

4/J42211/2014

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*Unofficial translation*PRELIMINARY SAFETY ASSESSMENT OF THE FENNOVOIMA OY NUCLEAR POWER
PLANT PROJECT

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1. INTRODUCTION

On January 14, 2009, Fennovoima Oy submitted an application to the Government for a Decision-in-Principle concerning the construction of a new nuclear power plant at either Simo, Pyhäjoki or Ruotsinpyhtää. On April 15, 2009, the Ministry of Employment and the Economy requested the Radiation and Nuclear Safety Authority (STUK) to conduct a preliminary safety assessment pursuant to Section 12 of the Nuclear Energy Act.

Section 12 of the Nuclear Energy Act stipulates that it is the duty of STUK to draw up a preliminary safety assessment concerning the application for a Decision-in-Principle. In its request for a statement, the Ministry of Employment and the Economy referred to Section 14(1) of the Nuclear Energy Act, according to which a positive Decision-in-Principle may only be issued by the Government if no factors have arisen indicating a lack of sufficient prerequisites for constructing a nuclear facility in accordance with the provisions of Section 6 of the Act. Pursuant to this section, the use of nuclear energy must be safe and must not cause injury to people, or damage to the environment or property.

The application for a Decision-in-Principle concerns the construction of a new nuclear power plant in Finland. According to the application submitted by Fennovoima on January 14, 2009, the nuclear power plant will consist of one or two light water reactor nuclear power plant units, the buildings and storage facilities required for nuclear fuel management and nuclear waste management, and a repository for the disposal of low and intermediate level reactor waste generated in the operation of the nuclear power plant.

When submitting the application for a Decision-in-Principle, Fennovoima submitted to STUK documentation on the three plant alternatives (ABWR, EPR and SWR1000) for the preliminary safety assessment. On June 9, 2009, STUK requested further information on these alternatives and their implementation. Fennovoima responded to this request for additional information on June 17, 2009 and July 31, 2009 and later provided additional material. On October 20, 2009, STUK submitted its statement, a preliminary safety assessment and a statement from the Advisory Commission on Nuclear Safety to the Ministry of Employment and the Economy.

The Government issued Decision-in-Principle M 4/2010 vp, May 6, 2010 regarding the Fennovoima application. In its decision, the Government states that *the building of a new nuclear power plant and the nuclear facilities needed for its operation, at the proposed power plant site in either Pyhäjoki or Simo, in such a fashion as the application proposes in terms of key operating principles and safety and security arrangements, is for the overall good of society. The nuclear power plant may consist of one nuclear power plant unit with a maximum thermal output of 4,900 MW and a final disposal facility for the low- and medium-level nuclear waste generated by their operations. The application also concerns nuclear facilities related to the operations of the new*

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nuclear power plant and located on the same site, required for the storage of fresh nuclear fuel, interim storage of spent nuclear fuel, and the processing, storage and final disposal of low- and medium-level reactor waste.

In autumn 2011, following the reports and overall evaluation it had carried out, Fennovoima selected Hanhikivi, Pyhäjoki as the intended nuclear power plant site.

On December 21, 2013, Fennovoima signed a plant delivery contract with Rosatom Overseas CJSC regarding the AES-2006 nuclear power plant alternative. Fennovoima did not discuss the AES-2006 plant alternative in its application for a Decision-in-Principle dated January 14, 2009.

On September 23, 2013, Fennovoima requested STUK to review reports concerning the plant project by virtue of Section 55 of the Nuclear Energy Act. The reports submitted by Fennovoima describe the changes that have taken place in the Fennovoima project since 2009 in terms of the matters discussed in the preliminary safety assessment by STUK (9/J42211/2009). Fennovoima also requested STUK to review the reports in the extent that STUK observes when preparing a preliminary safety assessment as part of the Decision-in-Principle processes. Fennovoima later supplemented the material and on October 10, 2013 submitted reports on the AES-2006 plant alternative as well as Rosatom's organization and quality management. In connection with the technical reports on the plant alternative, Fennovoima submitted its own assessment of how the plant alternative fulfils the requirements presented in the Government Decree on the Safety of Nuclear Power Plants. Fennovoima's assessment of the safety of the AES-2006 plant alternative was based on the draft decree dated August 26, 2013 and submitted to Fennovoima during a decree amendment process. The revised Government Decree on the Safety of Nuclear Power Plants (717/2013) entered into force on October 25, 2013.

STUK initiated the preparation of a preliminary safety assessment and submitted a request for clarification regarding the aforementioned reports on November 27, 2013. Fennovoima submitted additional reports on February 7, 2014 in response to the request for additional information.

On March 4, 2014, Fennovoima submitted to the Government an application for a supplementary decision on the nuclear power plant. The new decision would supplement the valid Decision-in-Principle issued in 2010, confirming that the Fennovoima project is still in line with the overall good of society, as set forth in Section 11 of the Nuclear Energy Act. Therefore, the Ministry of Employment and the Economy has submitted a request for a statement (TEM/11/08.04.01/2014) on March 6, 2014 and requested STUK to issue a preliminary safety assessment of the project outlined in the application under Section 12 of the Nuclear Energy Act. In its request for a statement, the Ministry requested STUK to especially focus on the changes that have taken place in the project. Furthermore, the Ministry reminded that STUK must

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append a statement from the Advisory Commission on Nuclear Safety to the safety assessment in accordance with the Nuclear Energy Act. The Ministry set a target deadline of May 25, 2014 for the preliminary safety assessment and the statement from the Advisory Commission.

This preliminary safety assessment comprises an evaluation of the AES-2006 plant alternative and the safety of the site location in Hanhikivi, Pyhäjoki as well as the licence applicant's organization, management system and quality management. The preliminary safety assessment also addresses security arrangements, emergency response arrangements, nuclear fuel management, nuclear waste management, nuclear liability and nuclear safeguards.

2. ASSESSMENT OF THE AES-2006 PLANT ALTERNATIVE

The following is a summary by STUK of how the design objectives and design principles of the AES-2006 plant alternative conform with the requirements of the Government Decree on the Safety of Nuclear Power Plants (717/2013, October 25, 2013). The detailed assessment on which this summary is based is given in Appendix 1.

The preliminary safety assessment concerns the AES-2006 nuclear power plant equipped with a pressurized water reactor. The key data of the plant alternative are given in Table 1.

Table 1. Key data of the plant alternative.

Unit	Supplier	Type	Thermal output [MW _t]	Electrical output [MW _e]
AES-2006/V491	Rusatom Overseas CJSC	Pressurized Water Reactor	3,220	approx. 1,200

The preliminary safety assessment is based on the following fundamental requirements laid down in the Government Decree on the Safety of Nuclear Power Plants (717/2013):

- assessment and verification of safety (Section 3),
- limitation of radiation exposure and releases of radioactive materials (Sections 8–10),
- prevention of accidents and mitigation of consequences (Section 12)
- engineered barriers for preventing the dispersion of radioactive materials (Section 13),
- safety functions and provisions for ensuring them (Section 14),
- protection against external events (Section 17),
- protection against internal events (Section 18),

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- monitoring and control of nuclear power plant (Section 19),
- safety culture (Section 28),
- safety and quality management (Section 29), and
- lines of management, responsibilities and expertise (Section 30).

STUK shall specify the detailed safety requirements for the implementation of the safety level in accordance with the Nuclear Energy Act. These requirements are presented in the YVL Guides. Fulfilment of the requirements presented in the YVL Guides will be assessed in more detail at later phases of the licensing procedure. STUK has updated all YVL Guides. Most of the new YVL Guides entered into force on December 1, 2013 and the Guides apply to new nuclear facilities as such.

