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Ministry of Employment and the Economy

P. O. Box 32
FI-00023 GOVERNMENT, Finland

Request for a statement TEM/2955/08.05.01/2012 15 February 2013 and 11 July 2014

Statement of the Radiation and Nuclear Safety Authority on the construction of the Olkiluoto encapsulation plant and disposal facility for spent nuclear fuel

The Ministry of Employment and the Economy has requested a statement referred to in Section 23 of the Nuclear Energy Act (990/1987) from the Radiation and Nuclear Safety Authority (STUK) regarding the construction licence application by Posiva Oy (Posiva) concerning the Olkiluoto encapsulation plant and disposal facility for spent nuclear fuel¹.

Posiva has submitted the construction licence application and the documents required by Section 32 of the Nuclear Energy Decree (161/1988) to the Ministry of Employment and the Economy, and it also has separately submitted, to the Radiation and Nuclear Safety Authority (STUK), the documents in accordance with Section 35 of the Nuclear Energy Decree and Section 16 of the Government Decree on the Safety of Disposal of Nuclear Waste (736/2008), on which the safety assessment of the Radiation and Nuclear Safety Authority is primarily based. The documents and reports listed above have been delivered to the Radiation and Nuclear Safety Authority (STUK) in several batches and updated after the actual licence application was submitted during 2013 and 2014. The updates have been made and supplements added, both based on requests for clarification by the Radiation and Nuclear Safety Authority and the progress of Posiva's own design.

Posiva's construction licence application proposes the disposal of a maximum of 9,000 tU (tonnes of uranium) of spent nuclear fuel. The volume corresponds to the accumulation of spent nuclear fuel generated during the operation of Teollisuuden Voima Oyj's (TVO) operating plant units Olkiluoto 1 and 2, the plant unit Olkiluoto 3 under construction and the planned plant unit Olkiluoto 4, as well as the operating Loviisa 1 and 2 plant units of Fortum Power and Heat Oy (Fortum). The volume does not include the spent nuclear fuel delivered from the Loviisa plant units to the reprocessing facility in Mayak, Russia, in accordance with the agreement that remained in force until 1996.

¹ In this statement, the term 'nuclear waste facility' is used for the encapsulation plant and disposal facility in accordance with the definition of the Government Decree 736/2008, which covers both facilities.

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The statement and the safety assessment by the Radiation and Nuclear Safety Authority on the safety of the Olkiluoto encapsulation plant and disposal facility and Posiva's project are valid, even if TVO's Olkiluoto 4 plant unit would not progress into the construction licence application phase and its spent nuclear fuel was left outside Posiva's construction licence. If the Olkiluoto 4 project were not to be realised, it would decrease the amount of spent fuel to be disposed of and decrease the surface area and rock volume required for the area needed for disposal.

Posiva's disposal project is based on the KBS-3 disposal concept in accordance with the multibarrier principle, in which the spent nuclear fuel packed into canisters made out of copper and iron is disposed of, after a minimum of 20 years of interim storage, in repositories to be built at the approximate depth of 430 metres in bedrock. The disposal canisters are protected by buffer material manufactured out of swelling clay, and the deposition tunnels are filled with clay material. Once the operation is over, the whole disposal facility will be closed by backfilling all excavated areas with clay material and crushed rock. Close to the surface, the underground rooms are filled in with structures that make intrusion into the repository difficult. The planned disposal of spent nuclear fuel will be passively safe after closure. Ensuring the safety of the facility will not require monitoring of the disposal site or other maintenance activities.

The Radiation and Nuclear Safety Authority has drawn up a safety assessment on the project, which can be found in Attachment 1 to this statement. Attachment 2 includes the statement from the Advisory Committee on Nuclear Safety, requested by the Radiation and Nuclear Safety Authority.

The nuclear waste facility is a nuclear facility of considerable general significance as referred to in Section 11 of the Nuclear Energy Act, which means that granting it a construction licence requires a valid Government decision-in-principle (Nuclear Energy Act, Section 18). The Government has issued a decision-in-principle regarding Posiva's project in December 2000, and the Parliament has ratified it in May 2001. This decision-in-principle covers the disposal of the spent fuel from the Olkiluoto 1 and 2 plant units as well as the Loviisa 1 and 2 plant units. In addition to the decision-in-principle confirmed in 2001, the Government has issued two separate decisions-in-principle in 2002 and 2010, on the basis of which the disposal project has been expanded to cover the disposal of the spent nuclear fuel from the Olkiluoto 3 and Olkiluoto 4 plant units. The Parliament confirmed both separate decisions-in-principle in the corresponding years. The first decision-in-principle was specified as valid for a period of 15 years. Posiva's construction licence application has been submitted at the end of 2012, which means that the requirement of a valid decision-in-principle is fulfilled for Posiva's project.

