Comments on the "Application for a Construction License pursuant to Section 18 of the Nuclear Energy Act (990/1987) for the Hanhikivi 1 Nuclear Power Plant"

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Construction of Leningrad Nuclear Power Plant (VVER-1200)
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ISR
Institut für Sicherheits- und Risikowissenschaften

K. Gufler
N. Arnold
S. Sholly
N. Müllner

Prepared for Greenpeace Finland

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1. Introduction

The applicant – Fennovoima Oy – issued an “Application of Construction License” (ACL) for the Hanhikivi 1 Nuclear Power Plant planned to be built on the Hanhikivi headland, Pyhäjoki. The plant type it Rosatom’s AES 2006, with a thermal power of 3220 MW and an electrical output of 1200 MW.

In the document „Application for a Construction License pursuant to Section 18 of the Nuclear Energy Act (990/1987) for the Hanhikivi 1 Nuclear Power Plant” Fennovoima aims to outline that it fulfills the prerequisites for granting a construction license pursuant Section 18 Paragraph 2 of the Nuclear Energy Act. Section 19 of the Nuclear Energy Act defines the prerequisites for the granting of the construction license.

The Nuclear Energy Act, Section 19 – Construction of other nuclear facilities is used by the authors as benchmark to check in a first step the completeness of the document. The Nuclear Energy Decree (161/1988) Section 32 Licensing is taken as basis by the applicant to elaborate the Construction License Application. It is the basis for the data and information to be provided by the applicant.

The ACL has a brief main body, which is supplemented with five appendices. The main body is a short document in which the applicant claims that the prerequisites for granting a construction license are fulfilled and refers to the appendices. The relevant information and data are described in the appendices.

Structure of the analyses:

This review document is structured alongside the chapters / appendices of the ACL to guarantee a comprehensible content. For every chapter some general information on the topic is provided. Then the relevant legal requirements are presented and the chapters of the application are compared to the legal requirements. Questions and remarks are then stated in a separate section for every annex.

1.1.A Name and Number of the Appendix

1.1.A.1 General Information

Provides general Information on the topic. If otherwise unclear, information taken for the ACL is indicated by the heading "Information from the ACL", further information by "Additional information".

1.1.A.2 Requirements

Description of the relevant legal requirements

1.1.A.3 Open questions / remarks

Number of the question remark	
Topic	Name of the Topic
Background	Background information on the topic, and or basis for the question/ remark
Question(s)/ Remarks	Question(s) and Remarks

2. Requirements

2.1. Nuclear Energy Act, Section 18 - Construction of a nuclear facility having considerable general significance

"A license to construct a nuclear facility referred to in section 11 may be granted:

1) if a decision-in-principle referred to in section 11 has deemed the construction of a nuclear facility to be in line with the overall good of society, and Parliament has decided that the decision-in-principle remains in force; and

2) if the construction of a nuclear facility also meets the prerequisites for granting a construction license for a nuclear facility as provided in section 19."

2.2. Nuclear Energy Act, Section 19 – Construction of other nuclear facilities

"A license for the construction of a nuclear facility other than that referred to in section 18 can be granted:

1) if plans concerning the nuclear facility meet the safety requirements laid down in this Act, and appropriate account has been taken of the safety of workers and the population when planning the operations in question;

(2) if the location of the nuclear facility is appropriate with respect to the safety of the planned operations and environmental protection has been taken into account appropriately when planning operations;

(3) if physical protection has been taken into account appropriately when planning operations;

4) if a site has been reserved for the construction of a nuclear facility in a local detailed plan in accordance with the Land Use and Building Act (132/1999), and the applicant is in possession of the site required for the operation of the facility;

(5) if the methods available to the applicant for arranging nuclear waste management, including the final disposal of nuclear waste and the decommissioning of the facility, are sufficient and appropriate;

(6) if the applicant's plans for arranging nuclear fuel management are sufficient and appropriate;

(7) if the applicant's arrangements for the implementation of control by the Radiation and Nuclear Safety Authority (STUK) as referred to in paragraph 3 of section 63(1), in Finland and abroad, and for the implementation of control, as referred to in paragraph 4 of section 63(1), are sufficient;

(8) if the applicant has the necessary expertise available;

(9) if the applicant has sufficient financial prerequisites to implement the project and carry on operations; further

(10) if the applicant is otherwise considered to have the prerequisites to engage in operations safely and in accordance with Finland's international contractual obligations;

and the planned nuclear facility otherwise fulfils the principles laid down in sections 5–7."

Nuclear Energy Act, Sections 5 to 7

- Section 5 - Overall good of society
- Section 6 – Safety
    - Section 6 a – Management of nuclear waste generated in Finland
    - Section 6 b - Provisions concerning nuclear waste not generated in Finland
- Section 7 - Physical protection and emergency planning and other comparable arrangements
    - Section 7 a – Guiding principles
    - Section 7 b – Safety principle of defense-in-depth
    - Section 7 c – Maximum values for radiation exposure
    - Section 7 d – Preparation for operational occurrences and accidents
    - Section 7 e – Verification and assessment of safety
    - Section 7 f – Construction and operation
    - Section 7 g – Decommissioning
    - Section 7 h – Nuclear material and nuclear waste
    - Section 7 i – Personnel
    - Section 7 j – Management system
    - Section 7 k – Responsible Manager
    - Section 7 l – Arrangements for security
    - Section 7 m – Security control
    - Section 7 n – Preparation for prevention of unlawful action
    - Section 7 o – Use of forcible means
    - Section 7 p – Emergency response arrangements
    - Section 7 q – General safety provisions
    - Section 7 r – Detailed safety requirements

2.3. Nuclear Energy Decree (161/1988) Section 32

"The application for a construction license shall be supplemented with the information about the applicant mentioned in paragraphs 1 and 2 of section 24 subsection 1 or in section 24 subsection 2, and with: (473/1996)

1) proof of the applicant's right to use the site planned for the nuclear facility;

2) a description of settlement and other activities and planning arrangements at the planned nuclear facility site and in its immediate vicinity;

3) a description of the type of the nuclear facility to be constructed, and the planned suppliers of the essential parts;

4) a description of the quality and maximum amounts of the nuclear materials or nuclear waste that will be fabricated, produced, handled, used or stored at the nuclear facility;

5) an outline of the technical operating principles and features and other arrangements which are used to ensure the safety of the nuclear facility;

6) a description of the safety principles that the applicant intends to observe, and an evaluation of the fulfilment of the principles;

7) a description of the effects of the nuclear facility on the environment and a description of the design criteria that will be observed by the applicant to avoid environmental damage and to restrict the burden on the environment;

8) an outline of the operating organization planned for the nuclear facility;

9) a description of the applicant's plans for arranging nuclear fuel management;

10) a description of the applicant's plans and available methods for arranging nuclear waste management, including the decommissioning of the nuclear facility and the disposal of nuclear waste, and a description of the timetable of nuclear waste management and its estimated costs;

11) a description of the economic viability of the nuclear facility project and its other financial prerequisites;

12) the cost estimate and financing plan of the nuclear facility project;

13) the applicant's financial statements for the last five years;

14) a description of the expertise available to the applicant and the organization implementing the construction project; and

15) any other description considered necessary by the authorities."

3. Formal completeness check

The formal completeness check was carried out in order to check if all the formal prerequisites from the Nuclear Energy Act and the Nuclear Energy Decree are included in the Construction License Application.

All the necessary topics and prerequisites were addressed, except the prerequisite according to the Nuclear Energy Decree 13, which was only discussed in Appendix 1D but the relevant information were not given.

Table 1: Formal Check Nuclear Energy Act, Section 19

Prerequisites		addressed by ACL in section
1	*safety requirements, safety of workers and the population*	3A, 4A, 4B
2	*location of the nuclear facility*	3C
3	*physical protection*	4B
4	*plan in accordance with the Land Use and Building Act*	3C
5	*nuclear waste management*	5B
6	*nuclear fuel management*	5A
7	*implementation of control by STUK*	References throughout the ACL
8	*necessary expertise available*	2A
9	*financial prerequisites*	1A, 1B, 1C, 1D
10	*prerequisites to engage in operations safely*	4A, 4B
11	*fulfils the principles laid down in sections 5–7*	4B, and some general references throughout the ACL

Table 2: Formal Check Formal Check Nuclear Energy Decree, Section 32

Prerequisites		addressed by ACL in section
1	*proof of the applicant's right to use the site planned for the nuclear facility*	3A
2	*a description of settlement and other activities and planning arrangements at the planned nuclear facility site and in its immediate vicinity*	3C
3	*a description of the type of the nuclear facility to be constructed, and the planned suppliers of the essential parts*	4A
4	*a description of the quality and maximum amounts of the nuclear materials or nuclear waste that will be fabricated, produced, handled, used or stored at the nuclear facility*	5B
5	*an outline of the technical operating principles and features and other arrangements which are used to ensure the safety of the nuclear facility*	4A

6	*a description of the safety principles that the applicant intends to observe, and an evaluation of the fulfilment of the principles*	4A, 4B
7	*a description of the effects of the nuclear facility on the environment and a description of the design criteria that will be observed by the applicant to avoid environmental damage and to restrict the burden on the environment*	3A
8	*an outline of the operating organization planned for the nuclear facility*	2B
9	*a description of the applicant's plans for arranging nuclear fuel management*	5A
10	*a description of the applicant's plans and available methods for arranging nuclear waste management, including the decommissioning of the nuclear facility and the disposal of nuclear waste, and a description of the timetable of nuclear waste management and its estimated costs*	5B
11	*a description of the economic viability of the nuclear facility project and its other financial prerequisites*	1C
12	*the cost estimate and financing plan of the nuclear facility project*	1B, 1C, 1D
13	*the applicant's financial statements for the last five years*	missing
14	*a description of the expertise available to the applicant and the organisation implementing the construction project*	2A
15	*any other description considered necessary by the authorities*	3B, 4A

4. Discussion

The Appendices for the construction license application provided by Fennovoima are discussed in this section. Each Appendix is checked according to the legal requirements, some general information are provided, and if necessary some questions and remarks are raised.

4.1. Information about Fennovoima

4.1.A. Appendix 1A: Fennovoima Ltd trade register extract, articles of association and shareholder register

4.1.A.1. General Information

Section 32 of the Nuclear Energy Decree (161/1988) requires this appendix includes the applicant's trade register extract in accordance with section 24, subsection 1, paragraph 1, and a copy of the articles of association and shareholder register in accordance with subsection 1, paragraph 2.

4.1.A.2. Requirements

Nuclear Energy Decree (161/1988) Section 32

"The application for a construction licence shall be supplemented with the information about the applicant mentioned in paragraphs 1 and 2 of section 24 subsection 1 or in section 24 subsection 2,[…]"

Nuclear Energy Decree (161/1988) Section 24 (1) paragraphs 1 and 2, or Section 24 (2)

"The application shall be supplemented with the following documents:

(1) an extract from the population register or an extract from the trade register or some other document showing that the applicant is a Finnish citizen or a Finnish corporation, foundation or a government authority;

(2) if the applicant is a company, a copy of its articles of association, partnership agreement and shareholders' register or, if the applicant is some other corporation or foundation, a copy of its rules;"

4.1.A.3. Open questions / remarks

1A.1	
Topic	Fennovoima Ltd trade register extract, articles of association and shareholder register
Background	On page 18 it is noted: *"Appendix 1A of the application submitted to the government by Fennovoima includes the following documents as required by the aforementioned Decree:* *1. Fennovoima Ltd trade register extract, issued June 26, 2015* *2. A copy of Fennovoima articles of association, issued June 26, 2015* *3. A list of Fennovoima Ltd's shareholders, issued June 30, 2015 0* *The Fennovoima Ltd trade register extract or the articles of association are not included in this publication created from the application."*
Question(s)/ Remarks	Why are the Fennovoima Ltd trade register extract and a copy of Fennovoima articles of association not included? Can they be provided?