The AES-2006 is a pressurized water reactor with an output of approximately 1,200 MW_e marketed by Rusatom Overseas CJSC, a subsidiary of Russian ROSATOM. There are two different development versions of the AES-2006 plant: AES-2006/V392M and AES-2006/V491. This preliminary safety assessment discusses the AES-2006/V491 development version presented in Fennovoima's application. The design service life of the plant is 60 years.

The AES-2006 is based on the VVER 91/99 plant, which is developed from the operating VVER-1000 plants. Plants of the VVER type have been constructed in Russia and many other countries for more than 30 years. The Loviisa 1 and 2 plant units are based on the VVER-440 plant type. A reference plant of the Fennovoima plant alternative is the Leningrad NPP-2, which is currently under construction in Russia. The Leningrad NPP-2 comprises two plant units, which, together with the Novovoronezh-2 plant unit (AES-2006/V392M), are the first AES-2006 type plants in Russia. In Russia, one more unit is under construction in Kaliningrad (AES-2006/V491) in addition to the Leningrad NPP-2 plant units. The construction of the Leningrad NPP-2 was started in 2008.

The safety functions of the AES-2006 have been improved compared to the VVER-91/99. The safety functions of the AES-2006 plant are primarily implemented by means of active systems and supplemented, as is typical with pressurized water reactors, with safety injection accumulators. Furthermore, the plant is equipped with passive systems for residual heat removal. The new systems to be used during disturbances and accidents are the residual heat removal system connected to the steam generators for cooling the primary circuit and the passive containment cooling system. Both of these are based on natural circulation. Experimental substantiation of the functionality of the new passive systems is a prerequisite for their approval.

The basic design of the plant is at an advanced level. The design objectives and design principles mainly comply with the Finnish safety requirements. Based on the material submitted to STUK, it cannot be ascertained in detail on a system level and, therefore, comprehensively on a plant level that the redundancy, separation and diversity solutions that are employed by the

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systems that ensure the safety functions of the AES-2006 plant alternative conform with the Finnish requirements.

According to the Finnish requirements, the design of nuclear power plants shall take the crash of a large commercial airliner into consideration as an external hazard. The design of the plant shall take into account the direct and indirect effects of an airliner crash. The protection strategy of the AES-2006 plant against a large airliner crash is to construct the outer containment to withstand such a crash. Furthermore, the strategy uses shielding and separation by distance to protect the safety functions. In the absence of more extensive structural protection, it is difficult to demonstrate the adequate retention of the safety functions in the event of an aircraft crash. The plant supplier has presented options for the reinforcement of the structural protection of the buildings that are deemed the most important to safety. STUK finds that conformity with the Finnish safety requirements with regard to an aircraft crash has not yet been demonstrated. The solution presented now requires more detailed design and analyses as well as plant modifications to demonstrate compliance with the safety requirements.

In the AES-2006 plant alternative, the structural elements of the safeguard building that contain safety systems (safety divisions) are located side by side and connected by service corridors and air-conditioning system channels. These connections between the redundant subsystems are separated by doors and dampers, rendering the adequate implementation of fire compartmentation and other physical separation of the redundant subsystems of the safety systems questionable. According to the Finnish requirements, system design shall apply the separation principle to ensure the implementation of the safety functions even in the event of a failure and during internal and external hazards. The redundant parts of a system implementing safety functions shall be assigned to separate safety divisions. Doors, hatches and penetrations between the safety divisions shall be avoided. STUK finds that compliance with the Finnish safety requirements with regard to internal or external events, including flooding and fires, has not yet been demonstrated. The solution presented requires more detailed design and analyses as well as plant modifications to demonstrate compliance with the safety requirements.

The AES-2006 features severe accident management systems. However, the depressurization of the primary circuit in a severe accident is not in line with the Finnish safety regulations because the depressurization is planned to be carried out using the safety valves in the primary circuit that are designed for the operational conditions and postulated accidents of the plant. The Finnish regulations require that the severe accident systems are independent of the plant's operational conditions and the systems designed for postulated accidents. The plant design shall be modified in this respect.

According to the preliminary safety assessment by STUK, the AES-2006 plant alternative can be brought to fulfil the Finnish nuclear and radiation

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safety requirements following the implementation of design changes as well as additional analyses and qualification. According to STUK's judgement, the necessary further engineering and modifications can be carried out while preparing for the construction license phase in such a manner that the requirements set forth in Government Decree (717/2013) can be met at the construction licence phase. The technical details that in STUK's current opinion do not comply with the requirements of the Decree are presented in Appendix 1.

3. ORGANIZATIONS

The Government Decree on the Safety of Nuclear Power Plants (717/2013) lays down the licensee's duties concerning the implementation and operation of a plant project. These duties require the organization in question to have a wide range of expertise available. Furthermore, the Decree sets requirements for the management system. STUK evaluates the organizations against the Finnish requirements and, in its evaluation, draws on recent experiences of the construction of nuclear power plants.

At this point, the assessment focuses on the Decision-in-Principle applicant and on the plans and procedures that the applicant has in place to control and supervise other organizations that contribute to the plant delivery.

Expertise

Fennovoima Oy is planning its first nuclear power plant project, and the company has no prior experience of nuclear power plant construction projects, construction or operation. As a new company, it needs to organize and find resources for its operations from scratch. In Finland, the licensee shall ensure safety, and for this purpose the licensee's organization must have sufficient expert resources.

According to the plans presented in 2009, it was Fennovoima's intention to build up its organization gradually, relying heavily on the expert resources and competence of its largest individual owner at the time, German energy company E.ON AG. E.ON has since withdrawn from the project. E.ON's withdrawal does not introduce any changes into Fennovoima's responsibility to ensure adequate expertise for the project. Fennovoima plans to replace E.ON's expertise primarily by reinforcing its own organization. Furthermore, Fennovoima proposes that it will utilise external experts as consultants, and the company has conducted preliminary negotiations with Rosatom on exchange of experts and consulting services, among other matters. Fennovoima also intends to support its operations by using one or more "Owner's Engineer" consulting companies.

At the end of March 2014, Rosatom's Finnish subsidiary RAOS Voima Oy became Fennovoima's second owner with a share of 34 per cent. With a view to the licensee's indivisible responsibility, it is important, even in such an

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ownership arrangement, for Fennovoima to have resources independent of the Rosatom design organization to assess the key issues significant to the safety of the plant. According to Fennovoima, the core competence of its organization will be independent of the competence of other organizations. According to the Nuclear Energy Act, the licensee has indivisible responsibility for safety, and any other organizations may not affect the priority of safety.

Rosatom's project implementation organization has not yet been decided on and, therefore, it is presented on a rather general level in Fennovoima's report. STUK finds that having a clear and comprehensive definition of the implementation organization and responsibilities in the design phase is essential to ensure well managed operations and to identify the needs and risks related to the interfaces between the various parties involved in the project.

Fennovoima states in its application that it will have access to a sufficient number of experts during the design, construction and commissioning phases for the duties required in Government Decree (717/2013). Fennovoima presents preliminary resourcing plans for the various phases of the project and notes that it is aware that it is competing over a limited pool of expert resources in the field of nuclear energy.

Fennovoima plans to considerably reinforce its own organization in the next few years. Fennovoima states that it is preparing a strong recruitment phase in order to reinforce its organization extensively. Through recruitment, Fennovoima aims to reinforce its competence in terms of technology and project management, especially. According to Fennovoima's application, the organization, at the time of transitioning from the procurement phase to the implementation phase in early 2014, comprised some 80 persons. At the time of this assessment, the number of experts in the Fennovoima organization is not in line with the plans it presented for this project phase in 2009 (150–200 persons in the procurement and licensing phase). According to the plans that the company presented in the application for supplementing the Decision-in-Principle, its organization will comprise some 200 persons by the end of 2014 and some 300 persons by the end of 2015. A timely, well planned and managed reinforcement of competence is important for creating an organization that supports safe operations. During the strong growth of the organization, it is necessary to pay attention to information management and knowledge management as well as other risks related to the changes taking place in the organization.