In addition to a valid decision-in-principle, the fulfilment of the prerequisites laid down in Section 19 of the Nuclear Energy Act is a condition for granting the construction licence. The Radiation and Nuclear Safety Authority has assessed the fulfilment of the prerequisites regarding nuclear

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and radiation safety in this statement and the attached safety assessment. The assessment of the Radiation and Nuclear Safety Authority on the fulfilment of the prerequisites laid down in Section 19 of the Nuclear Energy Act is as follows:

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;

The Olkiluoto encapsulation plant and disposal facility proposed by Posiva has been designed in such a way that the requirements on the nuclear and radiation safety during the operation of the facilities are fulfilled. The encapsulation plant as well as the necessary parts of the disposal facility follow the defence-in-depth safety principle. The structural safety of the facilities has been ensured by successive barriers; depending on the handling phase of the spent nuclear fuel, these barriers include the nuclear fuel cladding, nuclear fuel transport cask or the disposal canister, as well as the structures of the encapsulation plant and disposal facility. For functional safety, the removal of decay heat and the criticality safety of the fuel are managed structurally with passive solutions. Functions important for the management of radioactive substances include the nuclear fuel handling functions and filtration of exhaust air related to preventing the spread of radioactive substances, which are single failure tolerant at the encapsulation plant and disposal facility. Posiva will specify the detailed design requirements of the systems, for which the approval of the Radiation and Nuclear Safety Authority must be received as necessary, before construction of the facility's structures and the manufacturing of the components are initiated.

Posiva has prepared for operational occurrences and accidents at the encapsulation plant and disposal facility in accordance with safety requirements. Posiva has analysed the potential operational occurrences and accidents and prepared for them by following the redundancy, separation, and diversity principles as part of the defence-in-depth safety principle in the design of the systems that implement the safety functions.

Posiva has provided analyses on the releases and radiation doses caused by normal operation, operational occurrences and accidents at the encapsulation plant and disposal facility. The radiation doses caused by the operation of the encapsulation plant and disposal facility are lower than the maximum values of radiation exposure laid down in Government Decree 736/2008. The emergency arrangements required during the operation of the encapsulation and disposal facilities commensurate with the based on estimated radiation exposures.

Posiva has developed the KBS-3 concept described above for several decades together with the Swedish company Svensk Kärnbränslehantering AB (SKB). The manufacturability of the system components has been proved on a level sufficient for the construction licence by component-specific

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manufacturing tests, and correspondingly, the feasibility of constructing the bedrock facilities has been proven by demonstrations at the underground rock characterisation facility (Onkalo) in Olkiluoto. It is important that the reliability of the rock suitability classification system related to the implementation of the bedrock facilities is assessed during the first construction phase of the repository. In cooperation with each other, Posiva and SKB have tested the emplacement of the disposal canister, buffer and tunnel backfill in accordance with the requirements at the Äspö hard rock laboratory in Sweden. In addition, Posiva has also initiated the installation tests of the disposal system's components carried out in Onkalo. The goal of the installation tests is to prove that the components of the disposal system can be installed in accordance with the accuracy requirements set. Under the decision-in-principle in 2001, Posiva has constructed an underground rock characterisation facility, which is planned to function as a part of the disposal facility. In the construction of the underground rock characterisation facility, Posiva has complied with the requirements for nuclear facilities, and STUK has regulated the construction of the rock characterisation facility with the same procedures used for constructing a nuclear facility.

The post-closure safety of the disposal facility is based on two objectives, which are achieved by barriers that complement each other. The primary objective is the containment of the radioactive material from the bedrock. The leak-tight disposal canister protected by the clay material emplaced around it, as well as the bedrock surrounding the repository that separates them from the surface environment, play a key role in this. The bedrock and the closure of the disposal facility create favourable and foreseeable conditions for the engineered barriers. The second objective of the barriers is to limit and retard the migration of radionuclides from the disposal depth to the ground surface in the event that a release of radionuclides occurs.

