
FINLAND

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STUK

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<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>ALARA</td>
<td>As Low As Reasonably Achievable</td>
</tr>
<tr>
<td>ASME</td>
<td>American Society of Mechanical Engineers</td>
</tr>
<tr>
<td>BAT</td>
<td>Best Available Techniques</td>
</tr>
<tr>
<td>BWR</td>
<td>Boiling water reactor</td>
</tr>
<tr>
<td>DiP</td>
<td>Decision-in-Principle</td>
</tr>
<tr>
<td>EIA</td>
<td>Environmental Impact Assessment</td>
</tr>
<tr>
<td>ENIQ</td>
<td>European Network for Inspection Qualification</td>
</tr>
<tr>
<td>EPR</td>
<td>European Pressurized water Reactor</td>
</tr>
<tr>
<td>Fennovoima</td>
<td>Finnish nuclear power company Fennovoima Oy</td>
</tr>
<tr>
<td>Fortum</td>
<td>Finnish nuclear power company Fortum Power and Heat Oy</td>
</tr>
<tr>
<td>FSAR</td>
<td>Final Safety Analysis Report</td>
</tr>
<tr>
<td>GTK</td>
<td>Geological Survey of Finland</td>
</tr>
<tr>
<td>HOF</td>
<td>Human and Organisational Factors</td>
</tr>
<tr>
<td>HUT</td>
<td>Helsinki University of Technology, at present Aalto University</td>
</tr>
<tr>
<td>IAEA</td>
<td>International Atomic Energy Agency</td>
</tr>
<tr>
<td>ICRP</td>
<td>International Commission on Radiological Protection</td>
</tr>
<tr>
<td>IPPAS</td>
<td>IAEA's International Physical Protection Advisory Service</td>
</tr>
<tr>
<td>IRRS</td>
<td>IAEA's Integrated Regulatory Review Service</td>
</tr>
<tr>
<td>IRRT</td>
<td>IAEA's International Regulatory Review Team</td>
</tr>
<tr>
<td>IVO</td>
<td>Imatran Voima, at present Fortum Power and Heat Oy</td>
</tr>
<tr>
<td>KTO</td>
<td>STUK's periodic inspection programme for operating NPPs</td>
</tr>
<tr>
<td>LUT</td>
<td>Lappeenranta University of Technology</td>
</tr>
<tr>
<td>MDEP</td>
<td>Multinational Design Evaluation Programme</td>
</tr>
<tr>
<td>MEE</td>
<td>Ministry of Employment and the Economy</td>
</tr>
<tr>
<td>NDT</td>
<td>Non-destructive testing</td>
</tr>
<tr>
<td>NPP</td>
<td>Nuclear power plant</td>
</tr>
<tr>
<td>OECD/NEA</td>
<td>Organisation for Economic Co-operation and Development / Nuclear Energy Agency</td>
</tr>
<tr>
<td>OSART</td>
<td>Operational Safety Review Team</td>
</tr>
<tr>
<td>PRA</td>
<td>Probabilistic risk assessment</td>
</tr>
<tr>
<td>PSAR</td>
<td>Preliminary Safety Analysis Report</td>
</tr>
<tr>
<td>PSR</td>
<td>Periodic safety review</td>
</tr>
<tr>
<td>PWR</td>
<td>Pressurised water reactor</td>
</tr>
<tr>
<td>RPV</td>
<td>Reactor pressure vessel</td>
</tr>
<tr>
<td>SAFIR</td>
<td>Finnish nuclear safety research programme</td>
</tr>
<tr>
<td>SAHARA</td>
<td>Safety As High As Reasonably Achievable</td>
</tr>
<tr>
<td>SSCs</td>
<td>Systems, structures and components</td>
</tr>
<tr>
<td>STUK</td>
<td>Finnish Radiation and Nuclear Safety Authority</td>
</tr>
<tr>
<td>TVO</td>
<td>Finnish nuclear power company Teollisuuden Voima Oy</td>
</tr>
<tr>
<td>WANO</td>
<td>World Association of Nuclear Operators</td>
</tr>
<tr>
<td>WENRA</td>
<td>Western European Nuclear Regulators' Association</td>
</tr>
<tr>
<td>VTT</td>
<td>Technical Research Centre of Finland</td>
</tr>
<tr>
<td>VVER</td>
<td>Water-Water Power Reactor, Russian PWR</td>
</tr>
<tr>
<td>YVL Guide</td>
<td>Finnish regulatory guide for nuclear safety</td>
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</table>
1 INTRODUCTION

There are two nuclear power plants operating in Finland: the Loviisa and Olkiluoto plants. The Loviisa plant comprises of two VVER units that are operated by Fortum Power and Heat Oy (Fortum). The Olkiluoto plant consists of two BWR units that are operated by Teollisuuden Voima Oyj (TVO). TVO has also an EPR unit (Olkiluoto 3) under construction at the Olkiluoto site. At both sites there are fresh and spent fuel storage facilities, and facilities for storage and treatment of low and intermediate level radioactive wastes (see also Table 1).