The resources required for plant operation can be planned in more detail once the implementation schedule has been decided on. Resource acquisition and the development of expertise can proceed in parallel with the construction project.

When processing the construction licence application and operating licence application, STUK will pay particular attention to the availability of sufficient

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expertise in the applicant's own organization. STUK finds it important that Fennovoima have sufficient expertise concerning safety and quality matters available already for the design phase taking place before the application for a construction licence.

Management system during design and construction

The provisions on safety culture and on safety management and quality management laid down in Chapter 7 of the Government Decree on the Safety of Nuclear Power Plants (717/2013) apply, in addition to Fennovoima itself, to all organizations involved in the design and construction of the Fennovoima nuclear power plant whose involvement affects the safety of the plant unit.

According to Section 28 of Government Decree 717/2013, when designing, constructing, operating and decommissioning a nuclear power plant, a good safety culture shall be maintained. Fennovoima has prepared a safety culture programme that presents, among other things, the objectives of the safety culture and the principles for assessing and developing the safety culture. STUK finds that the safety culture programme presented for the Decision-in-Principle phase is comprehensive.

The development of Fennovoima's management system is ongoing. Fennovoima is committed to creating an integrated management system for the project, based on the industry standards and meeting the requirements of the YVL Guides in all project phases. For the revision of the preliminary safety assessment, Fennovoima has, among others, presented to STUK the current status of its management system, the primary processes and their implementation schedules. The plans presented by Fennovoima demonstrate that the company is familiar with the Finnish requirements concerning a nuclear facility licensee and its management system.

In its preliminary safety assessment of Fennovoima Oy's nuclear power plant project in 2009, STUK stated the following:

Fennovoima states that it will be responsible for the Nuclear Power Plant being built in compliance with Finnish safety and quality requirements and, by extension, for undertaking quality management as per requirements. Fennovoima will require that Finnish nuclear energy legislation and official instructions as well as professional standards in the sector be taken into account in the quality management of any participating actors whose work will have a bearing on nuclear and radiation safety. Fennovoima proposes that its own personnel and all its suppliers, subcontractors and other partners involved in functions relevant for safety be required to commit to systematic safety and quality management. The required procedures will be included in the management system for the design and construction project and runtime operations.

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Fennovoima proposes that the quality management system of the applicant be presented within the management system of the construction project. The management system is to be drawn up as an integrated system including not only quality management but also the project policies, project plan and organization.

In this system, safety relevance will be taken into account in the defining of products and functions so that the quality requirements will be the strictest for the devices, systems and functions that are the most critical for safety, and the procedures employed to ensure compliance will be the most comprehensive.

Fennovoima notes that attainment of the following objectives will be particularly considered in defining quality management procedures:

- *ensuring compliance with safety requirements*
- *fulfilling quality requirements for devices, systems and structures*
- *ensuring that project personnel has the required expertise in safety management, quality management and safety culture*

According to the Fennovoima application, it will require its suppliers to uphold a high-quality safety culture and also require its suppliers to require the same of their own subcontractors in turn. Fennovoima states that it will evaluate the safety culture of the potential power plant unit suppliers and of subcontractors relevant for the safety of the project. STUK requires that if and when the Nuclear Power Plant project proceeds, Fennovoima must establish procedures for developing and monitoring a safety culture covering the entire project and agree on these procedures in advance with the power plant unit supplier and key subcontractors.

Fennovoima has not presented any changes to the above operational principles in connection with its application for supplementing the Decision-in-Principle.

Under Section 29 of Government Decree 717/2013, systematic procedures shall be in place for identifying and correcting the deviations that are significant in terms of nuclear safety and radiation safety. STUK requires Fennovoima to ensure that all parties participating in the project employ effective and uniform procedures in the reporting, classification, processing and approval of deviations.

According to Fennovoima, supply chain management is a key factor in the successful quality management of the nuclear power plant project. Fennovoima states that it will communicate to the plant suppliers and subcontractors the project quality requirements set for each phase of the project and that it will monitor safety management and quality management in the organizations participating in the construction project. The means proposed by Fen-

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novoima include supplier assessments (including audits), delivery monitoring, requirement management, inspections and testing.

Under Section 29 of Government Decree 717/2013, the organizations participating in the design and construction of a nuclear power plant shall employ a management system to ensure the management of nuclear safety and radiation safety as well as quality. According to Fennovoima, the management system of the plant supplier, Rosatom, is based on international standards. Rosatom is also committed to comply with the IAEA's GS-R-3 (Management System for Facilities and Activities) nuclear requirements. The compliance of Rosatom's management system with the IAEA's GS-R-3 requirements has not been demonstrated. In the design phase, the management system of the plant supplier must meet the requirements applicable to the nuclear industry.

According to Fennovoima, the nuclear power plant implementation project will proceed in phases, from design to construction, commissioning and finally to operation. The quality management procedures for each phase will be planned before the phase in question is started. The project design phase and plant design phase is currently ongoing. Fennovoima does not have approved procedure descriptions for the processes of risk management, supplier quality management supervision, nuclear safety assessment and radiation safety assessment, and plant design supervision, for example. There are plans to have procedure descriptions approved in 2014. Fennovoima must manage the strong growth of its own organization simultaneously with the ongoing plant design phase and project design phase, which emphasizes the role of having procedures and process descriptions that can be communicated clearly in place.

STUK finds that Fennovoima is still far from having in place a management system that would meet the Finnish requirements in the construction licence phase. The current shortcomings of the management system are related to, among other matters, design management, plant configuration management, quality management, evaluation of nuclear safety and radiation safety, project management, risk management, improvement of operations, competence management, training and site management. The development and implementation of the processes and procedures of the management system requires Fennovoima to act promptly and obtain additional resources.

At the time of this assessment, Fennovoima has approximately one year to submit its construction licence application to the Government. Guiding the design of the AES-2006 plant alternative to comply with the Finnish safety requirements, preparing the documentation to be submitted to STUK in the construction licence phase and verifying the compliance of the documentation require Fennovoima to take measures even before it submits a construction licence application. The task is demanding and, considering Fennovoima's current resources and management system, STUK finds it questionable that the company would be able to submit comprehensive documenta-

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tion to STUK when submitting a construction licence application to the Government.

Management system during plant operation

Under Section 29 of Government Decree 717/2013, the organizations participating in the operation of a nuclear power plant shall employ a management system to ensure the management of nuclear safety and radiation safety as well as quality.

Fennovoima does not have experience concerning a management system for the operation of a nuclear power plant. Fennovoima intends to develop its operational competence during the construction of the plant. There are plans to support these development efforts with Rosatom's competence, external expertise and international operational instructions, for example. According to Fennovoima, the operation and decommissioning phases of the power plant will be taken into account from the outset of the nuclear power plant implementation project.

Provided that the company follows the procedures presented in the application for supplementing the Decision-in-Principle, Fennovoima has the prerequisites to create a management system conducive to the management of safety and quality as well as a good safety culture for the operation phase of its nuclear power plant.

4. SITE

The Nuclear Energy Act stipulates that, when considering a Decision-in-Principle, the Government shall pay particular attention to the suitability of the intended site of the nuclear facility (Nuclear Energy Act, Section 14(2)). The site of the nuclear facility must be appropriate with respect to the safety of the planned operations, and environmental protection must be taken into account appropriately when planning operations (Nuclear Energy Act, Section 19(2)). Furthermore, there must be a site reserved for the construction of a nuclear facility in a local detail plan prepared in accordance with the Land Use and Building Act (132/1999), and the applicant must be in possession of the site as required for the operation of the facility (Nuclear Energy Act, Section 19(4)).