In order to demonstrate the post-closure safety, Posiva has presented an analysis in the licence application material regarding the anticipated future evolution scenario, as well as variant and possible disturbance scenarios of the disposal system and the surrounding environment. Based on its scenario analysis, Posiva has selected the most significant evolutions that lead to a release of radionuclides, and has analysed the radiation doses incurred to humans and surrounding environment, as well as the radionuclide releases into the environment. The results of the analyses remain under the limit values set in the Government Decree (736/2008).

In the review of the facility's post-closure safety case, development needs have been identified; by taking these needs into account, the clarity, traceability and reliability of the post-closure safety case can be improved. The Radiation and Nuclear Safety Authority has presented the areas for improvement in a separate decision addressed to Posiva, in which taking these development needs into account in the operating licence application material is required.

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The plans presented by Posiva are appropriate and sufficient for the safety of the personnel and the population at the construction licence application phase, with the following observations and limitations:

- Posiva has submitted a plan on specifying the system design of the nuclear waste facility to the Radiation and Nuclear Safety Authority. The Radiation and Nuclear Safety Authority will have oversight of the progress of the design and verify the sufficient level of design in accordance with Section 108 of the Nuclear Energy Decree and YVL Guides before the construction of the facility's structures and the manufacturing of the components begin.
- Posiva has submitted a plan on the installation tests of the disposal system's components to the Radiation and Nuclear Safety Authority. The Radiation and Nuclear Safety Authority will review the installability of the system as based on the tests before excavation of the deposition tunnels can begin.
- In connection with construction of the first deposition tunnels, Posiva must prove the reliability of the rock suitability classification system. The Radiation and Nuclear Safety Authority will review the functionality of the rock suitability classification system as part of the oversight of the placement of the first deposition tunnels and the rock construction.
- Posiva has submitted a development programme of the disposal concept focusing on the barriers to the Radiation and Nuclear Safety Authority, in which it has taken account of the same areas of improvement as the ones that the Radiation and Nuclear Safety Authority has highlighted in the safety assessment. The Radiation and Nuclear Safety Authority will have oversight of the progress of the development work in accordance with the programme during the period between the construction and operating licences.

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;

The proposed location has been found suitable as a disposal site in the decision-in-principle in 2001. Based on the decision-in-principle, the project received permission to proceed with the construction of the underground rock characterisation facility and the more detailed site-specific studies. After the decision-in-principle, an underground rock characterisation facility, Onkalo, has been constructed at the site, and the characterisation of the site has continued. Knowledge of the site has increased significantly after the decision-in-principle stage.

The studies of the disposal site and the analyses on the evolution scenarios of the site reaching far into the future are sufficient for the construction licence, and they have not introduced any matters on the basis of which the selected disposal site would not be favourable for post-closure safety. Based on the studies and analyses, the conclusion may be reached that the bedrock's characteristics are suitable for implementing the disposal as

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proposed. The disposal depth of 400–450 metres of the spent fuel is in accordance with the decision-in-principle issued for the Olkiluoto disposal facility and the safety requirements set by the Radiation and Nuclear Safety Authority. The disposal depth has been selected taking account of the post-closure safety of the disposal and the sufficient protection from above-ground phenomena and human activity.

Based on studies performed the planned site is appropriate for a nuclear waste facility with regard to operational and post-closure safety, and environmental protection has been taken into account in planning the operation.

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

Posiva has used Design Basis Threat and risk analyses in the design and assessment of the security arrangements and has also analysed the physical protection requirements. The principles, procedures and plans related to security arrangements and the planned information security principles have been described in the application material. In the actual design of the nuclear waste facility, various security zones have been presented in accordance with the defence-in-depth safety principle, and the protection of important structures and systems have been taken into account in the design.

Posiva has presented the security plan for the construction period of the nuclear facilities as well as the composition of the security organisation and its tasks, monitoring equipment, communications equipment, protective equipment and equipment for use of force. Together with TVO, Posiva has also presented joint security standing orders for confirmation, which must be in force before the construction of Posiva's nuclear waste facility is initiated.

Based on what has been presented above, Posiva's plans for the implementation of security arrangements are appropriate and sufficient, with the following specifying comments:

- The joint security standing orders of Posiva and TVO must be confirmed before construction begins.
- The details of the security arrangements planned for the construction period must be specified before construction begins. The detailed requirements concerning these issues have been given in a decision by the Radiation and Nuclear Safety Authority that is confidential (Act on the Openness of Government Activities 621/1999, Section 24(1), paragraph 7).

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;

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Reviewing whether the requirements of this section are fulfilled is not within the sphere of authority of the Radiation and Nuclear Safety Authority, and its realisation shall be reviewed by other authorities.