4.1.B. Appendix 1B: Fennovoima's ownership base

4.1.B.1. General Information

In Appendix 1B Fennovoima´s ownership base is described.

4.1.B.2. Requirements

Nuclear Energy Decree (161/1988) Section 32, Paragraph 15

"The application for a construction licence shall be supplemented with […]

15) any other description considered necessary by the authorities."

Nuclear Energy Decree (161/1988) Section 24 (1) paragraphs 1 and 2, or Section 24 (2)

"The application shall be supplemented with the following documents:

(1) an extract from the population register or an extract from the trade register or some other document showing that the applicant is a Finnish citizen or a Finnish corporation, foundation or a government authority;

(2) if the applicant is a company, a copy of its articles of association, partnership agreement and shareholders' register or, if the applicant is some other corporation or foundation, a copy of its rules;"

4.1.B.3. Open questions / remarks

1B.1	
Topic	Fennovoima´s ownership base
Background	In Appendix 1B on page 23 the structure of the planned ownership base of the applicant is described. Figure 1B-1 shows the shareholders in detail. There are several companies which were recently be founded like Huoltovoima Oy, Yrittäjän Voima Oy and Hanhikiven Sähkönmyynti Oy. It is stated on page 23 that the target of at least 60% shareholders of Fennovoima from EU or EFTA is met. No detailed share distribution is given in the application.
Question(s)/ Remarks	Could you please show the detailed share distribution of the shareholders? Could you please indicate who the shareholders of the recently founded companies are?

4.1.C. Appendix 1C: Description of the financial resources and economic viability of Fennovoima's nuclear power plant project, and the project's cost estimate and financing plan

4.1.C.1. General Information

In Appendix 1C the applicant describes the financial resources and the economic viability of its nuclear power plant project and the projects costs estimate and financing plan.

4.1.C.2. Requirements

Nuclear Energy Decree (161/1988) Section 32, Paragraph 11 and 12

"The application for a construction licence shall be supplemented with […]

11) a description of the economic viability of the nuclear facility project and its other financial prerequisites;

12) the cost estimate and financing plan of the nuclear facility project;"

Nuclear Energy Act (990/1987) Section 19, Paragraph 9

"A license for the construction of a nuclear facility other than that referred to in section 18 can be granted:

(9) if the applicant has sufficient financial prerequisites to implement the project and carry on operations;"

4.1.C.3. Open questions / remarks

1C.1	
Topic	Financial resources distribution between shareholders
Background	In Appendix 1C a description of the financial resources and the economic viability of its nuclear power plant project and the projects costs estimate and financing plan is given. It is not clear how the costs will be shared between the shareholders.
Question(s)/ Remarks	Could you please give a detailed list of how the costs of the NPP project are going to be shared between the shareholders? Could you please give a detailed list of how the single shareholders will contribute to the costs, and which stakeholder needs to take loans and credits in order to provide its share?

1C.2	
Topic	Source of financing
Background	In Appendix 1C on page 28 the source of financing is described. Nevertheless the section is not detailed at all. There is some information missing regarding the loan itself, currency of the loan and the equity.

Question(s)/ Remarks	Could you please give us the information in which currency the loan will be granted? Could you please give us information on the interest rate on credits? Who will provide the described 25% equity share (EUR 1.7 billion)? Could you please indicate the share of this equity between the shareholders?

1C.3	
Topic	Costs of nuclear energy and other electricity production methods
Background	In Appendix 1C on page 29 and 30 the costs of nuclear energy and other electricity production methods were described. For this purpose a study from the IEA & NEA & OECD "Projected costs of generation electricity" from the year 2010 is used. In 2015 an updated study by the same institutions named "Projected costs of generation electricity 2015 edition" was published. The data regarding nuclear in the new study are less favorable than the data in the study from 2010. In the IEA & NEA & OECD study different discount rates were taken into account, which have a strong influence on capital intense technologies.
Question(s)/ Remarks	Why was an outdated study used as basis for the cost comparison? Please update your report by using the new study from 2015. Please include information and data when taking into account different discount rates (i.e. 10% as indicated in the "Projected costs of generation electricity 2015 edition" report)

1C.4	
Topic	The at cost price of electricity
Background	In Appendix 1C on page 30 it is stated that during the early years of operation the electricity costs are estimated to be around 50€ per megawatt-hour. Further it is stated that the price is assumed to drop in a later stage of the operation. The estimated price seems very cheap, when comparing it to other new nuclear power stations in the UK and in Turkey. But it is also stated that: *"The cost price of electricity produced in Fennovoima's nuclear power plant – referred to as the Mankala price – is comprised of the power plant's fixed and variable electricity production costs in accordance with the articles of association. The cost of equity invested by the shareholders is not included in the cost price."*
Question(s)/ Remarks	Could you please elaborate what the calculation basis for the 50€ per megawatt-hour price is? Does the price indicate only the overnight costs? As the price seems to be very low, are there any subsidies leading to this low price? Could you please present the final electricity price including all costs in order to be transparent to the public and to the investors? (including cost of equity, capital costs, construction, operation, dismantling and decommission and final storage)

1C.5	
Topic	Importance of predictability and price stability
Background	In Appendix 1C on page 31 it is stated: *"Uncertainty about electricity price trends makes it more difficult for industrial users of electricity to decide on investments in production. Profitability estimates for new investment projects with long payback periods are susceptible to electricity price trends.* *As the nuclear power plant will produce electricity at a stable and predictable cost level throughout its several decades-lasting operating phase, it will definitely do its part in improving the shareholders' potential to make investments in Finland."*
Question(s)/ Remarks	What electricity prices have been taken as benchmark? What is the upper limit of electricity costs that makes the project in a deregulated market no longer economically viable?

1C.6	**Provision for financial risks and uncertainties - Availability and terms of debt financing**
Topic	Importance of predictability and price stability
Background	In Appendix 1C on page 31 and 32 it is stated that the implementation of Hanhikivi 1 requires a significant amount of capital. In order to reduce risks associated with financing: *"Fennovoima's shareholders have agreed that JSC Rusatom Overseas, the parent company of both Fennovoima's plant supplier, RAOS Project Oy, and its minority shareholder, RAOS Voima Oy, will assume responsibility for obtaining long-term loan financing during the construction phase. However, uncertainties associated with Russia's economy may have an influence on the availability and terms of financing from Russia. Fennovoima has made contractual arrangements to provide for these risks."*
Question(s)/ Remarks	Could you please elaborate the role of RAOS Voima Oy for obtaining the long-term loan of the Russian Federation? Could you please elaborate what are the contractual arrangements by Fennovoima regarding risk management? Could you please indicate the influence of uncertainties regarding the Russian Economy? Does the applicant have other financial strategies, in case the Russian State loan could not be granted?

4.1.D. Appendix 1D: Fennovoima Ltd financial statements 2010–2014

4.1.D.1. General Information

The applicant’s financial statements of the last five years should be included in this Appendix.

4.1.D.2. Requirements

Nuclear Energy Decree (161/1988) Section 32, Paragraph 13

"The application for a construction licence shall be supplemented with […]

13) the applicant's financial statements for the last five years;

Nuclear Energy Act (990/1987) Section 19, Paragraph 9

"A licence for the construction of a nuclear facility other than that referred to in section 18 can be granted:

(9) if the applicant has sufficient financial prerequisites to implement the project and carry on operations;"

4.1.D.3. Open questions / remarks

1D.1	
Topic	Fennovoima´s financial statements
Background	The relevant financial statements of Fennovoima Ltd are mentioned in Appendix 1D, but were not included in the application (Nuclear Energy Decree (161/1988) Section 32, Paragraph 14, 13 the applicant's financial statements for the last five years)
Question(s)/ Remarks	Could you please include the financial statement of the last 5 years?

4.2. Fennovoima´s organization and available expertise

4.2.A. Appendix 2A: Description of the project implementation, the expertise available to Fennovoima, and Fennovoima organization during the licensing and construction phases

4.2.A.1. General Information

As required in the Nuclear Energy Act Section 19 paragraph 8 and in the Nuclear Energy Decree Section 32 paragraph 14 the applicant describes the available expertise in Appendix 2A.

Starting with page 48, the applicant describes its available expertise. It is divided into different sections: Nuclear safety expertise, engineering and construction expertise, quality management expertise, project management expertise and other expertise available to Fennovoima. The description of the expertise is cursory. It is pointed out several times, that expertise will be available to the applicant, without specifying the intended strategy to obtain the crucial expertise.

When it comes to the construction of the NPP, expertise seems very hard to get around the world, due to the fact that a lot of expertise was lost due to retirements in the last decade. Fennovoima has not presented any strategy how such a gap could be closed, or who will be in charge for the construction of the NPP. According to the Nuclear Energy Decree (161/1988) Section 32, Paragraph 14 a description of the expertise available to the applicant and the organisation implementing the construction project is needed. The section on the organisation implementing the construction project is missing in the application.

4.2.A.2. Requirements

Nuclear Energy Decree (161/1988) Section 32, Paragraph 14

"The application for a construction licence shall be supplemented with […]

14) a description of the expertise available to the applicant and the organisation implementing the construction project;"

Nuclear Energy Act (990/1987) Section 9

"It shall be the licensee's obligation to assure safe use of nuclear energy.

It shall be the licensee's obligation to assure such physical protection and emergency planning and other arrangements, necessary to ensure limitation of nuclear damage, which do not rest with the authorities.

A licensee whose operations generate or have generated nuclear waste (licensee under a waste management obligation) shall be responsible for all nuclear waste management measures and their appropriate preparation, as well as for their costs (waste management obligation)".

4.2.A.3. Open questions / remarks

2A.1	
Topic	Expertise available to Fennovoima
Background	In Appendix 2A from page 40 on the expertise available to Fennovoima is described. The description from page 48 to page 50 is very general. It is stated that Fennovoima will ensure that it has the necessary expertise to carry out all phases of procurement, licensing, construction and operation of the project. Nevertheless several questions are still open, as no detailed plan on recruitment is presented. The actual capacity is too low to carry out the project. The aim of Fennovoima is to hire several new employees for different areas.
Question(s)/ Remarks	Could you please indicate what the strategy of Fennovoima for the recruitment of experts is going to be? How will Fennovoima ensure that the design of the plant is correct (i.e. design verification)? Will it entirely rely on Rosatom for this purpose, or will Fennovoima conduct an independent design verification or contract for one to be performed? (Note that lack of independent design verification was the root cause of the long delay in licensing the Diablo Canyon nuclear power plant and the doubling of its construction cost.)

2A.2	
Topic	Expertise available to Fennovoima – Nuclear Safety Expertise
Background	In Appendix 2A on page 48 it is stated: *"In all the phases of the project, Fennovoima will have at its disposal the nuclear safety expertise required for the safe construction and operation of the nuclear power plant."* further *"Fennovoima will develop its competences in nuclear safety by participating in various domestic and international trainings and by international cooperation, among other things."* and *"Fennovoima will develop and maintain high safety culture within its organization."*
Question(s)/ Remarks	Is Fennovoima in the stage of building up nuclear safety expertise? If Fennovoima is in the stage of building up nuclear safety expertise, how can Fennovoima ensure nuclear safety at this stage of the project and in the design review phase of the nuclear power plant project? Could you please indicate how many nuclear safety specialists are working for Fennovoima at the moment?

2A.3	
Topic	Safety Culture
Background	The development and the maintenance of a high safety culture is described as an issue of high importance for Fennovoima. Nevertheless there is no indication how “high safety culture” is defined, nor it is described how such a “high safety culture” should be achieved. There is no reference to, for example, INSAG 15[1] or any other guidance document(s). – IS THIS THE CASE? One might also reference SSR-2/1 (Rev. 1)[2], with five authors from VTT Technical Research Centre of Finland. In addition, Finnish government degree on the Safety of Nuclear Power Plants (717/2013) [3]requires a good safety culture in design, construction, operation, and decommissioning (Section 28).
Question(s)/ Remarks	Could you please define “high safety culture”? Could you please indicate what the selected strategy to achieve the “high safety culture” is?