Other existing nuclear installations in Finland are the final disposal facilities for low and intermediate level radioactive wastes at the Olkiluoto and Loviisa plant sites. The disposal facility at Olkiluoto was taken into operation in 1992 and at Loviisa in 1998. For taking care of the spent fuel final disposal, a joint company Posiva Oy has been established in 1995 by Fortum and TVO. Research, development and planning work for spent fuel disposal is in progress and the disposal facility is envisaged to be operational in 2022. Posiva submitted the construction licence application for the spent nuclear fuel repository to the Ministry of Employment and the Economy in the end of 2012. However, these facilities are considered outside the scope of the Council Directive 2009/71/EURATOM and are not discussed in this report.

In May 2010, the Government granted two Decisions-in-Principle (DiP) for new reactor units, one to TVO (Olkiluoto site) and another to Fennovoima Oy (Pyhäjoki site), see also Table 1. The Parliament ratified both granted DiPs in July 2010. The Decisions-in-Principle set a schedule for Fennovoima and TVO to conclude their licensing feasibility studies and bidding processes and to submit the construction licence applications to the Government by mid 2015. After receiving the government DiP, Fennovoima started bidding negotiations on plant alternative (AES 2006), which was not mentioned in Fennovoima’s DiP application in 2009. Therefore, on 4 March 2014, Fennovoima started a complementary DiP process with the Ministry of Employment and the Economy. TVO is in bidding phase with five potential plant vendors on Olkiluoto unit 4 project. On 20 May 2014, TVO started a complementary DiP process with the Ministry of Employment and the Economy in order to extend the schedule for the submission of the construction licence application.

Finland observes the principles of the Directive, when applicable, also in other uses of nuclear energy than nuclear power plants, e.g., in the use of a research reactor. In Finland, there is one TRIGA Mark II research reactor (250 kW), FiR 1, situated in Espoo. The research reactor was taken into operation in 1962, and it is operated by VTT Technical Research Centre of Finland. In 2012, VTT decided to commence the activities related to the planning of the decommissioning of the research reactor. The preparation of the programme for the environmental impact assessment (EIA) procedure for the decommissioning of FiR 1 was started in May 2013 (see also Table 1). The EIA programme was published in October 2013. Presently the report on the performed EIA is being prepared and is planned to be completed in autumn 2014.
Table 1: List of the nuclear installations under the Directive 2009/71/EURATOM. In addition, there are fresh and spent fuel storage facilities, and facilities for storage and treatment of low and intermediate level radioactive wastes at Loviisa and Olkiluoto sites. The final disposal facilities for low and intermediate level radioactive waste at the Olkiluoto and Loviisa plant sites and the spent fuel disposal facility in deep crystalline bedrock near the Olkiluoto plant site are considered outside the scope of the Directive.

<table>
<thead>
<tr>
<th>Name</th>
<th>Operator</th>
<th>Type</th>
<th>Status</th>
<th>Location</th>
<th>Power</th>
<th>Start-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>FiR 1</td>
<td>VTT</td>
<td>TRIGA</td>
<td>Preparation of EIA for decommissioning</td>
<td>Otaniemi, Espoo</td>
<td>250 kW</td>
<td>27 Mar 1962</td>
</tr>
<tr>
<td>Loviisa 1</td>
<td>Fortum</td>
<td>PWR</td>
<td>Operational</td>
<td>Loviisa</td>
<td>496 MWe</td>
<td>8 Feb 1977</td>
</tr>
<tr>
<td>Loviisa 2</td>
<td>Fortum</td>
<td>PWR</td>
<td>Operational</td>
<td>Loviisa</td>
<td>496 MWe</td>
<td>4 Nov 1980</td>
</tr>
<tr>
<td>Olkiluoto 1</td>
<td>TVO</td>
<td>BWR</td>
<td>Operational</td>
<td>Olkiluoto, Eurajoki</td>
<td>880 MWe</td>
<td>2 Sep 1978</td>
</tr>
<tr>
<td>Olkiluoto 2</td>
<td>TVO</td>
<td>BWR</td>
<td>Operational</td>
<td>Olkiluoto, Eurajoki</td>
<td>880 MWe</td>
<td>18 Feb 1980</td>
</tr>
<tr>
<td>Olkiluoto 3</td>
<td>TVO</td>
<td>PWR</td>
<td>Under construction</td>
<td>Olkiluoto, Eurajoki</td>
<td>1600 MWe</td>
<td>-</td>
</tr>
<tr>
<td>Olkiluoto 4</td>
<td>TVO</td>
<td>BWR or PWR</td>
<td>Bidding phase</td>
<td>Olkiluoto, Eurajoki</td>
<td>approx. 1600 MWe</td>
<td>-</td>
</tr>
<tr>
<td>Hanhikivi 1</td>
<td>Fennovoima</td>
<td>PWR</td>
<td>Rosatom chosen as the plant supplier</td>
<td>Hanhikivi, Pyhajoki</td>
<td>approx. 1200 MWe</td>
<td>-</td>
</tr>
</tbody>
</table>