According to Section 11 of the Government Decree on the Safety of Nuclear Power Plants (717/2013), site selection must also take into account the impact of local conditions on safety as well as on security arrangements and emergency arrangements. The site must be such that the impediments and hazards to the vicinity of the plant arising from the plant are minimal and that heat removal into the environment can be reliably implemented.

According to the 2010 Decision-in-Principle by the Government concerning the Fennovoima nuclear power plant project, the alternative sites are Han-

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hikivi, Pyhäjoki and Karsikko, Simo. Fennovoima has later announced that it has selected Hanhikivi, Pyhäjoki as the intended site. The planned site is an even, wooded headland located approximately 20 kilometres southwest from central Raahe and has no agriculture and little housing. The housing is located close to the shore and mainly consists of recreational housing.

No significant changes have taken place at the planned nuclear power plant site since the preliminary safety assessment carried out by STUK in 2009.

Implementation of the nuclear power plant project requires that the necessary land areas are reserved for the plant in the regional land use plan, the local master plan and the local detail plan for the area in question.

The land use planning at the plant site has mostly been completed: the regional land use plan that indicates the precautionary action zone that is used in the emergency planning for the nuclear power plant has become legally valid. The local master plan became legally valid in the summer of 2013, and the local detail plans are mostly legally valid. STUK has issued a statement in terms of nuclear safety on all the processed land use plans. The supplementary information regarding environmental impacts that is required by the Ministry of Employment and the Economy to process the application for a Decision-in-Principle has been considered in the statements issued and will be considered in any future statements. STUK finds that radiation safety and nuclear safety aspects can be appropriately taken into consideration in Pyhäjoki in the land use plans that have not yet been processed.

Housing in the precautionary action zone has not materially increased since 2009, and the existing land use plans restrict the construction of housing in the area. At the moment, one road leads to the intended power plant site, but the land use plan includes another road to the area. In terms of emergency planning, the road arrangements laid down in the land use plan meet the future requirements concerning the accessibility of the plant. The plant site offers sufficient space for the access arrangements necessary for emergency planning (including evacuation and an entry route for the fire and rescue services).

Fennovoima has commissioned geological and ground surveys of Hanhikivi from the Geological Survey of Finland and consulting companies in the field. Findings from the topographical and magnetic studies of the bedrock were presented in the application for a Decision-in-Principle. During the processing of the application for a Decision-in-Principle in 2009, Fennovoima submitted to STUK findings from drill sampling and seismic surveying of the bedrock at the Hanhikivi site.

In Finland, the buildings important to the safety of a nuclear power plant must be built on the bedrock. Ground surveys are used to ascertain that the bedrock is sufficiently near the surface in order to build the foundations. Geological studies are employed in order to study rock fracturing and water

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conductivity, which are relevant when assessing the suitability of the site for the disposal of low and intermediate level reactor waste in the bedrock.

In the preliminary safety assessment in 2009, STUK found that sufficient studies of the geological properties had been carried out at the Hanhikivi site for the application for a Decision-in-Principle to be processed. The geological characteristics of the intended site can be taken into account in the design of the plant. No issues have emerged that would prevent the construction of the new nuclear power plant or the related repository for reactor waste in compliance with the safety requirements.

Earthquakes are also taken into account when designing the new nuclear power plant. Pyhäjoki is located in a transition zone between the seismically quiet zone in Southern Finland and the considerably more active zone in Northern Finland. For the 2009 application for a Decision-in-Principle, Fennovoima commissioned preliminary studies concerning design basis earthquakes from the University of Helsinki Institute of Seismology and, to support the processing of the application, STUK commissioned an independent report from a consulting agency experienced in the field.

After the Decision-in-Principle issued in 2010, Fennovoima has continued to conduct reports to define the design basis earthquake in collaboration with the Institute of Seismology and consulting agencies in the field and submitted results to STUK for processing. Fennovoima has proposed that the design basis for the Pyhäjoki bedrock should be a peak ground acceleration value of 0.2 g, whereas the equivalent value in Olkiluoto and Loviisa is 0.1 g. According to the information submitted by the plant supplier, the reference plant is designed for a PGA of 0.12 g but the design basis can be increased to PGA 0.25 g through minor technical modifications.

STUK finds that sufficient seismic reports have been carried out at the intended site for the application for a Decision-in-Principle to be processed and that the seismic properties of the site do not prevent building the plant in compliance with the Finnish safety requirements.

However, concluding its review of the reports submitted in 2010, STUK stated that before approving the design basis earthquake proposed by Fennovoima, it is necessary to conduct some additional studies to confirm the methods and initial data used in defining the design basis earthquake. Fennovoima is carrying out a STUK-approved programme to conduct the necessary additional reports in collaboration with the Institute of Seismology as well as other Finnish and foreign experts. The final approval of the seismic design bases shall be evaluated in connection with processing the construction licence application.

Fennovoima has commissioned preliminary studies of extreme weather phenomena, extreme sea levels and ice conditions at the intended site from the Finnish Meteorological Institute, the Finnish Institute of Marine Re-

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search and consulting companies. There are no exceptional special features in the weather conditions at the site. Sea level variation is relatively high in the Pyhäjoki region, but this variation can be taken into consideration when designing the new unit. In the winter, packed ice forms in Pyhäjoki, and this can be taken into consideration when designing the water intake structures. The occurrence of extreme weather phenomena and the impact of climate change upon them are also studied in the ongoing Finnish Research Programme on Nuclear Power Plant Safety, SAFIR2014.

After the Decision-in-Principle, Fennovoima submitted to STUK its proposal for the design bases regarding the weather phenomena and sea levels. According to an assessment by STUK and an independent statement, the proposed values did not warrant any comments. When processing the construction licence application, the adequacy of the design bases related to extreme weather phenomena and sea levels will be assessed based on the most recent knowledge in the field in cooperation with independent experts. STUK finds that preparations for extreme weather phenomena, sea level variation and ice conditions can be made at the intended site taking the necessary safety aspects into consideration.

Large quantities of sea water are required for cooling the turbine condenser of the nuclear power plant. There are no known obstacles to implementing the sea water intake and discharge arrangements presented in the application for a Decision-in-Principle in compliance with the safety requirements. Fennovoima will commission the detailed geological surveys required for the excavation of the sea water tunnels when preparing the construction licence application.

The effects of the heated cooling water that is discharged into the sea have been studied in the 2014 environmental impact assessment report.

The processes of a nuclear power plant require substantial quantities of purified fresh water. Large quantities of purified process water may be required in cases of disturbances occurring in the sea water cooling system and for the management of certain accidents. A nuclear power plant must have the facilities for the pumping, storage, purification and demineralization of raw fresh water. Fennovoima has explored alternative ways of obtaining raw water at the intended site and described them in the environmental impact assessment report. The reports on raw water sourcing are sufficient for the purposes of the preliminary safety assessment of the application for a Decision-in-Principle.

There are no industrial or storage facilities, land transportation routes or gas pipes in the vicinity of the intended site where accidents could pose a hazard to the proposed nuclear power plant.

In comparison with the Gulf of Finland, there is less ship traffic, especially oil transportation, in the vicinity of Pyhäjoki, and the ships operating in the area

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are typically of smaller size. Therefore, the risk of a major oil spill is substantially lower.

If oil were to enter a sea water cooling systems, it could decrease the efficiency of sea water cooling or, in the worst case, clog cooling systems. The compromised cooling water intake because of oil or other chemicals in the sea water, algae or ice formation, will be taken into account in the technical design of the plant. According to the requirements in force, a new power plant unit must be designed so that it can survive at least a three-day interruption of sea water cooling.