2A.4	
Topic	Expertise available to Fennovoima – Quality management expertise
Background	In Appendix 2A on page 49 the applicant outlines that quality management is planned to be among the most important competence areas in the project. *“The quality department is also responsible for evaluating suppliers, managing nonconformities, and coordinating corrective actions.* *The quality department operates as an independent unit separate from the rest of the project organization to ensure the independence of quality-related decisions.* *In the procurement and licensing phases, Fennovoima pays particular attention to quality management and the development of the management system, and has several experienced quality management professionals in its organization.”*
Question(s)/ Remarks	Would you please give us some more information on the planned quality department? As the quality department is in a buildup phase, how could it up to now (procurement and licensing phase) carry out its work? Could you please indicate the role of the quality department, and the provisions that it can carry out its work independently?

[1] INSAG (2002): Key Practical Issues in Strengthening Safety Culture, INSAG 15, 2002.

[2] IAEA (2013): SSR-2/1 (Rev. 1), Requirement 3. NKS-278, Safety Culture in Design, April 2013. Available at http://www.iaea.org/inis/collection/NCLCollectionStore/_Public/44/054/44054114.pdf

[3] http://www.finlex.fi/en/laki/kaannokset/2013/en20130717.pdf

2A.5	
Topic	Expertise available to Fennovoima – Other available expertise
Background	In Appendix 2A on page 50 describes the expertise by the Rosatom Group and subcontractors. Further it is stated: *"External expertise will also be used for assessments in which the independence from the company's operations is essential. Such tasks are evaluations of Fennovoima and its management system, as well as assessments and analyses carried out to validate the plant supplier's safety analyses."*
Question(s)/ Remarks	Could you please indicate what criteria for the selection of the independent external experts will be applied? Who will carry out the validation of the plants supplier´s safety analyses?

2A.6	
Topic	Available Expertise to the organization implementing the construction project
Background	According to the Nuclear Energy Decree (161/1988) Section 32, Paragraph 14 a description of the expertise available to the applicant and the organisation implementing the construction project is needed. The section on the organisation implementing the construction project is missing in the application.
Question(s)/ Remarks	Please include a section on the organization implementing the construction project based on the requirements in the Nuclear Energy Decree (161/1988) Section 32, Paragraph 14.

4.2.B. Appendix 2B: An outline of Fennovoima's planned operating phase organization

4.2.B.1. General Information

An outline of the operation organisation planned for the nuclear facility was provided by the applicant.

4.2.B.2. Requirements

Nuclear Energy Decree (161/1988) Section 32, Paragraph 8

"The application for a construction licence shall be supplemented with […]

8) an outline of the operating organisation planned for the nuclear facility;"

4.2.B.3. Open questions / remarks

2B.1	
Topic	Role of Quality Management
Background	In Appendix 2A on page 49 the applicant outlines that quality management is planned to be among the most important competence areas in the project. Its independence play an important role in Appendix 2A. This fact is not taken into account in Appendix 2B.
Question(s)/ Remarks	According to Appendix 2B Figure 2B-1 the Quality department is not independent. Could you please elaborate the structure of the organization in order to highlight the independence of the Quality department referred to Appendix 2A.

4.3. Nuclear power plant site

4.3.A. Appendix 3A: An account of the environmental impacts of the construction and operation of the nuclear power plant, as well as of measures to prevent and mitigate the adverse impacts

4.3.A.1. General Information

According to Section 32, Paragraph 7 of the Nuclear Energy Decree (161/1988) the applicant needs to include a description of the nuclear facility's environmental impacts and the design criteria adopted by the applicant to avoid environmental damage and to restrict the burden on the environment. Appendix 3A covers most of the relevant information and data regarding Section 3 Paragraph 7 of the Nuclear Energy Decree (161/1988).

A designated part of Appendix 3A was dedicated to the thermal load from the cooling water and its impact on the temperature of sea and its impact on the maritime wildlife. Due to the long planned lifetime of the nuclear power plant, a section on potential implications in the light of climate change would be appreciated.

4.3.A.2. Requirements

Nuclear Energy Decree (161/1988) Section 32, Paragraph 7

"The application for a construction licence shall be supplemented with […]

7) a description of the effects of the nuclear facility on the environment and a description of the design criteria that will be observed by the applicant to avoid environmental damage and to restrict the burden on the environment;"

4.3.A.3. Open questions / remarks

3A.1	
Topic	Role of climate change
Background	In Appendix 3A the applicant outlines the impact of the thermal load from the cooling water and its impact on the temperature of sea and its impact on the maritime wildlife, not taking into account possible cross sections with the climate change. In addition, an increase in water temperature will result in a reduction of thermal efficiency of power operation and a decrease in the gross and net power level capable of being sustained.
Question(s)/ Remarks	Please include a section on the effects of the thermal load of the cooling water taking into account potential impacts of climate change, in order to present a comprehensive and more realistic picture of the future implications of the project.

3A.2	
Topic	Emissions in case of a severe accident
Background	In Appendix 3A on page 77 and 78 it is stated: *"The Hanhikivi nuclear power plant will not, even during a severe reactor accident, release a quantity of emissions that would require civil defense measures outside the areas close to the plant, or long-term restrictions on the use of extensive land and water areas.* *The actual analyses to prove that emissions from the plant will be, in all accident conditions, lower than the limits defined in the Government Decree on the Safety of Nuclear Power Plants will be submitted to STUK as part of the materials related to the construction license application."*
Question(s)/ Remarks	The statement by the applicant is very clear. Nevertheless it is needed to check the analyses which prove the statement, regarding the release and the source term.

4.3.B. Appendix 3B: Additional surveys required by the Ministry of Employment and the Economy on the impacts of the nuclear power plant on the marine environment and fishery during operation

4.3.B.1. General Information

Following the EIA the Ministry of Employment and the Economy asked the applicant to provide more detailed information on the impacts of the nuclear power plant on the marine environment and fishery during operation.

4.3.B.2. Requirements

Nuclear Energy Decree (161/1988) Section 32, Paragraph 15

"The application for a construction licence shall be supplemented with […]

15) any other description considered necessary by the authorities."

4.3.C. Appendix 3C: A description of the plant site in Hanhikivi, Pyhäjoki, and Fennovoima's right to use the planned site

4.3.C.1. General Information

In Appendix 3C Fennovoima gave a description of the plant site in Hanhikivi, Pyhäjoki, and its right to use the planned site. Fennovoima concludes that it possesses all the land needed for the project. Nevertheless there are some complaints going on, which question the eminent domain with the Supreme Administration Court.

4.3.C.2. Requirements

Nuclear Energy Decree (161/1988) Section 32, Paragraph 15

"The application for a construction licence shall be supplemented with […]

1) proof of the applicant's right to use the site planned for the nuclear facility;

2) a description of settlement and other activities and planning arrangements at the planned nuclear facility site and in its immediate vicinity;"

4.3.C.3. Open questions / remarks

3C.1	
Topic	Local detailed plans
Background	In the summary on page 106 the applicant describes all issues to be resolved: *"Land use in the Hanhikivi headland is prescribed by the Hanhikivi regional land use plan for nuclear power, and the Raahe and Pyhäjoki component master plans and local detailed plans for the nuclear power plant area. The land use planning for the nuclear power plant is now legally valid at all three levels of planning."* On page 116 it is stated: *"The land use plan defines an energy management area in block 3 in accordance with the principles presented in the component local master plan for the Hanhikivi nuclear power plant area prepared earlier. Block 3 will have nuclear power plant support functions and functions related to construction and maintenance operations.* *Extension II in block 3 of the local detailed plan has been approved by the Pyhäjoki Municipal Council, but it is not yet in force. A complaint concerning the decision of the Municipal Council has been filed with the Administrative Court of Northern Finland. Extension II in block 3 of the local detailed plan is expected to reach validity by the end of 2015."*
Question(s)/ Remarks	Could you please update the data related to the land use plan?

3C.2	
Topic	Ownership of the nuclear power plant site
Background	In the summary (page 106) the applicant describes the land use and ownership of the land as following: *"Land use in the Hanhikivi headland is prescribed by the Hanhikivi regional land use plan for nuclear power, and the Raahe and Pyhäjoki component master plans and local detailed plans for the nuclear power plant area. The land use planning for the nuclear power plant is now legally valid at all three levels of planning.* *Fennovoima controls all the areas required for the nuclear power plant and its support functions either via direct ownership or based on the power of eminent domain and the right to take possession. Fennovoima owns a total of 397.3 hectares of land and water areas in the Hanhikivi headland."* On page 116 it is stated: *"The power of eminent domain applies to land and water areas that are currently part of four properties, totaling around 108 hectares. Around 107 hectares of the area to which the power of eminent domain applies are land and water areas owned by a single partnership. A complaint has been filed regarding the power of eminent domain with the Supreme Administrative Court, but the complaint procedure will not prevent taking possession of the areas based on the right to take possession granted to Fennovoima."*
Question(s)/ Remarks	Could you please give an update on the complaint? What will be the effect if the complaint will be successful? What makes you sure, that the complaint will not be successful as mentioned on page 116?

4.4. *Safety of the nuclear power plant*

4.4.A. Appendix 4A: A description of the type and technical principles of the nuclear facility to be constructed and the planned suppliers of the essential parts

4.4.A.1. General Information

Information from the ACL:

In accordance with Nuclear Energy Decree section 32, paragraphs 3 and 5 a description of the type of the nuclear facility to be constructed is provided. The NPP to be constructed will be a VVER-1200 (AES-2006), a Generation 3 pressurized water reactor with 1,200 MW of electrical output, developed by the Russian Rosatom Group. New features advertised for this reactor type are *"the extensive utilization of passive cooling systems, the core catcher used in the management of severe reactor accidents, the programmable automation system, and the reactor containment able to withstand the impact of a collision of a large passenger airplane."*

In its preliminary safety assessment the Finish Nuclear Safety Authority concluded that certain design modifications, additional analysis and qualification procedures are needed to fulfill Finish requirements.

Additional Information:

In evaluating the construction license application for Hanhikivi, we have referred to specific Finnish regulations in STUK YVL guides, primarily the following (available at STUK's website[4]):

- YVL Guide A.2, Site for a Nuclear Facility, 15 November 2013.
- YVL Guide A.7, Probabilistic Risk Assessment and Risk Management of a Nuclear Power Plant, 15 November 2013.
- YVL Guide A.8, Ageing Management of a Nuclear Facility, 20 May 2014.
- YVL Guide B.1, Safety Design of a Nuclear Power Plants, 15 November 2013.
- YVL Guide B.2, Classification of Systems, Structures, and Components of a Nuclear Facility, 15 November 2013.
- YVL Guide B.3, Deterministic Safety Analyses of a Nuclear Power Plant, 15 November 2013.
- YVL Guide B.4, Nuclear Fuel and Reactor, 15 November 2013.
- YVL Guide B.5, Reactor Coolant Circuit of a Nuclear Power Plant, 15 November 2013.
- YVL Guide B.6, Containment of a Nuclear Power Plant, 15 November 2013.
- YVL Guide B.7, Provisions for Internal and External Hazards at a Nuclear Facility, 15 November 2013.
- YVL Guide B.8, Fire Protection at a Nuclear Facility, 15 November 2013.
- YVL Guide E.6, Buildings and Structures of a Nuclear Facility, 15 November 2013.
- YVL Guide E.7, Electrical and I&C Equipment of a Nuclear Facility, 15 November 2013.
- YVL Guide E.9, Pumps of a Nuclear Facility, 15 November 2013.
- YVL Guide E.10, Emergency Power Supplies of a Nuclear Facility, 15 August 2014.
- YVL Guide E.11, Hoisting and Transfer Equipment of a Nuclear Facility, 15 November 2013.

