Letter

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Answers to questions presented by Saxon State Ministry of Environment and Agriculture to Environmental Impact Assessment of Extending the Service Life of the Olkiluoto 1 and Olkiluoto 2 Plant Units and Uprating Their Thermal Power

1. **When will a planned power increase be implemented, and will the proof of ageing behavior for the planned lifetime extension be prepared in advance?**

   TVO has not yet done the decision for the lifetime extension and the power uprate. In the environmental impact assessment, the power uprate is implemented earliest in 2028. The aging behavior of power uprate will be evaluated beforehand.

2. **As a result of the EU stress test following the reactor accident in FukushimaDaiichi, have measures been implemented for OL 1 and OL2 with regard to their design against EvA?**

   Yes, several safety improvements have been implemented for OL1 and OL2 to make it possible to manage situations related to loss of ultimate heat sink (seawater) or station blackout. Finland's and TVO's results of the EU stress tests are available at the ENSREG webpage.

3. **Specific information on corresponding precautionary and retrofitting measures at OL 1 and OL2 is of interest here. Have corresponding precautions also been taken or are they planned for OL 1 and OL2?**

   External hazards that might occur in Olkiluoto site area have been analysed. Relevant precautionary measures have been implemented for all plant units on site. The analyses and the sufficiency of the precautionary measurements are evaluated periodically, and corrective measures are done if necessary.

4. **To what extent has it been possible to reduce the core melt frequency (CDF value) in connection with the plant modifications carried out in OL 1 and OL2 (specific information on the safety gain)?**

   The power uprate is planned in such a way that the nuclear safety of OL1 and OL2 does not decline from the current level. The increase in CDF caused by the power uprate can be fully compensated with the planned safety improvements.

5. **To what extent will safety margins change in connection with the planned power increase?**

   The effect of the power uprate on safety margins has been studied, and the power uprate is planned in such a way that the nuclear safety level of OL1 and OL2 does not decline from the current level. The essential safety systems have been designed with the 4 x 50 % principle (four safety trains fulfilling the failure criteria N+2), providing the ability to manage several accident situations even with one safety train. This does not change due to the power uprate. The power uprate is mainly seen to affect the margins related to the cooling of the condensation pool. Due to the planned pump renewal for the containment spray system, the cooling capacity can be increased and the negative effect on the margins can be cancelled out.

6. How should the change in safety margins in connection with the planned lifetime extension be assessed?

The lifetime extension does not change the plant configuration and therefore the safety margins remain unchanged as long as the good operating condition of the safety-important components is taken care of. This will be managed through maintenance and equipment reliability activities. With regard to possible changes in the operating environment, e.g. related to changing weather phenomena and other external hazards, the situation will be monitored, and the need for possible future safety modifications will be evaluated according to normal procedures that are already in effect today.

7. Are developments or proofs still required in connection with modifications to the fuel or fuel elements? Are these fuel elements already being used in other reactors?

No new developments or proofs are required in themselves, but fuel licensing in relation to the chosen operating conditions is necessary. In the licensing process, TVO must demonstrate, through careful analysis and experimental evidence, that the fuel meets all safety requirements and is suitable for the operating conditions selected for OL1 and OL2. STUK's approval is required. Some fuel design changes to optimize safety margins and performance under uprated power conditions have already been implemented and are in use for OL1 and OL2 fuel. An increase in fuel discharge burnup is planned only in the case of a power uprate and must be approved by STUK. In all future scenarios outlined in the EIA, the fuel will be operated within known limits using approved fuel technology from leading BWR fuel vendors.

8. How is the current distance between OL 1 and OL2 and the current state of science and technology assessed?

This work consists of several activities. TVO is actively involved in collaboration activities with other nuclear facilities, both within Nordic countries and globally. TVO is also continuously participating in many national and international nuclear safety-related research projects. Peer review activities with the help of WANO and IAEA also bring valuable information on best available practices. The information and operating experiences gathered are used to develop the performance of both the plants and the organizations operating them. Whenever new regulatory requirements are introduced, TVO evaluates the level of compliance, and if deficits are identified, TVO analyzes the safety importance and agrees with STUK on possible improvements to be implemented. The principle of the continuous improvement in Nuclear Energy law section 7a, means the measures of the state of art are continuous – not only PSR or LTE-related in Finland.