Continuous safety assessment and enhancement approach is presented in the Finnish nuclear legislation. The Nuclear Energy Act states that the safety of nuclear energy use shall be maintained at as high a level as practically possible. For the further development of safety, measures shall be implemented that can be considered justified considering operating experience and safety research and advances in science and technology. The implementation of safety improvements has been a continuing process at both Finnish nuclear power plants since the commissioning of the operating reactor units.

The current Finnish nuclear safety legislation is based on the Nuclear Energy Act originally from 1987. The Act has been amended more than 20 times during the years it has been in force and, for instance, in 2011 the Nuclear Energy Act was amended to implement the Council Directive 2009/71/EURATOM. Based on the Nuclear Energy Act the Government has issued Government Decrees on the Safety of Nuclear Power Plants, on the Security in the Use of Nuclear Energy, on the Emergency Response Arrangements at Nuclear Power Plants, and on the Safety of Disposal of Nuclear Waste.
According to Section 7 r of the Nuclear Energy Act, Radiation and Nuclear Safety Authority (STUK) shall specify detailed safety requirements concerning the implementation of safety level in accordance with the Act. These requirements are presented in the Finnish regulatory guides called YVL Guides. STUK regularly updates the regulatory guides based on advances in science and technology and on analysis of operational experience. The revised regulatory guide system was finalised in 2013 for the most part. The overall revision of the YVL Guides takes into account international guidance such as IAEA standards and WENRA (Western European Nuclear Regulators' Association) reference levels for existing reactors and safety objectives for new reactors. No deviation from the Directive obligations has been identified in the present Finnish regulatory infrastructure including nuclear and radiation safety regulations.

Finland has implemented the obligations of the Directive and also the objectives of the Directive are complied with. Legislation and regulatory guidance have been further developed taking into account nuclear safety research and advances in science and technology as well as the operating and construction experiences. Safety improvements have been annually implemented at the Loviisa and Olkiluoto nuclear power plants since their commissioning. Additional safety assessments and implementation plans for safety improvements have been made at the Loviisa and Olkiluoto NPPs based on the lessons learnt from the TEPCO Fukushima Dai-ichi accident. IRRS mission (IAEA's Integrated Regulatory Review Team) was carried out in October 2012 and STUK has developed its action plan for improvement on the basis of the IRRS mission results and the self-assessment. Follow-up mission will be conducted in June 2015. There exists no immediate need for additional improvements in the Finnish legislative, regulatory and organizational framework or the need to upgrade the safety of the Finnish nuclear power plants in the context of the Directive.

This report is aimed to be a stand-alone document demonstrating how Finland is fulfilling the obligations under the Council Directive 2009/71/EURATOM. The report follows an article-by-article approach and is structured according to the ENSREG Guidelines: Chapter 2 serves as a major information source by summarizing the findings reported in Chapter 3 which is structured in accordance with the given articles and sub-paragraphs of the Directive.
SUMMARY

This member state report as required under Article 9.1 of Council Directive 2009/71/EURATOM is aimed to demonstrate how Finland is fulfilling the obligations of the Directive. This report is first of its kind and focuses on recent changes in national laws, regulations, administrative arrangements, and practices related to nuclear safety. Finnish regulatory practices in, e.g., licensing, provision of regulatory guidance, safety assessment, inspection and enforcement are covered. In the report, the implementation of each of the Articles 4 to 8 of the Directive is separately evaluated.

In the context of Article 4, national legislative, regulatory and organisational framework is discussed including, e.g., description of the renewal of the regulatory guide system and principles for continuous improvement.

Continuous safety assessment and enhancement approach is presented in the nuclear legislation. Nuclear Energy Act states that the safety of nuclear energy use shall be maintained at as high a level as practically possible. For the further development of safety, measures shall be implemented that can be considered justified considering operating experience and safety research and advances in science and technology. The implementation of safety improvements has been a continuing process at both Finnish nuclear power plants since the commissioning of the operating reactor units.