Under the Aviation Act (1194/2009), a no-fly zone may be defined around a nuclear power plant. The purpose of the no-fly zone is to prevent disturbing light aircraft traffic and to reduce the risk of crashes. The no-fly zone cannot prevent a terrorist attack. No-fly zones are enacted on a case-by-case basis in a Government decree. However, legislation does not stipulate that there must be a no-fly zone around every nuclear power plant. Furthermore, legislation does not stipulate how large the no-fly zone should be if there is one. The existing nuclear power plants at Loviisa and Olkiluoto have no-fly zones with a radius of 4 km and an altitude of 2,000 m, as laid down in Section 4 of Government Decree 1374/2009.

The airports closest to Hanhikivi in Pyhäjoki are the Raahe general aviation airfield located approximately 30 km away and the Oulunsalo commercial airport located 70 km away. If a nuclear power plant were built in Hanhikivi, it would not have any impact on the operations of the airports, nor would air traffic cause any safety concerns at the site. In 2009, Finavia, the body that operates the airports, issued a statement to the Ministry of Employment and the Economy on the Fennovoima nuclear power plant project, stating that it is entirely possible to enact a no-fly zone at Hanhikivi similar to that in force at the operating nuclear power plants.

STUK finds that air traffic does not constitute an obstacle to the construction of the nuclear power plant at the intended site.

Reliable connections from the nuclear power plant to the national grid are necessary to ensure uninterrupted electricity production and transfer and, if necessary, the feeding of electricity from the national grid to the plant. In order to ensure that the power plant's safety systems have power in case of a disturbance or an accident, the nuclear power plant units have their own emergency power supply.

A new 400 kV power line connection will be needed from the new power plant unit to the national grid, and 100 kV power lines at the chosen site will have to be boosted. Under the Electricity Market Act, responsibility for developing the national grid and maintaining its systems rests with Fingrid Oyj, which is thereby obliged to strengthen the national grid as required and to ensure sufficient reserve capacity for disturbances. Fingrid Oyj is also re-

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sponsible for conducting any environmental impact assessments needed to strengthen the national grid. On June 15, 2009, Fingrid issued a statement to the Ministry of Employment and the Economy concerning the Fennovoima application for a Decision-in-Principle. According to this statement, the planned nuclear power plant of one or two plant units can be connected to the national grid at the proposed sites. Fingrid further presented preliminary plans on how the Fennovoima nuclear power plant could be connected to the national grid and how the national grid should be strengthened depending on the site and output alternative chosen. The power plant currently under assessment has a lower output than what was presented in the 2009 application for a Decision-in-Principle and, therefore, the conclusions concerning the connection to the national grid remain valid.

As far as STUK is concerned, the intended site of the new nuclear power plant proposed by Fennovoima has been studied sufficiently for the application for a Decision-in-Principle to be processed. It is the considered opinion of STUK that there are no features at the proposed site that would prevent the construction of the new nuclear power plant and the other related nuclear facilities referred to in the application for a Decision-in-Principle in compliance with the safety requirements.

In terms of nuclear waste management, the proposed site is also discussed in chapter 8 and the security arrangements and emergency arrangements are discussed in chapter 5.

5. EMERGENCY ARRANGEMENTS AND SECURITY ARRANGEMENTS

The purpose and objectives of emergency arrangements

According to Section 7 of the Nuclear Energy Act, sufficient security arrangements and emergency arrangements as well as other arrangements to limit nuclear damage and protect the use of nuclear energy against unlawful action are a prerequisite for the use of nuclear energy.

'Emergency arrangements' refer to advance preparation for accidents or events impairing safety at the nuclear facility or in its area (Nuclear Energy Act, Section 3). Emergency arrangements must take the event that significant quantities of radioactive material are released from the plant, even if the likelihood of such an event is extremely low, into consideration. Requirements for emergency arrangements are given in Section 7 p of the Nuclear Energy Act and in the Government Decree on Emergency Response Arrangements at Nuclear Power Plants (716/2013). The emergency arrangements to be implemented by the licensee include the emergency plan, a trained emergency organization and the facilities, equipment and communication systems commensurate with the duties in question.

Under the Government Decree on Emergency Response Arrangements at Nuclear Power Plants (716/2013), there must be a precautionary action

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zone and an emergency planning zone around a nuclear power plant. The purpose of defining these zones is to facilitate planning and executing the emergency arrangements, but the zones do not designate safe perimeters outside which the effects of an accident would be less severe than inside them. STUK expects that it is possible to evacuate the persons in the precautionary action zone within approximately four hours from taking the decision to evacuate and that, within the same period of time, the persons in the emergency planning zone can prepare to stay indoors for some 48 hours.

The precautionary action zone is an area that extends approximately 5 km from the power plant and where land use restrictions are in force.

The emergency planning zone extends approximately 20 km from the plant and authorities must draw up a rescue plan for this zone as laid down in Section 48 of the Rescue Act (379/2011). Ministry of the Interior's Decree on external rescue plans for sites posing a special hazard (406/2011) sets out the detailed requirements for the contents of such a plan. The rescue plan shall specify how to warn the residents in the zone and which rescue measures to undertake. In case of a severe nuclear power plant accident, possible protective measures include taking cover indoors, ingesting iodine tablets and, as an extreme measure, evacuating the danger area. Therefore, the construction of a nuclear power plant also imposes obligations on the authorities. Fennovoima has engaged in negotiations with authorities concerning local population rescue planning.

A precautionary action zone has been defined in the regional land use plan for the proposed nuclear power plant site at the Hanhikivi headland in Pyhäjoki. The precautionary action zone and its land use restrictions will be shown in whole in the relevant regional land use plan. The emergency planning zone will be defined in more detail (according to municipal boundaries or local communities) in the regional rescue plan, drawn up jointly by the licensee and local rescue services during the construction phase of the nuclear power plant.

Under the Nuclear Energy Decree, the licensee must submit plans and reports on its preparedness for emergency situations together with the application for a construction licence, to which a preliminary emergency plan referred to in Section 36(1)(5) of the Nuclear Energy Decree must be appended. When applying for the operating licence, the licensee must submit the final emergency plan and demonstrate that all the other emergency arrangements requirements have been fulfilled (emergency organization, facilities, equipment, training etc.). STUK will approve the emergency plan when processing the applications for the construction licence and operating licence.

In emergency situations, the licensee shall be prepared to carry out radiation monitoring at the power plant site and precautionary action zone, alongside meteorological measurements, on the basis of which the dispersion of radio-

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active materials in the emergency planning zone will be assessed (Government Decree 716/2013, section 4). Fixed measuring points for this purpose will be designed and built, and instructions for these arrangements drafted, at the construction phase of the nuclear power plant.

Emergency exercises must be held at regular intervals at the nuclear power plant in order to test the emergency arrangements jointly with the local rescue services and with regional and national authorities. Emergency training for the personnel of the nuclear power plant will be provided during the construction phase of the plant unit. The adequacy of the emergency arrangements shall be demonstrated by means of an exercise before the commissioning of a new nuclear power plant unit (Government Decree 716/2013, Section 7).

Before the commissioning of the nuclear power plant, the licensee shall, in cooperation with the local rescue services, supply the population in the emergency planning zone in advance with instructions on preparing for a nuclear accident and distribute iodine tablets in advance to the population in the precautionary action zone. In the event of an accident, the licensee shall participate in warning any members of the population who are under imminent threat (Government Decree 716/2013, Section 13).

It is advantageous for emergency arrangements if the plant is located in a sparsely populated area, well away from large population centres. In this case, the measures preparing for an accident concern a small population.