9. What modernization measures are still planned in the event of an extension of an extension of operation to 70 or 80 years in order to bring OL 1 and OL2 even closer to the state of the art in science and technology?

TVO has continuously modernized and improved the safety and efficiency of the power plants throughout their lifetime. This is intended to continue throughout the power plants operation lifetime.

10. How is the condition of the safety-relevant components that cannot be replaced or upgraded assessed?

The condition of these components is monitored and assessed as part of TVO's normal ageing management processes. Relevant analyses, such as strength and fatigue calculations of the reactor pressure vessel, will be done for the extended lifetime and power uprate.

11. Are the programs implemented for OL 1 and OL2 for ageing management and long-term operation compliant with the requirements formulated in SSG-48 and the WENRA SRL? What is this assessment based on? What deviations, if any, are there?

OL1 and OL2 ageing management programs are based on the requirements in SSG-48. The assessment is based on the OL1/OL2 failure history and preventive maintenance coverage compared to identified aging phenomena. TVO's ageing management is done according to national requirements, which correspond to WENRA SRL. Finnish Regulation includes the same requirements; for example, YVL Guide A.8 "Ageing management "uses references IAEA, Ageing Management for Nuclear Power Plants, Safety Guide No. NS-G-2.12, 2009. [2013-11-15] and WENRA Reactor Safety Reference Levels, Issue I: Ageing Management, Issue K: Maintenance, In-service Inspections and Functional Testing. [2013-11-15]

12. How is the scope of consideration of the technical facilities for ageing management of OL 1 and OL2 defined?

Ageing management targets all safety-classified equipment and also the most important equipment for usability. In addition to these, a risk-based approach is used in determining the scope of pipelines.

13. On which analyses is the statement (/TVO 24/, p. 31) based that no ageing-related damage mechanisms are expected that could call into question an operating life of the two units of up to 80 years?

TVO has calculated preliminary load and fatigue analyses on the reactor's primary circuit components, and these will not prevent the plant from operating for 80 years. The final analyses will be submitted to the authorities (STUK) for approval when applying for a 70- or 80-year operating license.

14. What measures have been/will be taken for OL 1 and OL2 to safeguard the supply chains?

Several measures have been implemented to safeguard the supply chains of the OL1 and OL2 plants. These include strengthening supplier risk management methods, continuously assessing and collaborating with critical suppliers, and identifying alternative suppliers. The commissioning of the OL3 plant has also expanded supplier options for OL1 and OL2 operations. Systematic and continuous modernization of the plants has aimed to manage both technological and resource-related risks. Methods related to the management of critical components and spare parts are being developed in accordance with the updated spare parts strategy.

15. What specific changes to the relevant operating parameters are to be expected if the output of OL 1 and OL2 is increased to 10 %?

If TVO decides to increase the reactor's thermal output, the reactor pressure and temperature will be kept at the current level (70 bar). The reactor coolant flow increases, and the plant's main process flows will increase by approximately 10%.

16. How are the changes in the relevant operating parameters taken into account when analyzing the ageing behavior of safety-relevant technical equipment?

Load and fatigue analyses have been performed, taking into account the increase in reactor power and its aging effects. A time-based replacement interval has been defined for some equipment and the impact on it will be assessed in connection with the implementation of the reactor power increase. The operational condition of some equipment is monitored through periodic tests and inspections, and replacements are made as necessary.

17. To what extent does the source term used in the EIA report cover radiological effects?

Finnish legislation and requirements set a 100 TBq limit for Cs-137, and this has been accepted by competent authority (Ministry of Economic Affairs and Employment of Finland) to be used for evaluations in the EIA. Modelling has been made with 100 TBq Cs-137 release including other nuclides correspondingly. This can be easily scaled to different amounts of radionuclide release to reflect other situations as needed. The 100 TBq Cs-137 is a conservative assumption for a severe accident in which the containment barrier works as designed.

