMA 2013, p.37).

Final Disposal of Spent Nuclear Fuel

According to the Nuclear Energy Act, nuclear waste shall be handled, stored and disposed of in a permanent manner in Finland. The producer of nuclear waste shall be responsible for the management of the spent fuel that it has generated until the disposal facilities are sealed. In order to cover the expenses, a preparation charge is added to the price of nuclear electricity (FENNOVOIMA 2013, p.37).

The Decision-in-Principle of 2010 requires that Fennovoima shall at the latest on 30 June 2016, present to the Ministry of Employment and the Economy (MEE) either an agreement on the cooperation on nuclear waste disposal or an environmental impact assessment program relating to Fennovoima's own spent nuclear fuel disposal plant. In addition to this, the final report of the MEE specifies that Fennovoima shall, in conjunction with the application for the construction licence, provide a specification for its disposal project that it has the necessary technological methods available for the implementation of the plans (FENNOVOIMA 2013, p.21).

According to the EIA program, Fennovoima's primary plan is to join the final disposal of spent fuel, which is in the responsibility of the Posiva Oy (FENNOVOIMA 2013, p.21).

In 2012, the MEE set up a task force to guide the joint study of the power companies on the alternatives for the disposal of spent nuclear fuel. In January 2013, the Ministry published the final report of the task force. In the opinion of Fennovoima, the most essential recommendation of the end report was that it is purposeful and cost-efficient in the disposal to aim at an optimised solution and to utilise the knowhow and experiences evolved in the industry through the Posiva project (FENNOVOIMA 2013, p.21).

5.2 Discussion

The Austrian expert statement on the 2008 EIA report concluded: Radioactive waste management is presented in the EIA report in a very general manner. Different technological options for interim storage, final disposal of spent fuel and high and intermediate level radioactive waste are described, but without concrete decisions on technology and location of the facilities. It appears that Fennovoima has not yet developed a comprehensive nuclear waste management strategy.

On the basis of the information regarding waste management provided by the EIA program it has to be supposed that Fennovoima has not yet developed a comprehensive nuclear waste management strategy.

According to the 2008 EIA report, Fennovoima is planning to dispose its medium and low-level operating waste in underground repositories which are either of the rock cave type (preliminary storage capacity: 29,000 m^3) or of the rock silo type (preliminary storage capacity: 43,000 m^3). Fennovoima should give details about the site of the final repository of low and medium-level waste and its depth. Information about the geological suitability of the considered sites for the storage should be provided as well.

The 2008 EIA report specified neither which alternative of interim storage of spent fuel the company intends to use nor the planned duration of the storage (UMWELTBUNDESAMT 2008). The EIA program indicates that both of these will not be specified in the updated EIA report.

However, the choice of interim storage is essential for assessing national and international aspects of security. The risk of wet storage facilities compared to dry storage facilities is much higher. Generally, a severe accident in a wet spent fuel storage facility at the Hanhikivi site could affect Austrian territory.

Among other issues, the enhanced vulnerability of wet storage facilities to terrorist attacks has been criticized by the IAEA (2007): An attack that partially or completely drained a spent fuel pool could lead to a propagating zirconium cladding fire and to the release of large quantities of radioactive materials to the environment.

Loss of coolant and a subsequent fire can also occur accidentally, either due to earthquakes of very large magnitude or the drop of spent fuel casks – although the probability of this kind of accident is considered to be very low. In addition, the source term in case of a severe accident is higher for wet storage – as it stores a large inventory of radioactivity under a relatively vulnerable shielding (UMWELTBUNDESAMT 2008).

The assumed storage time of 20–40 years for the spent fuel in the interim storage facility seems to be too short considering the fact that probably Fennovoima has to develop its own final disposal of spent fuel.

In Finland, a final disposal of spent fuel is planned by Posiva Oy, which was set up in 1995 as a joint venture company of TVO (60%) and Fortum (40%). Its plans do not include accommodation for spent fuel from Fennovoima's nuclear power plant, and Posiva, TVO and Fortum have routinely said they will not accept Fennovoima as a partner (WNA 2013).