In addition, since the construction permit application states that the safety design "*has aimed to comply with International Atomic Energy Agency's (IAEA) safety guidelines and Standards, European Utility Requirements (EUR), and the Russian national regulations and requirements*", we have also referred to

[4] http://www.stuk.fi/web/en/regulations/stuk-s-regulatory-guides/regulatory-guides-on-nuclear-safety-yvl-

these documents as appropriate. The Russian general regulations on ensuring the safety of nuclear power plants are set forth in OPB-88/97[5], in force from 1 July 1988. The EUR[6] are available to registered users only. With specific reference to the IAEA safety guidelines and standards, we note primarily to the following (accessible on the IAEA's website[7]):

IAEA Safety Fundamentals and Safety Requirements (mandatory)

- Fundamental Safety Principles, SF-1, November 2006.
- Safety Assessment for Facilities and Activities, GSR Part 1 (Rev. 1), February 2016.
- Site Evaluation for Nuclear Installations, NS-R-3 (Rev. 1), February 2016.
- Safety of Nuclear Power Plants: Design, SSR-2/1 (Rev. 1), February 2016.
- Safety of Nuclear Power Plants: Commissioning and Operation, SSR-2/2 (Rev. 1), February 2016.

IAEA Safety Guides (recommendations and guidance)

- Format and Content of the Safety Analysis Report for Nuclear Power Plants, GS-G-4.1, May 2004.
- Design of Reactor Containment Systems for Nuclear Power Plants, NS-G-1.10, September 2004.
- Protection Against Internal Hazards Other Than Fires and Explosions in the Design of Nuclear Power Plants, NS-G-1.11, September 2004.
- Instrumentation and Control Systems Important to Safety in Nuclear Power Plants, NS-G-1.3, March 2002.
- External Events Excluding Earthquakes in the Design of Nuclear Power Plants, NS-G-1.5, November 2003.
- Seismic Design and Qualification for Nuclear Power Plants, NS-G-1.6, November 2003.
- Protection Against Internal Fires and Explosions in the Design of Nuclear Power Plants, NS-G-1.7, September 2004.
- Design of Emergency Power Systems for Nuclear Power Plants, NS-G-1.8, August 2004.
- Design of the Reactor Coolant System and Associated Systems in Nuclear Power Plants, NS-G-1.9, September 2004.
- Fire Safety in the Operation of Nuclear Power Plants, NS-G-2.1, July 2000.
- Maintenance, Surveillance and In-service Inspection in Nuclear Power Plants, NS-G-2.6, October 2002.
- Ageing Management for Nuclear Power Plants, NS-G-2.12, January 2009.
- Severe Accident Management Programmes for Nuclear Power Plants, NS-G-2.15, July 2009.
- External Human Induced Events in Site Evaluation for Nuclear Power Plants, NS-G-3.1, May 2002.
- Deterministic Safety Analysis for Nuclear Power Plants, SSG-2, December 2009.
- Development and Application of Level 1 Probabilistic Safety Assessment for Nuclear Power Plants, SSG-3, April 2010.
- Development and Application of Level 2 Probabilistic Safety Assessment for Nuclear Power Plants, SSG-4, May 2010.
- Seismic Hazards in Site Evaluation for Nuclear Installations, SSG-9, August 2010.
- Storage of Spent Nuclear Fuel, SSG-15, February 2012.
- Meteorological and Hydrological Hazards in Site Evaluation for Nuclear Installations, SSG-18, November 2011.
- Volcanic Hazards in Site Evaluation for Nuclear Installations, SSG-21, October 2012.

[5] http://en.gosnadzor.ru/framework/nuclear/OPB-99%20%28NP-001-97%29.pdf

[6] http://www.europeanutilityrequirements.org/Documentation/EURdocument.aspx

[7] http://www-ns.iaea.org/standards/default.asp?s=11&l=90

- Safety Classification for Structures, Systems and Components in Nuclear Power Plants, SSG-30, May 2014.

Notwithstanding the fact that the construction permit application does not refer to it, we will also refer to the WENRA report on Safety Design of New NPP Designs[8], March 2013. (Note that Finland, represented by STUK, is a member of WENRA. The Russian Federation, represented Rostechnadzor, is an observer at WENRA.)

4.4.A.2. Requirements

Nuclear Energy Decree (161/1988) Section 32, Paragraph 3, 5, 6

"The application for a construction licence shall be supplemented with […]

3) a description of the type of the nuclear facility to be constructed, and the planned suppliers of the essential parts;

5) an outline of the technical operating principles and features and other arrangements which are used to ensure the safety of the nuclear facility;

6) a description of the safety principles that the applicant intends to observe, and an evaluation of the fulfilment of the principles;"

Nuclear Energy Act (990/1987) Section 19, Paragraph 1 and 10

"A licence for the construction of a nuclear facility other than that referred to in section 18 can be granted:

(1) if plans concerning the nuclear facility meet the safety requirements laid down in this Act, and appropriate account has been taken of the safety of workers and the population when planning the operations in question;

(10) if the applicant is otherwise considered to have the prerequisites to engage in opertions safely and in accordance with Finland's international contractual obligations;"

4.4.A.3. Open questions / remarks

4A.1	
Topic	Departures of the Hanhikivi design from the AES-2006, VVER-1200/491 reference unit, Leningrad II-1, under construction at the Leningrad II site at Sosnovy Bor in Russia.
Background	Appendix 4A of the CL application indicates on page 121 that the reference plant for Hanhikivi is the Leningrad II-1 unit at Sosnovy Bor in Russia. The application indicates, however, on page 120 that certain design modifications will be needed in order to comply with STUK requirements.
Question(s)/ Remarks	Could you please identify the required design modifications needed in order to make the VVER-1200/491 reference design comply with STUK requirements?

[8] WENRA (2013): Safety Design of New NPP Designs, available at http://www.wenra.org/media/filer_public/2013/04/30/rhwg_safety_of_new_npp_designs.pdf

4A.2	
Topic	Official language of project documentation
Background	The Hanhikivi plant is planned for construction in Finland for a Finnish utility. Russian entities have already been noted for their involvement with the plant (Rusatom Overseas, RAOS Project Oy, Rosatom Group, JSC Atomproekt, JSC OKB Gidropress, JSC TVEL, CJSC Concern Titan-2, JSC VNIIAES, and JSC Atomenergomash). Other companies from additional countries have been identified as providing systems, components, and structures. • The turbine design is based on Arabelle technology from Alstom, a French company which will manufacture the main components of the turbine; Alstom is owned by GE, an American company. • The safety-classified automation systems important for nuclear safety will be supplied by Rolls-Royce (UK) or Schneider Electric (France). • A WorleyParsons joint venture in Russia, InterRAO-WorleyParsons, has a contract with RAOS Project Oy for consultancy services during the process of obtaining a construction license. WorleyParsons is an Australian company. WorleyParsons will be supported by the company's offices in Sofia, Bulgaria. • Siemens, a German company, has been contracted to electrify the construction site, and M+W Group, also a German company, is part of a consortium for consulting in project management, nuclear safety, licensing, and auditing of the subcontracting chains. • Finnish companies are also involved Destia Oy, Suomen Maastorakentajat Oy, Ruskon Teboni Oy, Wasa Dredging Ltd., and ÅF-Consult Oy, and more will become involved as construction plans proceed.
Question(s)/ Remarks	Could you please identify in what language the official project documentation will be produced for the Hanhikivi plant, and indicate which official project documentation (if any) will be in a different language from that identified?

4A.3	
Topic	Best available technology
Background	Appendix 4A of the CL application (page 120) states, "The safety solutions of the plant represent the best available technology."
Question(s)/ Remarks	Could you please identify how this conclusion was reached? Could you please identify the other Generation III pressurized water reactor designs to which comparison was made with the VVER-1200/491 in order to ensure that the best available technology is used in the Hanhikivi design?

4A.4	
Topic	Impact of a collision with a large passenger airplane
Background	Appendix 4A of the CL application (page 120) states, "*Among the most important features of the AES-2006 that represent new technology are ... the reactor containment able to withstand the impact of a collision of a large passenger airplane.*"

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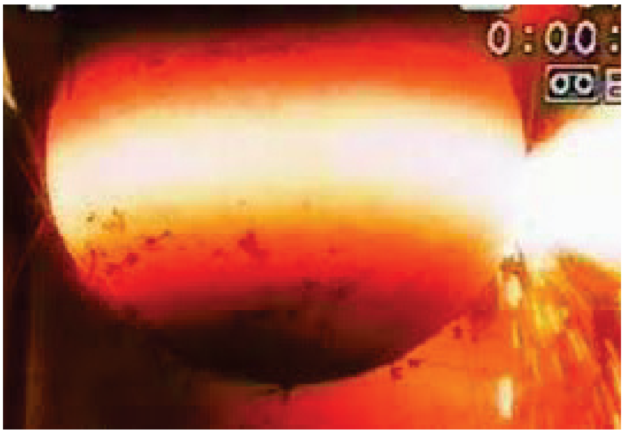
Question(s)/ Remarks	Could you please identify the characteristics of the "large passenger airplane" considered in the design of the Hanhikivi containment (e.g. maximum weight, number of engines, quantity and type of fuel, angle of impact, speed of the aircraft at impact)? Could you also please indicate the process by which these characteristics were selected? Could you also indicate whether, in the design of the containment to withstand aircraft impact, military aircraft were also considered, such as in-flight refueling aircraft and aircraft with live weapons, and if so, which particular configurations and characteristics were considered? Could you also indicate whether there are any other plant structures, systems and components (SSCs) which are designed to withstand the impact of a collision of a large passenger airplane (e.g. the four safety system trains, the emergency diesel generators, the main and - if present - emergency control rooms)? Could you please indicate whether the secondary containment alone is sufficient to resist penetration in the event of the collision of a large passenger airplane? If not, could you identify the means by which aircraft fuel dispersal into the containment annulus is avoided, and how deflagration-to-detonation transition and direct detonation of the aircraft fuel in the annulus is avoided?

4A.5	
Topic	Programmable automation system
Background	Appendix 4A of the CL application (page 120) states, *"Among the most important features of the AES-2006 that represent new technology are ... the programmable automation system ..."*
Question(s)/ Remarks	Could you please explain generally how the configuration of the programmable automation system is controlled and protected against unintended modification by persons or entities both within and outside the power plant? Could you also please explain how changes in the programmable automation system are validated and verified (V&V) before implementation at the power plant? Could you explain how the programmable automation system is protected against lightning strikes and electromagnetic interference (EMI)? Could you also explain how unplanned changes to the configuration of the programmable automation system are identified by the plant staff, and whether such unplanned changes are annunciated in the main and - if present - emergency control rooms?

4A.6	
Topic	Core catcher used in the management of severe reactor accidents
Background	Appendix 4A of the CL application (page 120) states, "*Among the most important features of the AES-2006 that represent new technology are ... the core catcher used in the management of severe reactor accidents ...*". Based on available information the core catcher does not appear to be much wider than the reactor vessel itself. However, a number of experiments, including those

	conducted in the Swedish severe accident research program (the so-called EC-FOREVER experiments at RIT/NPS) and also experiments conducted at Sandia National Laboratory in the U.S. (the so-called LHF and OLHF experiments), indicate that one reactor vessel failure location in a severe accident is on the side of the reactor vessel. If there is any pressure at all above the core debris at such a failure location (such as gas pressure in the reactor coolant system or simply the pressure of the core debris above the failure location), the core debris could be expelled from the vessel rather than passively pouring from the failure location. Under such conditions, the core debris could miss the core catcher, and this could result in corium-concrete interactions that the core catcher is designed to prevent.  *Figure 1: Reactor Pressure Vessel during Core Melt Down Scenario (Source: https://www.hzdr.de/)*
Question(s)/ Remarks	Could you identify the reactor vessel failure modes and locations used in the design of the core catcher? Could you please identify the range of pressures above the core debris considered for these reactor vessel failure modes? Could you please indicate the extent to which in-vessel retention (IVR) of core debris is relied upon in the VVER-1200/491 design planned for Hanhikivi, and the experimental and calculation bases for such reliance?