18. Were cases with failure of the containment function (containment bypass) considered in the probabilistic safety analyses performed for OL 1 and OL2 and what are the source terms for these release categories?

Yes, the level 2 PRA (probabilistic risk assessment) study includes many kinds of accident scenarios, including direct containment bypass and containment failures due to possible severe accident phenomena. In the level 2 PRA, all these possible accident outcomes are combined together in order to estimate the large release frequency. The source terms are naturally very much dependent on the success or failure of the containment function and can exceed the limit set for a large release by one or two order of magnitude in the extremely unlikely situation where the containment function is not able to manage the accident consequences appropriately.

19. How is it ensured that the reactor cavern is flooded in good time before the RPV fails?

Flooding of the containment lower drywell (reactor cavern) is a simple action that takes place by gravity without any active pumping when the flooding valves are opened. It is one of the first actions that the operators implement when they enter the severe accident management instructions. The entry conditions for these actions are defined so that they are simple to identify and that there will be enough time available, even in the worst accident scenarios. The high success probability for timely flooding is ensured by providing two redundant flooding lines, by making it possible to open the flooding valves from the main control room or locally, with the possibility to use mobile generators for power if needed, and by training the operators for the performance of the required actions.

20. **How is the statement of a 99.5 % release of noble gases to be understood in connection with the information given in STUK-A268, Table 2.2?**

    The cases presented in the EIA do not have an identical basis with the cases in STUK-A268. In the chosen accident scenario in EIA, the release of noble gases has been assumed to reflect the worst-case scenario, in which basically all noble gases are released. This is a conservative assumption.

21. **The assumed accident scenario is classified as an INES level 6 event, which, according to the definition, results in significant releases of radioactive substances that make the implementation of planned countermeasures likely. To what extent can it be assumed that no far-reaching protective measures are required for the amount of release assumed in this accident scenario?**

    The Finnish VAL 1 states actions (dose criteria) based on doses. If the dose is estimated to exceed 10 mSv in 2 days for an unprotected person, sheltering indoors needs to be considered. If the dose is estimated to exceed 20 mSv in 7 days for an unprotected person, evacuation needs to be considered. According to those criteria, protective measures are limited to Finland.

22. **The assumed source term of 100 TBq Cs-137 (including other radionuclides released) corresponds to the limit value for the release of radioactive material in the event of a severe reactor accident according to the Finnish Nuclear Energy Decree(161/1988). Are there reasons why an accident scenario with higher release quantities was not considered for the assessment of transboundary effects?**

    Finnish legislation and requirements set a 100 TBq limit for Cs-137, and this has been accepted by the competent authority (Ministry of Economic Affairs and Employment of Finland) to be used for evaluations in the EIA.

23. **Various exposure paths are considered in the dose calculation. In contrast to the calculation according to the German accident calculation basis, neither beta radiant (external exposure due to beta radiation within the radioactive cloud) nor inhalation (internal exposure due to ingestion of radioactive substances through inhaled air) are taken into account according to the EIA report. Are there reasons why beta radiant and inhalation were not considered as possible exposure pathways to determine the effective dose?**

    The modelling takes into account the accumulation of doses via food intake and inhalation, as well as cloud dose and dose from fallout. The effect of beta radiation from the radioactive cloud is not considered significant compared to radiation doses caused by photons.

24. **Are there reasons why no variation ranges of the determined soil contamination values were given for the respective countries under consideration?**

    The fallout modelling has been made using the same 95 % fractile as with the dose estimations. Fall-out estimates are shown in the TVO EIA report full English version (table 67). The table lists the values as a function of distance, and information regarding any specific countries can be deduced based on the data in the table while table 71 does not directly show the variation range for fallout.

25. **Are restrictions on the consumption and market of food and feed expected on the basis of the contamination calculations?**

    This depends on the local guidelines and recommendations. The Finnish VAL 1 states that protective measures are necessary when radiation levels exceed a certain value. These measures include for example the temporary banning of sales and use of foodstuffs, etc. Criteria are presented as dose rates. The conservative analysis in the EIA shows that with the parameters used, there is a possibility of exceeding operational criteria, for example, regarding I-131 levels in dairy products outside of Finland.