Early in 2012, the government threatened to use its legal authority under the Nuclear Energy Act if necessary to ensure that Fennovoima fuel would be included, but when this did not break the impasse they set up a working group to make recommendations.

The Ministry of Employment and the Economy (MEE) has urged Posiva to co-operate with Fennovoima to investigate the potential for expanding the repository to host spent fuel from the planned Hanhikivi nuclear power plant. However, a MEE working group said that the exact capacity in Olkiluoto for spent nuclear fuel final disposal would take decades to become clear. It said that extending the Olkiluoto final disposal facility to accommodate Fennovoima's nuclear waste (some 3,000 tonnes of uranium) would require derogation from Posiva's current research and operational principles, and stressed that surveys regarding possible expansion must not endanger the safety and operational preconditions of the current project (NEI 2013).

According to the working group's final report in January 2013, mentioned in the EIA program, Posiva and Fennovoima's Hanhikivi should continue negotiations to find a solution for final storage of spent fuel that takes advantage of Posiva's experience (WNA 2013).

In December 2012, however, Posiva applied for a construction licence for the final repository for 9,000 tons of spent fuel and the encapsulation plant.[13] The Olkiluoto repository will be used for disposal of fuel from Finland's four existing plants (Olkiluoto 1&2 and Loviisa 1&2) as well as Olkiluoto 3 and 4. Posiva claims that it will have no space in the planned repository for fuel from Fennovoima (WNA 2013).

In the 2008 EIA report, Fennovoima did not clarify whether they intend to use Posiva's final disposal. During the bilateral consultation in Helsinki (2009), Fennovoima clarified that they definitely would prefer an agreement with Posiva. But the response of Posiva was negative so far. Fennovoima added that preparing an alternative final disposal site would violate the spirit and letter of previous Government decisions aiming at one final disposal facility for all spent fuel generated in Finland (UMWELTBUNDESAMT 2010). However, today it seems that Fennovoima is forced to develop its own final disposal of spent fuel.

In January 2013, Fennovoima stated that it will continue the preparation of an environmental impact assessment program of its own nuclear waste final disposal solution, which will present a number of alternative final disposal sites (NEI 2013). Geological final disposal is considered the safest long-term method of storing high level radioactive waste and spent fuel at present. However, no country worldwide is yet operating such a geological repository. Thus, it is an ambitious task of Fennovoima to develop such a final disposal in a relatively short time frame.

[13] The concepts of the final disposal will be based on the multi-barrier KBS-3 system, developed by the Swedish Nuclear Fuel and Waste Management Company (SKB). Encapsulation will involve putting 12 fuel assemblies into a boron steel canister and enclosing this in a copper capsule. Each capsule will be placed in its own hole in the repository and backfilled with bentonite clay. The spent fuel will be retrievable at every stage of the disposal process.

5.3 Conclusions

On the basis of the information regarding waste management provided by the EIA program it has to be supposed that Fennovoima has not yet developed a comprehensive nuclear waste management strategy.

For the demonstration of a proper waste management and to evaluate the possible risk due to a possible accident at the interim storage facility, it is recommended that in the updated EIA report Fennovoima should declare the planned type of interim storage, its capacity and the schedule of the construction works. The intended duration of interim storage should also be clarified.

In this regard a decision about the final disposal strategy of spent fuel is of interest from the Austrian point of view. In particular, in case it is intended to construct an own final disposal by Fennovoima, a time schedule as well as information on the sites envisaged and its timely availability should be provided in the EIA report. This additional information has to be seen to be able to estimate the required duration of interim storage and the subsequent security aspects, and to assess whether the planned sites fulfils the geological requirements.

6 RECOMMENDATIONS

Description of the Project

- It is recommended to include into the EIA report an explanation and justification for the new choice of the reactor type, in particular in regard of safety aspects.
- It is recommended to include into the EIA report a comprehensive comparison of all electricity production technologies and the options of saving energy, efficiency enhancement and demand side management. The EIA report should also include information on the cost structure of the project and the technological alternatives.
- It is recommended to include into the updated EIA report a comprehensive justification of the need to construct another new nuclear power plant.
- It is recommended to provide a comprehensive site evaluation that reflects the international efforts, in particular in the frame of EU stress tests, to enhance the safety margins of nuclear power plants against natural hazards.