The Hanhikivi headland in Pyhäjoki is in a sparsely populated area. There are no permanent residents on the headland, and there are relatively fewer leisure homes there than elsewhere on the waterfront of Pyhäjoki. At the moment, one road leads to the intended site in the Hanhikivi headland, but the land use plan includes two exit roads from the area. In terms of emergency planning, the road arrangements laid down in the land use plan meet the requirements set for accessibility of the plant. The plant site proposed has enough space for the facilities and access arrangements needed for emergency planning (including evacuation and entry routes for the fire and rescue services).

The nearest community, Parhalahti village (population approximately 400), is about 4 km from the proposed site. Parhalahti village is wholly included in the proposed precautionary action zone as outlined in the regional land use plan relevant to Hanhikivi. Therefore, the precautionary action zone includes about 450 permanent residents as well as some 40 leisure homes. The emergency planning zone, within a radius of about 20 km from the nuclear power plant site, has a permanent population of about 11,300 residents. Within a radius of 100 km, the population totals some 370,000 residents. The nearest major industrial facilities and the harbour are located some 15–16 km from Hanhikivi.

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According to STUK's assessment, emergency arrangements required by the Guides can be implemented in the precautionary action zone and the emergency planning zone, provided that the road infrastructure is constructed according to the land use plan and effective warning and protection measures for the population are ensured.

According to STUK's assessment, Fennovoima has the capability to implement the emergency arrangements to prepare for potential accidents at the nuclear power plant as required by the law. STUK finds that the early warning and evacuation arrangements concerning the permanent population in the immediate vicinity, for which the rescue services are responsible, can be implemented at the site.

Security arrangements

According to the Nuclear Energy Decree (Section 24(2)(5)), the application for a Decision-in-Principle must include a report on the suitability of the proposed site for its purpose, considering the effects of local conditions on security arrangements.

According to Section 7 of the Nuclear Energy Act, sufficient security arrangements and emergency arrangements as well as other arrangements to limit nuclear damage and protect the use of nuclear energy against unlawful action are a prerequisite for the use of nuclear energy. In order to determine the threat level of unlawful action, STUK has verified the design basis threat (DBT) referred to in Section 2(1 a) of the Government Decree on Security in the Use of Nuclear Energy (734/2008), which must be used as the basis for planning and assessing the security arrangements for which the licensee is responsible. According to Section 7 l of the Nuclear Energy Act, the security arrangements for the use of nuclear energy shall be based on threat scenarios applicable to the use of nuclear energy and analyses of the need for protection.

Security arrangements refer to the measures needed to protect the use of nuclear energy against unlawful action at a nuclear facility, in the area of the facility and some other location or vehicle where nuclear energy is used. According to Section 7 l of the Nuclear Energy Act, a nuclear facility shall employ security staff with training on the planning and implementation of security arrangements (security organization). The duties of and training requirements for the security organization and security staff must be defined, and they must have access to the monitoring equipment, communications equipment, protective equipment and equipment for use of force commensurate with their duties.

According to Section 8 of the Government Decree on Security in the Use of Nuclear Energy, the security arrangements include the control of vehicles, persons, objects and materials as well as goods transportation equipment in order to ensure that no dangerous objects are brought into the nuclear facil-

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ity site. Movement at the nuclear facility shall be restricted and controlled so that the security arrangements aspects and safety aspects can be taken into consideration effectively. In particular, the licensee shall ensure that no nuclear use items, nuclear waste, radioactive materials or confidential nuclear information can be removed from the nuclear facility without appropriate authorization. The Guide YVL A.11 "Security of a nuclear facility" sets forth further requirements concerning security arrangements.

According to the previous preliminary safety assessment by STUK regarding the Hanhikivi site (October 19, 2009), Fennovoima has the prerequisites to implement the security arrangements as required by the law. The assessment states the following:

Fennovoima notes in its application for a Decision-in-Principle that planning and action for the event of emergency situations are being prepared in cooperation with security authorities. Fennovoima also notes that in the case of all power plant unit alternatives it is preparing to combat illegal activities with a variety of structural and organizational security arrangements and intends to draw on the security expertise of the German E.ON power company in its emergency response arrangements.

In its application for the earlier preliminary safety assessment, Fennovoima stated that it intends to draw on the security expertise of the E.ON power company. In this respect, the situation has changed as E.ON withdrew from the project. In the request for additional clarification 2/J42211/2013, STUK presented the following requirement to Fennovoima:

Therefore, Fennovoima must present an additional clarification on the resources available for planning and implementing the security arrangements in the changed situation in order to ensure that the security arrangements can be implemented at the proposed plant site and in the plant project as required by the law.

As per the requirement, Fennovoima has submitted to STUK report "Käytettävissä olevat resurssit turvajärjestelyjen suunnittelemiseksi ja toteuttamiseksi Fennovoiman Hanhikivi 1-hankkeessa vuosina 2014–2024" (Restricted use, security level IV, Act on the Openness of Government Activities 621/1999, Section 24(1)(7 k); Nuclear Energy Act, Section 78). The report describes the resources that Fennovoima intends to use to plan and implement the security arrangements throughout the project. STUK presents its assessment of the currently available and planned resources of Fennovoima in section 3.

In its application to the Government for supplementing Decision-in-Principle M 4/2010 vp, Fennovoima stated that planning the security arrangements together with security authorities and having right of possession at the proposed plant site provide good prerequisites for protecting the nuclear power plant against unlawful action.

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The preliminary security plan and emergency plan of the new nuclear power plant unit shall be submitted to STUK for the purpose of processing the possible construction licence application, and the final plans shall be submitted in connection with the possible operating licence application.

STUK has at regular intervals processed the security arrangements (including information security) together with Fennovoima experts, and Fennovoima has developed the security arrangements by following the principle of continuous improvement. It is not described in the application how information security is to be implemented in the plant project, and this shall be described at the construction licence phase.

The material that Fennovoima submitted after the completion of the earlier safety assessment states that the proposed plant site includes a passage from the actual plant area to the Hanhikivi boulder ("Rajakivi"). Therefore, STUK finds that, as the project advances, Fennovoima shall ensure with alternative measures, if necessary, that the security arrangements against unlawful action can be implemented in accordance with the law and STUK's requirements. The YVL Guides include the following requirement on the area where movement and stay are limited: *In a nuclear facility's outermost security zone, an adequately large area shall be reserved where movement and stay is limited based on a decision by the competent authority or under a decree. The security arrangements within this area shall concentrate on monitoring, threat detection and buying time for the initiation of immediate counter-measures.*

STUK is not aware of any obstacles to implementing the security arrangements in compliance with the requirements.

6. NUCLEAR FUEL MANAGEMENT

According to Section 24(7) of the Nuclear Energy Decree, the licence applicant shall append an outline plan on nuclear fuel management to the application for a Decision-in-Principle.

In the AES-2006 plant, the reactor essentially has the same structure as the VVER-1000 plants that are currently in operation. Due to the higher output, the active length of the fuel assemblies is increased so as to keep the maximum fuel load within the acceptable range. The fuel design and core design follow the same practices as the large pressurized water reactors that are currently in operation. According to the plans, fuel will be loaded into the core every 12 months by replacing one quarter of the loaded assemblies with fresh assemblies.

In connection with the plant delivery contract, Fennovoima signed a separate contract on the procurement of nuclear fuel including the initial core loading and the reloading in the first operation period. Currently, the only manufacturer of fuel for the AES-2006 reactor is the Russian TVEL.

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Fennovoima has stated that it is negotiating on the use of reprocessed uranium, which is obtained from spent fuel, as a source of uranium. The source for uranium does not affect the behaviour of the fuel in the reactor.