In the valid land use plan for the Olkiluoto region, an area has been reserved for a nuclear waste facility. In addition, the precautionary action zone required by Section 9(6) of the Government Decree 736/2008 has been reserved at the disposal area for the prohibitions on measures referred to in Section 63(1), paragraph 6 of the Nuclear Energy Act.

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

The low- and intermediate-level nuclear waste accumulated during the operation of Posiva's nuclear waste facility and from its decommissioning originates from the handling of spent fuel at the facility. Posiva has presented sufficient and appropriate arrangements and plans for the construction licence application phase regarding the handling and disposal of the nuclear waste generated as well as the decommissioning of the facility, with the following comments and limitations:

- Before construction of the disposal facility begins, Posiva must present specified, more detailed plans to the Radiation and Nuclear Safety Authority for the low- and intermediate-level waste repository at the disposal facility, as well as a specified estimate on the combined effects of the various types of nuclear waste to be placed into Posiva's disposal facility.

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

The purpose of the nuclear waste facility proposed in the construction licence application is the handling and disposal of spent nuclear fuel. There is no need to arrange nuclear fuel management for the facility.

The spent nuclear fuel handled at the nuclear waste facility is stored at the interim storages at nuclear power plants, from which it is transported into the encapsulation plant for disposal.

7) 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 subsection 1, in Finland and abroad, and for the implementation of control as referred to in paragraph 4 of section 63 subsection 1 are sufficient;

The arrangements and procedures for implementations of the regulatory control described in the report submitted by Posiva have been found to be adequate at the construction licence application phase. With its decision,

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the Radiation and Nuclear Safety Authority has approved the report on arranging the control possibilities of the Radiation and Nuclear Safety Authority submitted by Posiva in connection with the construction licence application. Posiva has implemented the personnel training required in the decision of the Radiation and Nuclear Safety Authority on the practical actions required by the Radiation and Nuclear Safety Authority's control. Based on this, Posiva's arrangements for implementing the control are appropriate and sufficient.

8) if the applicant has the necessary expertise available;

The Radiation and Nuclear Safety Authority has assessed the competence of Posiva's personnel and the external expertise available to Posiva in connection with processing the construction licence application as well as based on the document reviews and a separate inspection programme. As a result, the Radiation and Nuclear Safety Authority states that Posiva has a sufficient and extensive expertise available for constructing a nuclear waste facility.

In the long term, the use of nuclear energy can only be considered in line with the overall good of society if society on its part commits to maintaining the social structures required by the safe use of nuclear energy as well as the educational and research infrastructure required. The long-term nature of disposal requires the society to invest in maintaining the resources and competence for the entire duration of the facility's operation. In particular, preparations must be made for maintaining sufficient expertise in areas related to the post-closure safety of the disposal of nuclear waste.

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

Posiva's owners, TVO and Fortum, are responsible for ensuring that Posiva has sufficient financial prerequisites to implement the project safely and carry on operations. In accordance with the agreement between the owners of Posiva, it will collect the costs of the spent fuel disposal project from its owners. TVO and Fortum will remain under a waste management obligation in accordance with the Nuclear Energy Act, and they are therefore responsible for the costs of nuclear waste management.

In accordance with the Nuclear Energy Act, TVO and Fortum have provided for the cost of nuclear waste management by paying fund holdings into the National Nuclear Waste Management Fund. Sufficient funds have been collected into the National Nuclear Waste Management Fund for the processing and disposal of the currently existing nuclear waste. In this respect, the provisions strengthen the financial prerequisites.

Based on this, Posiva's arrangements are appropriate and sufficient.

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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;

With regard to Section 19(10) of the Nuclear Energy Act, the field of the Radiation and Nuclear Safety Authority includes international agreements on nuclear safeguards, nuclear liability issues and EU Council directives as well as the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. The requirements of the international agreements are implemented via Finnish legislation and prevailing practice.

In accordance with Section 118 b of the Nuclear Energy Decree, the use of nuclear energy must be planned and implemented so that the obligations concerning nuclear safeguards, as provided in the Nuclear Energy Act and in the Euratom Treaty and provisions issued under them, are met. Posiva's facilities are the first of their type, and the regulatory control measures by the International Atomic Energy Agency (IAEA) and the European Commission have not yet been completely resolved. In its plan, Posiva has taken the known control needs and obligations during construction and operation into account. Similarly, the Radiation and Nuclear Safety Authority has taken the corresponding needs and obligations into account in its control system.