Description of the Procedure

- It is recommended to include into the updated EIA report safety analyses and a plant-specific severe accident scenario of the AES-2006.
- It is recommended, in order to follow the ongoing procedures during later stages of decision making and licensing, that information concerning accident analyses, severe accidents and PSA results should be made available to the Austrian side.

Discussion of the Reactor Type

- It is recommended to explain which variant of reactor type of the AES-2006 is chosen as well as the reason for this choice.
- It is recommended to include into the EIA report a detailed description of the new passive safety systems including their limitations.
- It is recommended to describe the corium localization device (core catcher) in the EIA report in detail. The proof of functioning of this device (test, computer simulations), including the prevention of steam explosions, shall be presented.
- To gain a comprehensive picture of the functioning and reliability of safety systems of the AES-2006 design, a detailed description of those systems in the updated EIA report is recommended.
- It is also recommended to describe which parts of the design objectives and principles of the AES-2006 are not consistent with the Finnish safety requirements and/or with the WENRA´s Safety Objectives for New Nuclear Power Plants.

Accident Analysis

- The maximal source term is plant type specific, therefore it is recommended that the updated EIA report should present the maximum release in case of a severe accident and more detailed information on the design and safety features of the AES-2006. 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 and a description of the severe accident sequences envisaged.
- It is recommended that the EIA report should present the parameters used for the dispersion calculation and all respective results (in particular including unfavourable weather condition) as well as results at different large distances.
- It is recommended to include a conservative worst case release scenario in the updated EIA report, in addition to the limited release scenario according to Finnish regulation, since their effects can be widespread and long-lasting and even countries not directly bordering Finland, like Austria, can be affected.

Radioactive Waste Management

- For the demonstration of a proper waste management and to evaluate the possible risk due to a possible accident at the interim storage facility, it is recommended that in the updated EIA report Fennovoima should declare the planned type of interim storage, its capacity and the schedule of the construction works. The intended duration of interim storage should also be clarified.

7 GLOSSARY

ABWR................Advanced Boiling Water Reactor

AES ....English: NPP (nuclear power plant)

ASE ....Atomstroyexport

CO_2 ....Carbone Dioxide

Cs-137...............Caesium 137

EIA......................Environmental Impact Assessment

EPR ....European Pressurized Water Reactor

FlexRISK ....Flexible Tools for Assessment of Nuclear Risk in Europe

Fortum ....Fortum Heat and Power Oy

HA-1 ....Hydraulic Accumulator 1

HA-2 ....Hydraulic Accumulator 2

I&C ....Instrumentation and Control

IAEA ....International Atomic Energy Agency

INES ....International Nuclear and Radiological Event Scale

MEE....................Ministry of Employment and the Economy (former MTI)

mSv ....Milli-Sievert

MWe ....Megawatt electric

NPP ....Nuclear Power Plant

PHRS C..............Passive Heat Removal System Containment

PHRS SG ....Passive Heat Removal System Steam Generator

PHRS ....Passive Heat Removal System

PSA ....Probabilistic Safety Analysis

PWR...................Pressurized Water Reactor

RHWG................Reactor Harmonization Working Group

SKB ....Swedish Nuclear Fuel and Waste Management Company

STGR ....Steam Generator Tube Rupture

STUK..................Finnish Radiation and Nuclear Safety Authority

TBq ....Tera Becquerel

TVO ....Teollisuuden Voima Oy

VVER..................Voda Voda Energg Reactor

WENRA ....Western European Nuclear Regulator’s Association

YVL.....................Regulatory Guide on Nuclear Safety

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9 ANNEX 1

Table 2: Summary of the preliminary assessment and assessment methods (FENNOVOIMA 2013, p.58)