4A.7	
Topic	Core catcher used in the management of severe reactor accidents, possibility of ex-vessel steam explosion
Background	Appendix 4A of the CL application (page 120) states, "Among the most important features of the AES-2006 that represent new technology are ... the core catcher used in the management of severe reactor accidents ...“. Following reactor pressure vessel failure in a severe accident, it is possible that reactor coolant injection systems may actuate, pouring water on top of the core debris within the core catcher. Such systems could include the passive accumulators and the active low pressure injection system (if not inhibited by the operators). These conditions could hypothetically lead to an ex-vessel steam explosion, the effects of which on the continued structural integrity of the core catcher are unclear.
Question(s)/ Remarks	Could you please provide a discussion of your evaluation of the potential for an ex-vessel steam explosion in the core catcher following reactor pressure vessel failure in a severe accident? Could you please indicate whether your evaluation of this possibility consider actuation of the reactor coolant system accumulators and low pressure injection system following reactor pressure vessel failure.

4A.8	
Topic	Fennovoima review of operating and safety principles of the AES-2006 design
Background	The CL application states, at page 120, "Fennovoima has reviewed the operating and safety principles of Rosatom's AES-2006 and found that the plant can be designed and constructed to meet the safety requirements set by Finnish authorities, and any other requirements set by Fennovoima for the nuclear power plant."
Question(s)/ Remarks	Referring to pages 120 and 122 of the Construction License application, could you please indicate in what respects - if any - Fennovoima found that, in its review of the operating and safety principles of the AES-2006 design, the design does not conform to the safety requirements set by Finnish authorities and Fennovoima? Could you please indicate whether Fennovoima believes that the unmodified AES-2006 design (as, for example, under construction at the Leningrad II-1 unit, which the Construction License refers to as the "reference plant" for Hanhikivi 1) meets the Finnish authorities' safety requirements? If it does not, could you please indicate what modifications Fennovoima believes would be necessary to comply? Whether Fennovoima believes that the unmodified AES-2006 design (as, for example, under construction at the Leningrad II-1 unit, which the Construction License refers to as the "reference plant" for Hanhikivi 1) meets the technical requirements set by Fennovoima? If it does not, could you please indicate what modifications Fennovoima believes would be necessary to comply?

4A.9	
Topic	Primary circuit design
Background	The VVER-440/230 and VVER-440/213 designs contain loop stop valves, the closure of which can isolate a steam generator such that in the case of a steam generator tube rupture or steam generator collector leak, no primary coolant is passed to the secondary side of the plant. The VVER-1000/320 design does not have such valves. Without such valves a steam generator tube rupture of collector leak results in containment bypass. Does the VVER-1200/491 design have such valves or not?
Question(s)/ Remarks	Could you please indicate whether the VVER-1200/491 design, as planned for implementation at Hanhikivi 1, includes loop stop valves? If so, can these valves be closed to isolate a steam generator in case of a steam generator tube rupture or steam generator collector leak, and under what conditions is this possible?

4A.10	
Topic	Pressurizer location
Background	The pressurizer is located on one of four primary coolant loops, and is connected to the loop by a pressurizer surge line.
Question(s)/ Remarks	Could you please indicate to which primary coolant loop (out of the four present) the pressurizer surge line is connected?

4A.11	
Topic	Leak-before-break
Background	The CL application at page 123 states, "The pipelines of the AES-2006 primary circuit will be designed and manufactured in accordance with the leak-before-break principle. This means that the pipes have no identified failure mechanisms that would cause a full and abrupt break. Instead of a full and abrupt break, any damage to the primary circuit pipes will appear as a minor leak that can be easily detected. Repairs can then be carried out before an accident occurs. The rooms that contain primary circuit pipelines will be equipped with complete leak detection systems." Minor leaks and cracks can, under some circumstances and orientations, rather rapidly propagate and evolve into a much larger break (e.g. a so-called fish-mouth break or a circumferential rupture). The question is whether leak detection always means that the plant can be shut down in a controlled manner that permits the minor leak to be repaired, and if so under what conditions is this not possible.
Question(s)/ Remarks	The Construction License application at page 123 indicates that the Hanhikivi primary system design complies with leak-before-break requirements. The application further states, "Instead of a full and abrupt break, any damage to the primary circuit pipes will appear as a minor leak that can be easily detected. Repairs can then be carried out before an accident occurs. The rooms that contain primary circuit pipelines will be equipped with complete leak detection systems." Could you please discuss whether there are limits to leak-before break such that unit shut down to safe conditions could be accomplished before an accident occurs, and, if so, could you please identify under what circumstances this could not be accomplished? Could you also please indicate whether the referenced "minor leak" does not in fact constitute a small loss-of-coolant accident? Could you indicate whether the entire primary coolant system is free from configurations that could lead to flow-accelerated-corrosion (FAC)? Could you indicate whether the leak detection system applies to the reactor pressure vessel head and its penetrations and closure seal bolts?

4A.12	
Topic	Automatic boron injection system
Background	The CL application states (page 124), "If the movement of the control rods is completely prevented for any reason, the reactor can be shut down by an automatic system that will pump borated water into the primary circuit from dedicated storage tanks located in the reactor building." No indication is provided, however, under what conditions this automatic function is planned to be actuated. In addition, no indicate is provided whether, in case of automatic system actuation, the control room operators can manually initiate system operation.
Question(s)/ Remarks	The Construction License application states (page 124), "If the movement of the control rods is completely prevented for any reason, the reactor can be shut down by an automatic system that will pump borated water into the primary circuit from dedicated storage tanks located in the reactor building."

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	In this regard, could you please identify the circumstances under which automatic initiation of this emergency boron injection system is planned to be performed? Could you also indicate whether failure of the system to start is annunciated to the control room operators? Could you also please indicate whether the control room operators can manually initiate operation of this system if, in their judgment, such operation is needed? Could you please indicate whether Fennovoima has designated this system as a nuclear safety related system and, if not, discuss the reason(s) why not? Finally, could you please indicate what power sources are needed for automatic and manual (if possible) operation of the system?

4A.13	
Topic	Redundancy and diversity
Background	The defense-in-depth principle requires that safety systems be provided for which the system trains are independent. Defense-in-depth requires both redundancy (multiple system trains) as well as diversity. Diversity implies redundant systems with different initiation and operational principles or, at the very least, use of non-identical system components. Redundancy and diversity are both required to provide protection against common cause failures (multiple component or safety system train failures due to a common cause). The VVER-1200/491 design appears to have relied largely on redundancy to the exclusion of diversity, notwithstanding the statement on page 124 of the CL application, "The active safety systems of the AES-2006 will be designed to comply with the diversity principle by using a minimum number of common factors that could result in the failure of several redundancies at the same time."
Question(s)/ Remarks	Could you please discuss the extent to which safety system design incorporates the diversity principle of defense-in-depth, addressing individually each safety system? By way of illustration, the design includes four diesel generators. Are all of these diesels provided by the same manufacturer? If not, how many different diesel manufacturers are used? If so, please discuss the provisions employed to reduce the likelihood of common cause failures (multiple component failures or safety system train failures due to a common cause)? Even if different diesel generator manufacturers are used, could you please discuss whether the emergency diesel generators are nonetheless susceptible to common cause failures originating in the use of a single diesel fuel supplier or a single lubrication supplier?

4A.14	
Topic	Containment annulus filtering systems
Background	Pages 124-125 of the CL application states, "During normal operation of the power plant, the pressure in the annular space between the outer and inner containment will be kept below atmospheric pressure to allow monitoring of the leak-tightness of the containment and to ensure that any leaks only occur through filtering systems."

Question(s)/ Remarks	Referring to the containment annulus filtering systems as discussed on pages 124-125 of the Construction License application, could you please indicate the extent to which these systems are redundant and diverse in operation? Could you also please indicate whether and to what extent the source term for which the containment annulus filtration systems are designed for severe accident conditions within the primary containment?

4A.15	
Topic	Diesel generators dedicated for design extension conditions and severe reactor accidents
Background	Page 126 of the CL application states, "The Hanhikivi 1 nuclear power plant will also have diesel generators dedicated for design extension conditions and severe reactor accidents. These diesel generators will be separate from the emergency diesel generators and improve the electricity self-sufficiency of the plant; power supply to the most critical systems of the plant can be arranged even in accident conditions which involve the loss of external power supply and the primary emergency diesel generators." The provision of extra diesel generators is a good idea, as far as it goes. However, a number of questions arise as indicated below.
Question(s)/ Remarks	Regarding page 126 of the Construction License application, it is indicated that additional diesel generators will be provided, separate from the emergency diesel generators, for design extension conditions and severe reactor accidents. Could you please identify the number of these additional diesel generators? Could you indicate where these additional diesel generators are located? Could you indicate whether these additional diesel generators have their own fuel supply, separate from the emergency diesel generators? Could you indicate whether the diesel fuel for these additional diesel generators comes from the same supplier as the diesel fuel for the emergency diesel generators? Could you indicate whether these additional diesel generators are supplied by the same manufacturer as the emergency diesel generators and, if so, indicate whether the same model of diesel generator is used for both the emergency diesel generators and the additional diesel generators? Finally, could you indicate whether the additional diesel generators for design extension conditions and severe reactor accidents are designed to withstand external hazards (including earthquakes more severe than the design basis earthquake, and heavy passenger aircraft crash)?

4A.16	
Topic	Management of severe reactor accidents
Background	On page 126 of the CL application, management of severe reactor accidents is briefly (in a single paragraph) discussed. No identification or description of the severe accident management guidance is provided there.

Question(s)/ Remarks	Could you please indicate whether severe accident management guidance and/or procedures will be used as part of the severe accident management regime at Hanhikivi? Could you please identify the plant conditions and instrumentation indications that will be used to enable a decision to be made to transfer from normal operating procedures, abnormal operating procedures, or emergency operating procedures to the severe accident management regime? Could you please indicate what entity is responsible for decision making under the severe accident management regime (e.g., control room operators, senior operators, shift supervisor, plant manager, technical support center, etc.)?

4A.17	
Topic	Passive containment heat removal system
Background	Page 128 of the CL application indicates that the passive containment heat removal system will be able to operator for 24 hours, and up to 72 hours with "the water reserves available in the plant area". No identification is made of these additional water reserves.
Question(s)/ Remarks	Page 128 of the Construction License application indicates that the passive containment heat removal system can function automatically for 24 hours, and for up to 72 hours "with the water reserves available in the plant area". Could you please indicate to which water reserves the text makes reference, and indicate the volume of water available at each source? Could additional water be supplied to any of these water sources be made from a fire truck? Could additional water be supplied to any of these water sources from the domestic water system?

4A.18	
Topic	Components in the turbine building having a potential nuclear safety classification
Background	At page 128, the CL application states that none of the systems located in the turbine building have a nuclear safety classification. This may not be true, depending on where the main steam isolation valves (MSIVs) outside containment are located.
Question(s)/ Remarks	Could you please identify the structure in which the main steam isolation valves outside containment are located? If these valves are located in the turbine building, could you please identify whether the valves have a nuclear safety classification and, if so, how the valves are protected against adverse conditions in the turbine hall (e.g. main steam line break, main feedwater line break, turbine hall fire, turbine missiles, etc.)

4A.19	
Topic	Containment anchorage to the basemat
Background	Pages 124-125 of the CL application briefly describe the primary and secondary containments. However, no mention is made whether the primary and secondary containments are on the same basemat (we assume that they are). Further, no discussion is provided regarding how the primary and secondary containments are anchored to the basemat. This is important in order that the potential for differential movement between two separate basemats is avoided in case of an earthquake and an aircraft crash?
Question(s)/ Remarks	Could you please indicate whether the primary and secondary containments share the same basemat? If they do not share the same basemat, how are the basemats for the primary and secondary containments constrained to avoid differential motion in, for example, seismic events and heavy passenger airplane impact?