In reprocessed uranium, the concentration of the fissile U-235 isotope (0.5–1.0%) is close to that of natural uranium (0.7%). With both cases, the U-235 concentration must be enriched to a level of approximately 4% for use as reactor fuel. Reprocessed uranium contains small amounts of the U-236 isotope, which has a negative impact on reactivity. Therefore, any fuel manufactured from reprocessed uranium must have a slightly larger U-235 concentration than fuel that is manufactured from natural uranium.

Furthermore, reprocessed uranium contains small amounts of the U-232 isotope, the decay chain of which generates high-energy gamma radiation. Due to U-232, radiation protection must be taken into account in fuel fabrication and storage at the plant. The fresh fuel manufactured from reprocessed uranium must be stored in a water tank at the plant, whereas fresh fuel manufactured from natural uranium can be stored in a dry storage. An appropriate storage system shall be built at the plant.

The fuel design objectives and design principles comply with the Finnish safety requirements. The acceptability of the nuclear fuel design shall be demonstrated before the manufacture of the fuel is started by submitting a fuel type-specific suitability report to STUK for approval.

It is the considered opinion of STUK that Fennovoima has the prerequisites to organise the nuclear fuel management of the nuclear power plants it is planning in compliance with the safety requirements.

7. NUCLEAR SAFEGUARDS

The purpose of nuclear safeguards is to ensure that nuclear fuel as well as other nuclear materials and products in the field are only used for peaceful purposes, as specified in the relevant licenses and notifications, and that nuclear facilities and nuclear technology are only used for peaceful purposes. The licensee has the obligation to plan and take care of its nuclear safeguards and document any and all nuclear use items in its possession, submit reports to authorities and to allow access to nuclear use item inspectors from STUK, the European Commission and the International Atomic Energy Agency (IAEA).

Fennovoima has improved its competence and has in its employ the necessary expertise and competence to arrange the monitoring required for the non-proliferation of nuclear weapons, thereby enabling Finland to comply with the international obligations in this respect. In the draft nuclear safeguards manual it submitted to STUK for information, Fennovoima has described the measures to ensure compliance with the regulations and fulfill-

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ing the obligations before the construction phase of the nuclear facility. Fennovoima plans to seek approval of its nuclear safeguards manual from STUK in 2014. This meets the requirement laid down in Guide YVL D.1 on the users of nuclear energy concerning the documentation in the nuclear safeguards manual of the nuclear safeguards of the operator and its measures to enable regulatory oversight and international oversight. The process to approve the nuclear safeguards manual ensures compliance with the obligations at all project phases.

Fennovoima proposes that it will appoint the persons responsible for the nuclear safeguards as required in the Nuclear Energy Act before commencing the construction of the nuclear facility but after appointing a responsible manager, which fulfils the legislative requirements and those presented in the YVL Guides.

According to the information provided to STUK, Fennovoima has the sufficient prerequisites to fulfil its obligations in terms of nuclear safeguards nuclear and non-proliferation in accordance with the nuclear energy legislation and the requirements of Guide YVL D.1.

8. NUCLEAR WASTE MANAGEMENT

According to Section 24 of the Nuclear Energy Decree, a general description of the applicant's plans and available methods to organise nuclear waste management shall be appended to an application for a Decision-in-Principle. In its report on nuclear waste management, Fennovoima has described the processing and disposal of operational waste and decommissioning waste that are generated in the operation of a nuclear power plant. Furthermore, the report briefly discusses the interim storage and the options for the disposal of spent nuclear fuel and the ongoing work to resolve the disposal project.

Operational waste and decommissioning waste

In its documentation, Fennovoima has described the accumulation of reactor waste during the operation of the nuclear power plant and the segregation of waste by activity and properties as well as the storage of waste. According to conservative estimates, approximately 5,000 m³ of waste will be accumulated during 60 years of plant operation. This is equivalent to the volume of waste at the Loviisa power plant and remains below 100 m³ per year. The use of the latest technology, for example in packing waste and solidifying liquid waste, reduces the volume of waste significantly. Furthermore, the current legislation makes possible the transportation of large metallic components abroad for melting, provided that the radioactive waste generated in the process is returned to Finland.

Before disposal, operational, low and intermediate level waste is stored packed and characterised under controlled conditions. According to Fenno-

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voima, the storage facility for solid waste will be constructed in the same building as the fresh fuel storage in the plant area. The storage building shall follow the design bases and safety requirements applicable to the fuel storage building. Furthermore, Fennovoima must take into account the requirements applying to storing, operational, low and intermediate level waste when designing and constructing the storage building. Minimizing the quantities of waste in the controlled area shall be particularly considered during the design process. Radiation safety and fire safety shall be ensured in the handling and storage of waste. The collection and processing of hazardous waste shall be separate from other waste.

In its documentation, Fennovoima has described the decommissioning strategy as well as the accumulation and classification of decommissioning waste. Fennovoima has specified its decommissioning strategy and, according to the current understanding, the dismantlement of the power plant could be started immediately after completing the preparations for the demolition. Fennovoima will specify the decommissioning strategy in connection with the construction licence application, at which time Fennovoima will have more detailed information on the plant type and can utilize the plant supplier's expertise concerning the details of the dismantlement of the plant type. Currently, Fennovoima estimates the quantity of dismantlement waste to be 10,000–15,000 m³. Some of the decommissioning waste has the same properties as reactor waste generated during the operation of the power plant, but decommissioning also generates high quantities of activated and/or contaminated dismantlement waste, such as concrete, steel and insulation waste. As dismantlement may periodically result in high quantities of waste, Fennovoima is prepared to construct, if necessary, more facilities for handling dismantlement waste.

For the disposal of low and intermediate level waste, Fennovoima proposes the disposal of all waste in underground final disposal repositories. Alternatively, some part of the very low level waste can be stored in a near-surface final disposal repository while the rest is stored in underground final disposal repositories.

According to Fennovoima's plans, the underground final disposal facility will be built in a separate construction project in the 2030s. Fennovoima shall apply for a construction licence for the final disposal facility from the Government no earlier than 2032 and for an operating licence no earlier than 2038. According to the preliminary plan, the operating licence will be applied for until 2090. The site proposed is the Hanhikivi headland in Pyhäjoki. In connection with the preliminary planning of the final disposal facility, Fennovoima selects a disposal solution and, based on detailed geological examinations that reach the final depth, defines a bedrock section and a specific location in the area that is allocated for the final disposal facility. The waste that is generated during the operation and decommissioning of the power plant shall be stored in the final disposal repositories. Subject to a

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separate licence, the disposal of high level dismantlement waste can take place in the spent nuclear fuel disposal repositories, if necessary. There are underground final disposal repositories in use by Finnish nuclear power plants and in Sweden, where the disposal of low and intermediate level waste is focused in one location. When planning the underground final disposal repository, Fennovoima will utilise the experiences gained in the design and operation of other equivalent facilities.

Fennovoima has not yet made a decision on near-surface final disposal. The facilities required for near-surface final disposal are, in terms of structure and construction work, simpler and faster to implement than underground final disposal repositories. It is possible to design and implement near-surface final disposal safely as proposed by Fennovoima. The facilities can use an operating licence issued by STUK, because Fennovoima's proposal is not considered extensive disposal of nuclear waste. Near-surface final disposal has been implemented in the disposal facilities that are located in Swedish nuclear power plant sites, and a similar plant is under construction in Ignalina, Lithuania.

STUK is not aware of any obstacles to the processing, near-surface disposal and deep geological disposal of reactor waste and decommissioning waste in the disposal facility proposed by Fennovoima in compliance with the safety requirements.

Spent fuel

Fennovoima's report briefly discusses the interim storage of spent nuclear fuel. It is estimated that Rosatom's AES-2006 power plant will generate 1,200–1,800 tU of spent fuel during a plant service life of 60 years. Spent nuclear fuel removed from the reactor is stored in the reactor building for a minimum of three years, after which it is transferred into the spent fuel interim storage for a minimum of 40 years.