As a part of Section 19(10) of the Nuclear Energy Decree, the following covers the prerequisites related to the safe operation or implementation of the disposal project presented in the Nuclear Energy Act, the decisions-in-principle issued to Posiva, and the construction licence application.

The Radiation and Nuclear Safety Authority has approved the management system manual describing Posiva's management system. In the management system manual, Posiva emphasises giving safety first priority in all activities and creating as well as maintaining a good safety culture. The goal is that the personnel are aware of the safety significance of their own work. Posiva evaluates the management system and the operation of the organisation regularly and systematically with the continuous improvement of the operation as the goal.

Based on Posiva's application, the Radiation and Nuclear Safety Authority has approved the responsible manager for the construction of the nuclear waste facility. The Radiation and Nuclear Safety Authority has approved the deputy of the responsible manager conditionally, requiring additional instruction in the security arrangements. The approval becomes valid after the additional instruction has been provided. Correspondingly, Posiva must nominate a manager responsible for the operation and his/her deputy for the operational phase of the nuclear waste facility, and propose them to the Radiation and Nuclear Safety Authority for approval.

In the construction licence application, Posiva has presented a report on the re-openability of the repository and an estimate on the costs of the

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opening. The safe re-opening of the facilities and the return of the disposal canisters is feasible technically with currently available working methods. In the view of the Radiation and Nuclear Safety Authority, the retrievability of nuclear waste to be disposed of is feasible technically, and re-openability does not endanger the post-closure safety of the disposal.

In parallel with the vertical disposal solution described above, Posiva has developed a horizontal disposal solution (KBS-3H) based on the same safety principles, which have been presented in the construction licence application material. The Radiation and Nuclear Safety Authority is not aware of any issues why the horizontal disposal solution could not fulfil the safety requirements. The Radiation and Nuclear Safety Authority would be able to process the change upon separate application by Posiva, in accordance with Section 112 of the Nuclear Energy Decree. A change made during the construction of the disposal facility would probably cause a delay in the planned start of the disposal.

In the construction licence application, Posiva has presented a report on the transports of spent nuclear fuel and, in addition, it has presented a preliminary report to the Radiation and Nuclear Safety Authority on the transport arrangements and the security for transport. The transports of spent nuclear fuel can be implemented as based on Posiva's plans. The safety of the transports is ensured separately and, in accordance with the Nuclear Energy Decree, a transport can only be carried out after the Radiation and Nuclear Safety Authority has ascertained that the transport arrangements and the required security and emergency planning arrangements meet the requirements set for them.

Summary

In addition to the Sections 18–19 of the Nuclear Energy Act, the general principles of the use of nuclear energy are presented in Sections 5-7 of the Nuclear Energy Act:

Section 5 The use of nuclear energy, taking into account its various effects, shall be in line with the overall good of society.

Section 6: The use of nuclear energy must be safe; it shall not cause injury to people, or damage to the environment or property.

Section 6 a Nuclear waste generated in connection with or as a result of the use of nuclear energy in Finland shall be handled, stored and permanently disposed of in Finland [...], and

Section 7 Sufficient physical protection and emergency planning as well as other arrangements for limiting nuclear damage and for protecting nuclear energy against illegal activities shall be a prerequisite for the use of nuclear energy.

The planned disposal of spent nuclear fuel in Olkiluoto has been found to be in line with the overall good of society in the decisions-in-principle made by the Government, and in the long term, disposal is also a prerequisite for the safe use of nuclear energy. The nuclear waste facility proposed

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by Posiva is part of nuclear waste management as a whole, in accordance with Section 6 a of the Nuclear Energy Act. In the statement, the Radiation and Nuclear Safety Authority has presented the conclusions on the fulfilment of Section 7 of the Nuclear Energy Act.

As a conclusion and based on what has been presented in this statement and the attached safety assessment, the Radiation and Nuclear Safety Authority states that the prerequisites of Sections 18 and 19 of the Nuclear Energy Act for granting a construction licence and the principles laid down in Sections 5–7 have been fulfilled. The encapsulation plant and disposal facility for spent nuclear fuel proposed by Posiva can be constructed to be safe.

Director General

Petteri Tiippana

Director

Risto Paltemaa

Appendices

1. Safety assessment by the Radiation and Nuclear Safety Authority, 11 February 2015
2. Statement from the Advisory Committee on Nuclear Safety, 26 January 2015

For information

Ministry of Social Affairs and Health, Posiva Oy, Teollisuuden Voima Oyj, Fortum Power and Heat Oy