4A.20	
Topic	Basemat for the buildings in which safety systems are located
Background	There are four separate compartments in a building on the side of the containments opposite from the turbine building, which contain active safety system trains. The CL application does not indicate whether these compartments share a common basemat with the primary and secondary containments.
Question(s)/ Remarks	The Construction License application at page 121 discusses the four independent, parallel trains of safety equipment. Could you please indicate whether this equipment shares the same basemat as the primary and secondary containments? If the safety equipment is located on a basemat that is separate from the primary and secondary containment, how is potential for differential motion between the basemats addressed in the plant design?

4A.21	
Topic	Filtered containment venting system
Background	The Construction License application does not indicate whether a severe accident capable filtered containment venting system will be provided for Hanhikivi 1. Such systems are common in European nuclear power plant units.
Question(s)/ Remarks	Could you please indicate whether a severe accident capable filtered primary containment venting system will be provided for Hanhikivi 1? If such a system will be provided, what are the design parameters for the system, and what are the actuation and isolation provisions for the system? If a severe accident capable primary containment venting system will not be provided, could you please discuss Fennovoima's rationale for not including such a system in the plant design?

4A.22	
Topic	Concrete thickness for the containment basemat
Background	Generic design information for the VVER-1200/491 design indicates that the containment basemat is 2.4 meters thick, the same as for the VVER-1000/320 design. In the VVER-1000/320 design, there are several meters of concrete within the containment (above the basemat) as well. Is this also the case for the VVER-1200/491?
Question(s)/ Remarks	Within the primary containment and above the basemat, could you please indicate the thickness of concrete below the core catcher?

4A.23	
Topic	Equipment in the annulus between the primary and secondary containments
Background	The CL application only identifies a containment annulus filtration system as being present between the primary and secondary containments. It is possible that the annulus is also the location of containment isolation valves outside the primary containment because it is typical to have the isolation valves as close to the containment boundary as feasible.
Question(s)/ Remarks	Could you please indicate whether there are any safety system components located in the annulus between the primary and secondary containment (such as, for example, containment isolation valves)? If there are safety system components in the annulus between the primary and secondary containments, could you please identify those components and the systems to which they belong?

4A.24	
Topic	Passive safety systems
Background	The CL application describes passive safety systems. In each case, however we suspect that there are valves that may have to actuate in order for the passive system to function correctly.
Question(s)/ Remarks	For passive safety systems, could you please provided the following information: • The system name • Identification of valves which must change position in order for the system to go into operation • Identification in each such instance of the motive force (AC power, DC power, instrument air, explosive squib) required in order for the valve to change position • Identification of how each such valve receives control to direct it to change position • For each such valve, how is valve position indicated to the control room operators • How is startup of the system indicated to the control room operators • How is system status signaled to the control room operators • For each such valve, Is it possible for the control room operators to change the position of the valve from the control room

4A.25	
Topic	Passive safety systems for response to steam generator tube rupture and/or steam generator collector leakage
Background	Passive safety systems are provided in the VVER-1200/491 design. It is unclear, however, whether there are passive safety systems provided to respond passively, in all respects, to single and multiple steam generator tube ruptures and/or to steam generator collector leakage or rupture.
Question(s)/ Remarks	Could you please identify the passive safety system(s) that would respond to a rupture of a single steam generator tube, and whether additional non-passive system operator and operator actions are required in order to response to the initiating event? Could you please identify the passive safety system(s) that would respond to a rupture of multiple steam generator tubes, and whether additional non-passive system operator and operator actions are required in order to response to the initiating event? Could you please identify the passive safety system(s) that would respond to a steam generator collector leak, and whether additional non-passive system operator and operator actions are required in order to response to the initiating event? Could you please identify the passive safety system(s) that would respond to a rupture of a steam generator collector, and whether additional non-passive system operator and operator actions are required in order to response to the initiating event?

4A.26	
Topic	Passive autocatalytic hydrogen recombiners
Background	Passive autocatalytic recombiners (PARs) are identified as being placed in the containment for purposes of safely oxidizing hydrogen back into water in case of a severe accident. It is unclear what is the design recombination rate (per second or hour), and it is also unclear how many recombiners are provided and in what locations. It is also not clear whether the design has considered the possibility of hydrogen saturation of the PARs to the point where they become hot enough to functionally serve as a hydrogen igniter.
Question(s)/ Remarks	The Construction License application indicates that passive autocatalytic recombiners (PARs) are provided in the design to safely deal with hydrogen released into the containment in the event of a severe accident. In this regard, what is the maximum design recombination rate of the system of PARs (per second or per hour)? In addition, where are the PARs located in the containment? Has the PAR location and expected hydrogen release rate to containment considered whether the PAR will inadvertently function as a hydrogen igniter (due to its temperature), and how does the design of the plant avoid such an outcome? In addition, could you please indicate whether there are PARs provided in the annulus between the primary and secondary containment in order to safely handle hydrogen released in case of primary containment leakage?

4A.27	
Topic	Emergency control room
Background	Most (if not all) nuclear power plants are equipped with a secondary or emergency control room to which the operators can evacuate in the event that the main control room becomes uninhabitable or the main control room equipment fails to function properly. The Construction License application does not discuss whether such a secondary or emergency control room is part of the Hanhikivi design.
Question(s)/ Remarks	Could you please indicate whether a secondary or emergency control room is provided in the Hanhikivi 1 design, to which the operators can evacuate in the event that the main control room becomes uninhabitable or the main control room equipment fails to function properly? If such a secondary or emergency control room is provided, how many trains of safety equipment can be monitored and controlled from there? Finally, for such a secondary or emergency control room, is the equipment there hard-wired analogue in nature or digital computer controlled in nature? Is the secondary or emergency control room protected from common cause failure in the event of damage to the main control room in case of a large commercial airplane crash?

4A.28	
Topic	Fire protection in the main control room
Background	Fire protection of the main control room is an important safety issue due to the potential for such a fire causing evacuation of the main control room and use of a secondary or emergency control room (if available).
Question(s)/ Remarks	Could you please indicate how the main control room and its instrumentation and controls are protected against fires? For automatic suppression systems provided for the main control room, what type of suppression system(s) are provided (water spray, water fog, CO_2, halon, or other)? Is manual fire suppression equipment provided in or near to the main control room for use in responding to control room fires? What combustible materials are present in the main control room, and in what quantities and locations? How are the operators and control room equipment protected against the effects of inadvertent actuation of an automatic fire suppression system?

4A.29	
Topic	Main control room issues
Background	The main control room must be protected from external hazards. In some VVER-440/213 nuclear power plants (such as Mochovce and Dukovany), there are windows between the control room and the outside environment. This presents obvious vulnerabilities in terms of: (a) radiation exposure in case of a

	severe accident causing a release of radioactivity to the environment; (b) exposure of the operators to external missiles such as those that might be caused by high winds or an explosion; and (c) the possible use of external, man-portable weapons (such as grenade launchers with gas, smoke and explosive rounds; machine guns; recoilless rifles) against the control room. The main control room (and the secondary or emergency control room, if provided_ must be protected against the effects of an airplane crash onsite. This includes such effects as impact damage, fire damage, and "ingestion" of combustible and/or toxic gases into the control room breathing air.
Question(s)/ Remarks	Could you please indicate whether there are windows in the main control room, and if so, to what compartment or environment outside the control room these windows face? In the event of the impact of a large passenger aircraft, could you discuss by what means control room operators are protected against "ingestion" of combustible and/or toxic gases from outside the control room building?

4A.30	
Topic	Manual fire-fighting onsite
Background	Compared with many nuclear power plants in Western Europe and North America, VVER plants in Eastern Europe and Russia are better protected with manual fire-fighting capabilities by having a professionally trained and equipped fire brigade on site. In the US, American plants generally rely on in-plant personnel from various operating departments who have received basic fire-fighting instruction using fire extinguishers and fire water hose connections. Reliance on offsite fire-fighting almost always results in plant equipment being destroyed before the fire fighters can respond to the site, process through security and access control, and be escorted to the fire location.
Question(s)/ Remarks	Could you please indicate whether the Hanhikivi site will be provided with an onsite, professionally trained and equipped fire-fighting organization? If not, could you please indicate the offsite fire-fighting personnel and equipment response time to the site from when a call is placed from the plant for assistance?

4A.31	
Topic	Onsite stores of toxic gases and other hazardous materials
Background	Nuclear power plants frequently have onsite stores of toxic gases and other hazardous materials. An example of such storage is the tank(s) containing hydrogen for cooling the plant generator. Nuclear power plant safety buildings, systems, and operators must be protected against such stores.
Question(s)/ Remarks	Could you please identify any onsite stores of toxic gases, combustible and explosive materials, and other hazardous materials, and discuss how plant buildings, safety equipment and plant personnel (including control room personnel) are protected in case of a release from storage of these materials?

4A.32	
Topic	Alternate emergency AC power possibilities
Background	Some nuclear power plants have onsite or near-site sources of alternate AC power. Examples include gas-turbine generators, diesel generators provided for security purposes, hydroelectric dams, and other nearby power plants with black-start capability. Such sources of power could be made available to power plant safety systems in extreme situations involving loss of normal and emergency AC power. In addition, since the Fukushima nuclear power plant accidents in 2011, a number of plants have obtained emergency AC and DC power sources for use onsite, such as portable batteries and mobile diesel generators. These sources of power, where available, can also be used to power plant safety systems in extreme situations.
Question(s)/ Remarks	Could you please indicate the extent to which alternate sources of AC and/or DC power could be available at or to the Hanhikivi site in extreme situations involving loss of normal power sources? (Such sources of power could include portable batteries, mobile diesel generators, and onsite or near-site black-start capable power plants such as gas turbine units, hydroelectric power stations, and other near-site power plants.)

4A.33	
Topic	Repair, maintenance, and surveillance test practices
Background	Repair, maintenance, and surveillance test practices, if not optimized, can increase the potential for common cause failures of safety systems, and instrumentation & control systems. Examples include having repairs, maintenance, or surveillance tests of multiple safety train components conducted by the same personnel on the same day. If the personnel make a mistake on one train of equipment, the chance of them making the same mistake on other trains of equipment are increased.
Question(s)/ Remarks	Could you please explain how repair, maintenance, lubrication, and surveillance test practices will be optimized at Hanhikivi 1 in order to minimize the potential for common cause failures of systems, components, and I&C equipment?

4A.34	
Topic	Departures of the Hanhikivi 1 design from IAEA Safety Requirements, EUR, WENRA guidance, and Russian safety requirements
Background	In the CL application, Fennovoima claims compliance with IAEA safety guidelines and standards, European Utility Requirements (EUR), and Russian national regulations and requirements. It is thus important to understand the nature of any departures of the Hanhikivi design from such guidance and requirements.
Question(s)/ Remarks	Page 121 of the Construction License application states, "From the start, the safety design of the AES-2006 has aimed to comply with International Atomic Energy Agency's (IAEA) safety guidelines and standards, European Utility Requirements (EUR), and the Russian national regulations and requirements."

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	Could you please identify whether, and if so to what extent, the design of Hanhikivi 1 will depart from IAEA Requirements Document SSR-2/1[9]? Could you please identify whether, and if so to what extent, the design of Hanhikivi 1 will depart from the WENRA safety reference levels for new nuclear power plants? Could you please identify whether, and if so to what extent, the design of Hanhikivi 1 will depart from the European Utility Requirements for safety? Could you please identify whether, and if so to what extent, the design of Hanhikivi 1 will depart from Russian national regulations and requirements? For each such departure noted in response to the above, could you please indicate how the design and operation of the Hanhikivi 1 plant compensates for the departures from the cited documents?