According to Fennovoima, the spent fuel interim storage will be constructed in the site area. Fennovoima will include the land reservation for the storage facility in its construction licence application and specify the implementation schedule of the storage. According to the current plans, the spent nuclear fuel interim storage must be in use no later than 2033. There are two alternative types proposed for the spent fuel storage: dry storage and water pool storage. The operating Finnish nuclear power plants utilise pool storage. Dry storage is used, for example, in Germany and North America.

After interim storage, the spent fuel will be transported away for disposal. Fennovoima has described the transport of spent fuel and related licensing in its application for a Decision-in-Principle (January 2009). According to Section 56 of the Nuclear Energy Decree, transportation of spent fuel is subject to a licence granted by STUK. The detailed safety requirements are given in STUK's Guide YVL D.2.

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STUK is not aware of any obstacles preventing the processing, interim storage and transportation of spent fuel as proposed by Fennovoima in compliance with the safety requirements.

The Decision-in-Principle issued to Fennovoima by the Government on May 6, 2010 requires specifications in terms of nuclear waste management as follows:

In submitting its application for a construction license, Fennovoima must also submit an explanation of its updated plans for handling its nuclear waste management. Moreover, Fennovoima must improve its plan for the final disposal of spent nuclear fuel so that within six years of the Government Resolution concerning the building of the nuclear power plant being approved by Parliament it shall submit to the Ministry of Employment and the Economy: either an agreement on nuclear waste management cooperation with the current parties liable for nuclear waste management, as outlined in the application for a Government Resolution; or an environmental impact assessment program pursuant to the Act on Environmental Impact Assessment Procedure (468/1994) for a repository for final disposal of spent nuclear fuel operated by Fennovoima itself.

The report shall be submitted no later than June 30, 2016. In November 2012, the Ministry of Employment and the Economy (MEE) appointed a working group to guide a joint report by power companies on the alternatives for the disposal of spent nuclear fuel. The working group included representatives of the MEE, Teollisuuden Voima Oyj, Fortum Power and Heat Oy, Fennovoima Oy and Posiva Oy. The MEE requested STUK and the Energy Authority to submit an opinion on the report. On January 10, 2013, the working group submitted its final report to the Minister of Economic Affairs, Jan Vapaavuori. A key recommendation in the report is that, in disposal, it is appropriate and cost-effective to strive for an optimised solution and to utilise the competence and experiences gained in the industry as a result of Posiva Oy's project. From the overall perspective, it is not decisive whether there is one or two disposal repositories. The working group recommends that the companies should continue negotiations on finding a solution for Fennovoima Oy's disposal project. In the report, the MEE states that, in connection with its construction licence application, Fennovoima must demonstrate that it has access to the technological means necessary to implement its plans in terms of its disposal project.

However, Fennovoima must follow the development of disposal technology and begin the disposal project in time. STUK supervises the nuclear waste management carried out by the parties under a waste management obligation based on a report referred to in Section 74 of the Nuclear Energy Act.

If collaboration with the other parties under a waste management obligation in Finland is not possible, Fennovoima has the time to implement its own

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disposal facility of spent nuclear fuel. For Fennovoima, the disposal of spent fuel would start no earlier than in the 2070s.

According to the previous disposal site studies conducted by TVO and Posiva, the bedrock in the five areas studied had no significant differences based on which the areas could be ranked in terms of safety. Therefore, bedrock suitable for the disposal of nuclear fuel can be found elsewhere in Finland in addition to Olkiluoto. The disposal of spent fuel is subject to a separate Decision-in-Principle.

9. NUCLEAR LIABILITY

Nuclear liability is provided for in the Nuclear Liability Act (484/1972). This Act takes into account the international conventions binding upon Finland that set the minimum levels of liability for nuclear damages. The international negotiations on the revision of the so-called Paris and Brussels agreements on nuclear liability were concluded in 2004. The negotiations agreed on increasing the funds available for damages and on the unlimited liability of the licensee of the facility. However, the enforcement of these agreements has been continually postponed. Therefore, Finland decided to enact the current higher insurance sums and the unlimited liability of the licensee on a national level. The temporary amendment of the Nuclear Liability Act entered into force in early 2012. The amendment will be repealed once the aforementioned agreements enter into force.

The licensee of a nuclear facility located in Finland has unlimited liability in respect of all nuclear damage inflicted in Finland as a result of a nuclear incident. The funds available for damages in an accident consist of three different sources: the funds of the licensee, the country of operation of the facility and the so-called international compensation community. A total of SDR600,000,000 is available for an accident from all of these sources. SDR (Special Drawing Right) is the value of a currency basket specified by the International Monetary Fund (IMF) based on the value of a number of currencies. In 2013, the currency basket was valued at approximately €1.12. Even if a nuclear facility has been granted an operating licence, the operation of the facility may not be started before STUK has deemed that the licensee of the nuclear facility has arranged indemnification regarding liability in the case of nuclear damage according to the law.

10. CONCLUSIONS

In its request for a statement, the MEE requests STUK to especially focus on the changes that have taken place in the project. These include the new plant alternative and the changes in the ownership of the company. The changes have materially affected the advancement of the project and the development of Fennovoima's organization, resources and operations.

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STUK's duty in the preliminary safety assessment is to assess that no factors have arisen indicating a lack of sufficient prerequisites for constructing the new nuclear power plant proposed by Fennovoima in accordance with the provisions of Section 6 of the Nuclear Energy Act. Concluding the preliminary safety assessment, STUK states the following:

1. The AES-2006 plant alternative can meet the Finnish nuclear and radiation safety requirements following the implementation of design changes, additional analyses and qualification. In STUK's opinion, the necessary further engineering and modifications can be carried out in such a manner that the requirements set forth in Government Decree (717/2013) can be met at the construction licence phase.
2. Of the alternatives presented in the Decision-in-Principle, Fennovoima has selected Hanhikivi, Pyhäjoki as the intended site. It is the considered opinion of STUK that there are no features at the Hanhikivi site that would prevent the construction of the AES-2006 nuclear power plant unit presented in the application for supplementing the Decision-in-Principle or the related other nuclear facilities or that would prevent the implementation of the security arrangements and emergency arrangements in compliance with the safety requirements.
3. Fennovoima has not grown its organization and developed its management system in accordance with the material submitted with the application for the 2010 Decision-in-Principle (M 4/2010 vp, May 6, 2010). At the time of this assessment, Fennovoima is reinforcing the competence of its organization and developing its management system. It is the considered opinion of STUK that the company has devised a plan to reinforce its organization and develop its management system to satisfy the requirements by the construction licence phase.

Regarding item three, STUK states the following: At the time of this assessment, Fennovoima has approximately one year to submit its construction licence application to the Government. Guiding the design of the AES-2006 plant alternative to comply with the Finnish safety requirements, preparing the documentation to be submitted to STUK in the construction licence phase and verifying the compliance of the documentation require Fennovoima to take measures even before it submits a construction licence application. The task is demanding and, considering Fennovoima's current resources and management system, STUK finds it questionable that the company would be able to submit comprehensive documentation to STUK when submitting a construction licence application to the Government. This fact shall be taken into consideration when scheduling and planning the documentation to be submitted to STUK in the construction licence phase and when estimating the duration of the construction licence phase.

4/J42211/2014

May 23, 2014

Public

In the preliminary safety assessment, no factors have arisen indicating a lack of sufficient prerequisites for constructing the new nuclear power plant proposed by Fennovoima in accordance with the provisions of Section 6 of the Nuclear Energy Act.

11. APPENDICES

Appendix 1

SUITABILITY ASSESSMENT OF THE AES-2006 PLANT ALTERNATIVE