Impact	**Preliminary assessment on the environmental impacts of an approximately 1200 MW_e plant compared to the 1800 MW_e plant presented in the EIA of 2008**	**Assessment methods**
Impacts during construction	There are no significant differences in the impacts, since both the construction work and the duration and extent of construction are similar to those of a plant with a higher electrical power.	Assessment based on the assessments presented in the EIA of 2008 and the present data.
Impacts on air quality and climate	Radioactive emissions in normal conditions are similar, and the radiation dosages caused by them are of the same magnitude. Other emissions to air and their impacts are of the same magnitude.	Assessment based on the assessment performed in the EIA of 2008 and the present emission data.
Impacts on water systems	Radioactive emissions in normal conditions are similar, and the radiation dosages caused by them are of the same magnitude. The quantities of cooling and wastewaters are smaller, the impact less than in the previous assessment.	The impacts of the cooling waters are assessed by modelling the dispersion of the thermal load to be directed to the water system. In addition to the modelling, the assessment is based on the assessments performed in the EIA of 2008 and the updated present-state assessment on the water systems, as well as new emission data.
Impacts of waste and its treatment	The quantity of spent nuclear fuel and operating waste is smaller, in which case the impacts are at most of the same magnitude. There are no significant differences in the quantity of other waste, in which case the impacts are of the same magnitude.	Assessment based on the assessments presented in the EIA of 2008 and the present data, as well as additional assessments when necessary.
Impacts on soil, bedrock and groundwater	The extent and dimensions of construction and structures are of the same size or smaller, in which case the impacts are at most of the same magnitude.	Assessment based on the assessments presented in the EIA of 2008 and on the present- state assessments performed after it.
Impacts on vegetation, animals and conservation areas	There are no significant differences in the impacts, since emissions, noise, traffic and thermal load to be directed to the water systems, as well as other factors with a possible impact on nature are smaller or of the same magnitude.	Assessment based on the assessments presented in the EIA of 2008 and on the present- state assessments of nature performed after it.
Impacts on land use, structures and landscape	There are no differences in the impacts, since the extent and dimensions of construction and structures are of the same size or smaller.	Assessment based on the assessments presented in the EIA of 2008.
Impacts on traffic	There are no significant differences in the impacts, since the necessary transports for materials and personnel are of the same magnitude.	Assessment based on the assessments presented in the EIA of 2008 and on the necessary updated.
Noise impacts	The sources and magnitude of noise are similar, so there are no significant differences in the impacts.	Assessment based on the assessments presented in the EIA of 2008.
Impacts of abnormal and accident situations	There are no differences in the impacts, since the requirements by the authorities that are to be set as the maximum sanction for the various plants due to these situations are the same.	Assessment based on the EIA of 2008 and on the additional assessments of the Decision-in-Principle.

Impact	Preliminary assessment on the environmental impacts of an approximately 1200 MW_e plant compared to the 1800 MW_e plant presented in the EIA of 2008	Assessment methods
Transboundary environmental impacts across the borders of Finland	According to the preliminary estimate, the impacts of radioactive emissions generated only by a serious nuclear power plant accident could have an impact outside of the borders of Finland.	Assessment based on the assessments presented in the EIA of 2008. Impacts exceeding the borders of the state of Finland are assessed also in conjunction with the international hearing in accordance with the Espoo Convention.
Impacts on people and society	There is no difference with regard to the adverse impacts to wellbeing and health, since the emissions, noise, traffic and other factors with a possible impact on humans are either smaller or of the same magnitude. There are no significant differences in the impacts on regional economy and structure, or on employment.	Assessment based on the assessments presented in the EIA of 2008 and on the assessments performed after it, as well as on a new resident inquiry, when necessary.
Impacts on energy markets	A new nuclear power plant will reduce Finland's dependency on the import of electricity and increase the supply on the electricity markets.	Assessment based on the assessments presented in the EIA of 2008.
Impacts of power plant decommissioning	There is no significant difference in impacts, since, among others, the structures, methods of dismantling and the quantities of waste are of a similar nature.	Assessment based on what was presented in the EIA of 2008.
Impacts of nuclear fuel production	In general terms, the impacts are the same.	Assessment based on the data presented in the EIA of 2008 and on updated dated as far as deviating from the EIA of 2008.
Impacts of associated projects	Associated projects, such as the construction and utilisation of transport connections and access power transmission lines are the same, in which case the impacts will also be of the same magnitude. Due to the lower power, the needs for strengthening the power transmission network will be smaller.	Assessment based on the assessments presented in the EIA of 2008.