4A.35	
Topic	External man-made hazards - LPG & LNG
Background	Transport or storage of liquefied petroleum gas (LPG) or liquefied natural gas (LNG) near a nuclear power plant site poses hazards to the power plant. For example, the Borssele nuclear power plant site is equipped with igniters in order to reduce the risk from LNG transport accidents. It is unknown whether there are any LPG or LNG transport and/or storage activities near the Hanhikivi 1 site.
Question(s)/ Remarks	Could you please identify any liquefied petroleum gas (LPG) storage tanks in the vicinity of the Hanhikivi 1 nuclear power plant site and their distance from plant safety buildings? Could you please identify any liquefied natural gas (LNG) storage tanks in the vicinity of the Hanhikivi 1 nuclear power plant site and their distance from plant safety buildings? Could you please indicate whether LPG or LNG are transported near the Hanhikivi 1 plant site and, if so, at what distance?

4A.36	
Topic	Turbine runback and house loads capability of Hanhikivi 1
Background	The VVER-1000/320 design features the capability to avoid a reactor trip and turbine trip on loss of load by automatic runback to "house loads" power and keep safety and operating systems running.
Question(s)/ Remarks	Could you please describe the capability of the Hanhikivi 1 design to automatically run back the turbine and go to house loads in case of loss of load?

[9] IAEA (2016): Safety of Nuclear Power Plants: Design. SSR-2/1, Rev. 1

4A.37	
Topic	Control rod materials
Background	The CL application mentions the fact that the Hanhikivi 1 design has 121 control rods, but does not comment on the materials used in the control rods. The operating VVER units have control rods containing boron carbide (B_4C). During a severe accident, the carbon in the boron carbide enhances production of organic iodine, which was a major cause of the high radioactive iodine releases during the Fukushima accident.
Question(s)/ Remarks	Could you describe the materials used internal to the control rods, and indicate whether boron carbide is used therein as a neutron absorber?

4A.38	
Topic	Borated water inventory for emergency coolant makeup
Background	The VVER-1000/320 design has a minimum of 500 cubic meters of borated water available for emergency coolant injection, and a maximum quantity of 800 cubic meters.
Question(s)/ Remarks	Could you please identify the minimum and normal quantity of borated water available to the emergency coolant injection system for Hanhikivi 1?

4A.39	
Topic	Essential service water surge tank location
Background	The essential service water system typically includes a surge tank to provide for service water system operation when the operating pump(s) trip, and before another pump starts up. In the VVER-1000/320 design of the Temelín nuclear power plant in the Czech Republic, the surge tank is located 28.8 meters above local grade. At this elevation, seismic accelerations are increased beyond those experienced at local grade level.
Question(s)/ Remarks	Could you please indicate whether the essential service water system for Hanhikivi includes a surge tank, and if so could you please identify the elevation (relative to local grade level) of the essential service water system surge tank? Could you also please indicate the location of the surge tank relative to the secondary containment and the turbine hall?

4A.40	
Topic	Emergency feedwater system design
Background	An important factor in plant safety for VVERs is the design of the emergency feedwater system. In this respect, it is important to understand the duration of emergency feedwater inventory in case of a scram from full power in which the normal feedwater system is unavailable. It is also important to understand the extent to which alternate sources of water can be used to extend the period of operability of the emergency feedwater system.

Question(s)/ Remarks	Could you please identify how much water inventory if available for use by the emergency feedwater system, as well as the expected duration of this water supply in case of a reactor trip from full power accompanied by a loss of main feedwater? Could you indicate whether there will be a capability to replenish the emergency feedwater system water inventory from alternate sources (such as the fire protection system, a fire truck, portable pumps and hoses, the domestic water system, or well water)?

4A.41	
Topic	Probabilistic risk assessment (PRA)
Background	Under Finnish regulations (specifically Regulatory Guide YVL A.7[10]) notes that Section 35 of the Nuclear Energy Decree (161/1988) requires an applicant for a construction license to submit to STUK "a design phase probabilistic risk assessment". In some parts of the world and in IAEA SSR-2/1[11] PRAs are also known as probabilistic safety assessments or PSAs. SSR-2/1 requires that the design "shall take due account of the probabilistic safety analysis of the plant for all modes of operation and for all plant states, including shutdown". IAEA Safety Guides SSG-3 and SSG-4 provide guidance on performing PSAs at Level 1 (core damage frequency) and Level 2 (accident progression, containment behavior, and characteristics of releases of radioactive materials to the environment). STUK Regulatory Guide YVL A.7 requires that (among other things): • the PRA take into account all of the nuclear fuel located at the plant, including spent nuclear fuel storage (§306); • the license applicant commission an "independent external peer review for the PRA, which is to be submitted to STUK" (§308), along with a report on how the results of the peer review have been or are intended to be taken into account in the PRA (§314); • the scope of the PRA shall consider internal and external events, including internal fires, internal flooding, exceptional weather conditions (strong winds, blizzards, and elevated sea level), and any other harsh environmental conditions (e.g. algae, oil, explosions) and seismic events, and must cover accidents of long duration (e.g. a long-term loss of AC power and the loss of the ultimate heat sink) (§310), as well as hoisting of heavy loads and external factors caused by human activities (§401); • the PRA must include both Level 1 and Level 2 analyses (§311 and §314); • updates to the PRA must be submitted at least once a year (§315); and • uncertainty analyses must be included (§405).

[10] STUK (2013): Regulatory Guide YVL A.7, Probabilistic Risk Assessment and Risk Management of a Nuclear Power Plant.

[11] IAEA (2013): Specific Safety Requirements SSR-2/1, Safety of Nuclear Power Plants: Design, Rev. 1, February 2013.

Question(s)/ Remarks	Could you please discuss the compliance of the design stage probabilistic risk assessment required by STUK Regulatory Guide YVL A.7 with the requirements in that document? Could you also please indicate when Fennovoima expects to submit the design stage PRA to STUK? Could you also please indicate whether the design stage PRA and its updates will be made publicly available, and if not the reasons therefore?

4A.42	
Topic	Ageing management
Background	STUK RG YVL A.8[12], requires a construction license applicant to submit to STUK for approval a plant for the principles of ageing management of structures, systems and components (SSCs).
Question(s)/ Remarks	Consistent with STUK Regulatory Guide YVL A.8, could you please identify the ageing management principles to be applied to structures, systems and components (SSCs) at Hanhikivi? Could you also please identify the duration of operation to which the ageing management plan applies (e.g. 60 years, 80 years, 100 years, or some other duration)?

4A.43	
Topic	Containment boundary
Background	STUK RG YVL B.6 [13] contains requirements for a nuclear power plant containment.
Question(s)/ Remarks	Consistent with STUK Regulatory Guide YVL B.6, could you please indicate whether Fennovoima considers the core catcher to be a part of the containment?

4A.44	
Topic	Secondary containment design
Background	STUK Regulatory Guide YVL B.6 requires that a concrete containment shall be lined with a leaktight steel cladding.
Question(s)/ Remarks	Could you please indicate, consistent with STUK Guide YVL B.6, Containment of a Nuclear Power Plant, whether the secondary containment of the Hanhikivi 1 plant will be lined with a leaktight steel cladding, and if not, could you please explain the reason(s) why not? Could you also please identify the design pressure of the secondary containment?

12 STUK (2014): Ageing Management of a Nuclear Facility, Regulatory Guide YVL A.8, 20 May 2014.

13 STUK (2013): Containment of a Nuclear Power Plant, Regulatory Guide YVL B.6, 15 November 2013.

4.4.B. Appendix 4B: Description of safety principles to be observed at the nuclear power plant and an assessment of their fulfillment

4.4.B.1. General Information

Appendix 4B shall provide a description of the safety principles to be observed, and the license applicant's evaluation of the fulfillment of the principles, as required by Nuclear Energy Decree section 32, paragraph 6. It describes the responsibility of Fennovoima for compliance with safety principles and requirements throughout the entire life cycle of the NPP.

4.4.B.2. Requirements

Nuclear Energy Decree (161/1988) Section 32, Paragraph 6

"The application for a construction license shall be supplemented with [...]

6) a description of the safety principles that the applicant intends to observe, and an evaluation of the fulfilment of the principles;"

Nuclear Energy Act (990/1987) Sections 5 to 7

Nuclear Energy Act (990/1987) Section 19, Paragraph 1

"A license for the construction of a nuclear facility other than that referred to in section 18 can be granted:

1) if plans concerning the nuclear facility meet the safety requirements laid down in this Act, and appropriate account has been taken of the safety of workers and the population when planning the operations in question; "

4.4.B.3. Open questions / remarks

4B.1	
Topic	Probabilistic Risk Assessment, PRA (Probabilistic Safety Assessment, PSA)
Background	Probabilistic Risk Assessment (PRA) and Probabilistic Safety Assessment (PSA) are essentially the same, although some have suggested that a PRA is examining whether there are residual risks in the design, whereas the PSA is attempting to prove how safe the design is - in reality, there is no difference in the type and methods of analysis. The Finnish regulatory requirements specify that a Level 2 PSA be prepared for the Hanhikivi 1 facility. The PSA must consider internally-initiated accidents, internal flooding, internal fire, and other internal hazards, as well as external man-made and natural phenomena hazards. The PSA must consider all operating states (i.e., full power, low power, shutdown, refueling, maintenance and modification outages, etc.). The discussion in the CL application on page 134 specifically states, "*According to the PRA of the reference facility, the probability of an accident leading to core damage as a result of different initiating events in the AES-2006 fulfills Finnish requirements with a sufficient safety margin*". What is the meaning of "sufficient" in this context - comparison of mean values, comparison of median values, or comparison of 95th percentile values? And by what means is uncertainty addressed?

Question(s)/ Remarks	Page 134 of the Construction License application states, "According to the PRA of the reference facility, the probability of an accident leading to core damage as a result of different initiating events in the AES-2006 fulfills Finnish requirements with a sufficient safety margin". Could you please explain what you mean by "a sufficient safety margin" means in this context, addressing the numerical basis for the comparison of the AES-2006 PSA results with Finnish regulatory requirements? How are uncertainties in the AES-2006 PSA addressed regarding the Finnish PSA regulatory requirements? Could you please discuss the AES-2006 PSA scope compared with the required PSA scope under Finnish regulatory requirements? Does the AES-2006 PSA consider all operating states? Does the AES-2006 PSA consider accidents involving the spent fuel pool? Does the AES-2006 PSA consider all relevant internal and external hazards? Could you please describe Fennovoima's plans for external peer review of the Hanhikivi 1 PSA?

4B.2	
Topic	Security / physical protection
Background	Requirements for security and physical protection are set in the Nuclear Energy Act, sections 19 and 7. The corresponding chapter in the ACL “Security and emergency response arrangements and other comparable arrangements” (Page 135) is very superficial.
Question(s)/ Remarks	Especially with regard to recent events in Brussels[14] security related measures gain even more importance, e.g. background checks on employees[15].

4B.3	
Topic	Emergency response operations
Background	Page 135 of the ACL states, *“Adequate routes for rescue operations will also be established at the plant site. For a more detailed description of the selected plant site, see Appendix 3C of this application.”*
Question(s)/ Remarks	Note there is little content on emergency planning, especially on site.

[14] https://en.wikipedia.org/wiki/2016_Brussels_bombings

[15] http://www.dailymail.co.uk/news/article-3507417/Brussels-bombers-DID-plan-attack-nuclear-power-station-police-uncover-12-hours-footage-jihadists-filmed-outside-plant-director-s-home.html, retrieved 30.03.2016.

4.5. Nuclear fuel and nuclear waste management at the nuclear power plant

Appendix 5 of the Application for a Construction License discusses nuclear fuel management (Appendix 5A) and nuclear waste management (Appendix 5B).

4.5.A. Appendix 5A: Nuclear fuel management plan

4.5.A.1. General Information

Information from the ACL:

The fuel for the Hanhikivi NPP shall be provided by the Russian TVEL, part of the Rosatom Group. TVEL will manufacture deliver and manufacture the fuel for at least 8 fuel cycles[16]. During this time the operator may test other fuel assemblies, also from other suppliers.
Fennovoima has preliminarily decided to use reprocessed uranium (RepU) at its NPP for the first operating years. This is not very common, but also not very different from using natural uranium.
The estimated number on uranium required per year is not very precise, it ranges from 20 to 40 tons of enriched uranium.

4.5.A.2. Requirements

The legal basis for the construction license application concerning fuel management is set in the following sections of the Nuclear Energy Act and the Nuclear Energy Decree.

Nuclear Energy Decree, Section 32, Paragraphs 4 and 9

"The application for a construction license shall be supplemented with […]

4) a description of the quality and maximum amounts of the nuclear materials or nuclear waste that will be fabricated, produced, handled, used or stored at the nuclear facility; […]

9) a description of the applicant's plans for arranging nuclear fuel management;

Nuclear Energy Act, Section 19, Paragraph 6

"A license for the construction of a nuclear facility other than that referred to in section 18 can be granted: [….]

(6) if the applicant's plans for arranging nuclear fuel management are sufficient and appropriate;"

Nuclear Energy Act, Section 7 h – Nuclear material and nuclear waste

"The nuclear facility shall have the facilities, equipment and other arrangements required to ensure the safe handling and storage of nuclear material required by the plant and any nuclear waste generated during operation.

Nuclear waste shall be managed so that after disposal of the waste no radiation exposure is caused, which would exceed the level considered acceptable at the time the final disposal is implemented.

[16] There is no mention of the duration of the fuel cycle.

The disposal of nuclear waste in a manner intended as permanent shall be planned giving priority to safety and so that ensuring long-term safety does not require the surveillance of the final disposal site.Nuclear waste management plans shall be kept up to date as provided in section 28."

4.5.A.3. Open questions / remarks

5A.1	
Topic	General / References
Background	Recommendations, Finish legislation and international agreements / recommendations are mentioned throughout the ACL, e.g. ACL, page 151: *"…implemented in accordance with Finnish legislation and international agreements."* ACL, page 152: *" … may be reduced to the recommended level, currently corresponding to approximately seven months' production operation."*
Question(s)/ Remarks	References to the laws, agreements and recommendations would be useful.

5A.2	
Topic	Nuclear fuel procurement and security of supply
Background	*"Nuclear fuel management at a nuclear power plant must be arranged so that the supply of nuclear fuel to the nuclear power plant is ensured throughout the planned service life of the plant, and so that the design, production, transportation and storage of nuclear fuel is properly controlled to ensure appropriate quality and safety."* (ACL, page 151)
Question(s)/ Remarks	This immediately suggests the question why the fuel contracts were signed for 8 fuel cycles and the entire reactor life (see also question 5A.6).

5A.3	
Topic	Reprocessed uranium (RepU) as nuclear fuel
Background	On page 151 of the ACL it is stated that *"Fennovoima has made a preliminary decision to use reprocessed uranium fuel during the first operating years. The contract signed provides Fennovoima with the option of choosing to use natural uranium instead of reprocessed uranium. Euratom Supply Agency, the European Union's nuclear fuel agency, approved the fuel supply contract between Fennovoima and TVEL in April 2014."*
Question(s)/ Remarks	It would be interesting to know, why the decision for reprocessed uranium was made. Are there economic reasons? Is RepU going to be standard for VVER-1200 reactors? Is the ESA approval publically available?

5A.4	
Topic	Nuclear fuel
Background	On page 151 of the ACL it is stated that *"The current contract allows Fennovoima to test alternative fuel assemblies in its reactor during the contract period. The testing will enable Fennovoima to carry out full tender process on nuclear fuel deliveries after the contract expires."*
Question(s)/ Remarks	Does the term *"alternative fuel assemblies"* mean other contractors or also other fuel type e.g. MOX?

5A.5	
Topic	Uranium supply
Background	The ACL states: *"Globally, there are both sufficient nuclear fuel raw materials and enough service providers available for Fennovoima to secure fuel deliveries to the nuclear power plant throughout its entire service life."* (page 151) or *"There are sufficient known global uranium resources to satisfy the needs of nuclear power …"* (page 153)
Question(s)/ Remarks	These statements are questionable. To support their argument Fennovoima quotes only industry sources (WNA). Other sources assume future uranium supply to be challenging, especially considering nuclear growth in China [17]. See e.g. Even a recent report of the WNA[18] states: "*As a result, existing and expected capacity plus secondary supply will be insufficient on current plans to meet reference scenario requirements by about 2024."*

5A.6	
Topic	Uranium requirements
Background	On page 153 of the ACL it is noted that *"The annual fuel consumption of a nuclear power plant with an electrical output of 1,200 MW is in the range of 20–40 tonnes of enriched uranium. To produce the required amount of fuel, an annual supply of 200–350 tonnes of natural uranium would be required."*
Question(s)/ Remarks	Why is there such a big difference in the uranium requirements? Is the first fuel load considered? Are there no detailed numbers on the fuel demand of a VVER-1200?

[17] Arnold, N, Gufler, K (2014): Comparing recent uranium supply scenarios. Presented at [URAM 2014 – International Symposium on Uranium Raw Material for the Nuclear Fuel Cycle, Vienna, AUSTRIA, JUN 23–27, 2014] In: IAEA, URAM-2014 Book of Abstracts, p.188.

[18] WNA(2013): The Global Nuclear Fuel Market: Supply and Demand 2013-2030

4.5.B. Appendix 5B: Overall nuclear waste management plan

4.5.B.1. General Information

Information from the ACL:

The Hanhikivi waste management plan is based on 60 years of operating time. The calculated values of waste are:

- 582 m³of very low level waste (VLLW)
- 5 400 m³ of low and intermediate level waste (LLW / ILW)
- 17 000 m3³ of decommissioning waste (no breakdown in waste classes)
- 1 200 to 1 800 t HM spent nuclear fuel (SNF)

VLLW: Very low level waste (< 0.1 MBq/kg) including very low level decommissioning waste will be disposed of in a landfill repository. The capacity of the landfill repository will be approximately 1,500 m³.

LLW/ILW: The reactor waste will be treated and (interim) stored in the power plant area. Final disposal of low and intermediate level waste will be at the plant site, in a depth of approximately 60–100 meters. Construction of the repository shall begin in 2030 and operation in 2035. The repository will be expanded at a later stage to also contain the decommissioning waste.

SNF: The spent nuclear fuel will be stored in the reactors SNF-pools for 3-10 years after use. Then, the SNF will be transferred to an interim storage at the site. There are currently two options under consideration a pool storage or a dry storage facility. A construction application is made for both types. There are also two options for the final disposal of the SNF. Either an agreement of nuclear waste management cooperation or Fennovoima's own final disposal facility. The latter requires the launch of an environmental impact assessment procedure by the end of June 2016. In any case the SNF will be deposited in Finnish bedrock using the KBS-3 method developed in Finland and Sweden. Final disposal of SNF will start no earlier than 2090.

Decommissioning plans in the ACL are not very detailed. Decommissioning shall start immediately after commercial operation, in 2085. It is expected to be completed in 2100 and generate approximately 17 000 m³ of very low level, low level and intermediate level dismantling waste.

4.5.B.2. Requirements

Nuclear Energy Decree, Section 32, Paragraphs 4 and 10

"The application for a construction license shall be supplemented with […]

4) a description of the quality and maximum amounts of the nuclear materials or nuclear waste that will be fabricated, produced, handled, used or stored at the nuclear facility; […]

10) a description of the applicant's plans and available methods for arranging nuclear waste management, including the decommissioning of the nuclear facility and the disposal of nuclear waste, and a description of the timetable of nuclear waste management and its estimated costs;"

Nuclear Energy Act, Section 19, Paragraph 5 and 6

"A license for the construction of a nuclear facility other than that referred to in section 18 can be granted: [….]

(5) if the methods available to the applicant for arranging nuclear waste management, including the final disposal of nuclear waste and the decommissioning of the facility, are sufficient and appropriate;

Nuclear Energy Act, Section 6 a – Management of nuclear waste generated in Finland

"Nuclear waste generated in connection with or as a result of use of nuclear energy in Finland shall be handled, stored and permanently disposed of in Finland."

Nuclear Energy Act, Section 7 g – Decommissioning

"The design of a nuclear facility shall provide for the facility's decommissioning, the related decommissioning plan being kept up to date as provided in section 28 herein.

When the operation of a nuclear facility has been terminated, the facility shall be decommissioned in accordance with a plan approved by the Radiation and Nuclear Safety Authority (STUK). Dismantling the facility and other measures taken for the decommissioning of the facility may not be postponed without due cause."

Nuclear Energy Act, Section 7 h – Nuclear material and nuclear waste

"The nuclear facility shall have the facilities, equipment and other arrangements required to ensure the safe handling and storage of nuclear material required by the plant and any nuclear waste generated during operation.

Nuclear waste shall be managed so that after disposal of the waste no radiation exposure is caused, which would exceed the level considered acceptable at the time the final disposal is implemented.

The disposal of nuclear waste in a manner intended as permanent shall be planned giving priority to safety and so that ensuring long-term safety does not require the surveillance of the final disposal site.

Nuclear waste management plans shall be kept up to date as provided in section 28."

4.5.B.3. Open questions/ remarks

5B.1	
Topic	Volume of LLW and ILW
Background	Table 5B-2 estimates a total of 2676 m³ of low-level waste (LLW) and 2082 m³ of intermediate level waste (ILW). The repository shall be designed for 3200m³ LLW and 2700 m³ ILW.
Question(s)/ Remarks	The design volumes of the repository are 20 % / 30% larger than the expected waste. Is this standard for repository design? Are there considerations for life-time extension and the necessity for additional storage capacities? What are the estimated shares of LLW and ILW for the 17 000 m³ of decommissioning waste and the corresponding repository volumes?

5B.2	
Topic	Amount of spent fuel
Background	Page assumes a fuel demand between 20 and 40 tons per year. This would result in 1200 – 2400 t HM in 60 years. On page 159 a *"spent nuclear fuel equivalent to between 1,200 and 1,800 tonnes of uranium"* is expected. The same higher number (1800 tons) can be found on page 163. Relates to the requirement Nuclear Energy Decree 32/4.
Question(s)/ Remarks	What is the maximum amount of spent fuel to be expected in 60 years, 1800 t HM or 2400 t HM?

5B.3	
Topic	Licensing documents - Interim storage / decommissioning
Background	*"Fennovoima is now applying for a construction license for both interim storage methods, and will supplement the construction license application materials, to be submitted to STUK, by the end of 2015 with a requirement specification for both methods, as well as an account of the fulfillment of the safety requirements related to interim storage operations. In addition, Fennovoima will submit an interim storage facility licensing plan to STUK for information, also by the end of 2015."* (ACL, Page 163) *"During the construction license application process, Fennovoima will submit the decommissioning plan required by section 35, paragraph 10 of the Nuclear Energy Decree (161/1988) to STUK."* (ACL, Page 166)
Question(s)/ Remarks	Are additional licensing documents available? NED 32/10 and NEA 7g require a decommissioning plan.

5B.4	
Topic	Costs of nuclear waste management
Background	Relates to the requirement Nuclear Energy Decree 32/10.
Question(s)/ Remarks	The chapter on costs of waste management consists of 4 sentences. Some more information on the calculations would be desirable.

Glossary

ACL	Application of Construction License
ESA	Euratom Supply Agency
HM	Heavy metal
ILW	Intermediate level waste
LLW	Low- level waste
NEA	Nuclear Energy Act
NED	Nuclear Energy Decree
NPP	Nuclear Power Plant
MOX	Mixed-oxide fuel (plutonium, uranium)
RepU	Reprocessed uranium
RG	Regulatory guide
SNF	Spent Nuclear Fuel
STUK	Säteilyturvakeskus, Radiation and Nuclear Safety Authority
VLLW	Very low-level waste
WENRA	Western European Nuclear Regulators Association