During recent years Finnish legislation and regulatory guidance have been further developed. For instance, in 2011 the Nuclear Energy Act was amended to implement the Council Directive 2009/71/EURATOM. These amendments included:

- licensee’s responsibility to provide adequate training for staff having responsibilities relating to the nuclear safety,
- prohibition to delegate the licensee’s responsibility of nuclear safety,
- the Ministry of Employment and the Economy’s responsibility to arrange periodic self-assessments and invite an international peer review according to the Article 9 of the Directive.

Based on the Nuclear Energy Act, the Government has issued in 2008 and 2013 the following regulations:

- Government Decree on the Safety of Nuclear Power Plants (717/2013)
- Government Decree on the Security in the Use of Nuclear Energy (734/2008)
- Government Decree on Emergency Response Arrangements at Nuclear Power Plants (716/2013)

STUK regularly updates the regulatory guides based on advances in science and technology, results of safety research and on analysis of operational experience. The revised regulatory guide system was finalised in 2013 for the most part. The overall revision of the regulatory guides takes into account international guidance such as IAEA standards and WENRA (Western European Nuclear Regulators’ Association) reference levels for existing reactors and safety objectives for new reactors. In addition, the lessons learnt from the TEPCO Fukushima Dai-ichi accident have been taken into account. No deviation from the Directive obligations has been identified.
in the present Finnish regulatory infrastructure including nuclear and radiation safety regulations.

The section discussing Article 5 describes, e.g., the legal basis and powers of STUK as well as its independence and resources.

STUK’s position and legal powers are conferred in the Nuclear Energy Act and in the Government Decrees (see above) that are based on the Act. The mission of STUK is to protect people, society, environment, and future generations from harmful effects of radiation. STUK is an independent governmental organisation for the regulatory control of radiation and nuclear safety as well as nuclear security and nuclear materials.

The resources of STUK are adequate to fulfil the needs for independent regulation, and have been increased to meet the needs to oversee the construction of the new nuclear power plant unit in Finland. However, ensuring an adequate national supply of experts in nuclear science and technology is a continuous challenge in Finland as is discussed under Article 7. The recent IRRS (IAEA’s Integrated Regulatory Review Service) mission results will be used, as applicable, to further improve nuclear safety legislation, and regulatory guidance and practices. VTT Technical Research Centre of Finland supports effectively the regulatory body in the safety assessment work providing safety analysis capabilities and tools, and performing safety analyses. There are also national research programmes which support and develop the competencies in nuclear safety and waste management.

The text dealing with Article 6 describes the responsibilities of the licence holder, safety assessments conducted (e.g., deterministic safety assessments, probabilistic risk assessments and assessment of safety as a result of TEPCO Fukushima Dai-ichi accident) as well as different verification programmes and the management system and resources of the licence holders.

The responsibility for the safety rests with the licensee as prescribed in the Nuclear Energy Act. According to the Act, it shall be the licensee’s obligation to assure the safe use of nuclear energy. This obligation can not be transferred. Furthermore, it shall be the licensee’s obligation to assure such physical protection and emergency planning and other arrangements necessary to ensure the limitation of nuclear damage, which do not rest with the authorities.

It is the responsibility of the regulatory body to verify that the licensees fulfil the regulations. This verification is carried out through continuous oversight, safety review and assessment as well as inspection programmes established by STUK. In its activities, STUK emphasizes the licensee’s commitment to strong safety culture. The obvious elements of licensee’s actions to meet these responsibilities are strict adherence to regulations; prompt, timely and open actions towards the regulator and the general public in unusual situations; active role in improving safety based on advances in science and technology; and results of safety research as well as effective exploitation of experience feedback. In addition to inspections and safety assessment, the follow-up of licensee’s efforts in achieving results is based on safety indicators. This system includes indicators, e.g., for incidents, probabilistic risk assessment results, safety system operability, radiation doses to personnel, plant
availability as well as releases to the environment and resulting radiation exposures to the general public.

Based on the results of safety assessments conducted in Finland after the TEPCO Fukushima Dai-ichi accident, it is concluded that no such hazards or deficiencies have been found that would require immediate actions at the Finnish NPPs. However, areas where safety can be further enhanced have been identified and there are plans on how to address these areas. The experiences from the TEPCO Fukushima Dai-ichi accident were also taken into consideration in the renewal of the Finnish legislation and regulatory guides and in the nuclear safety research programme.

The section discussing Article 7 describes the requirements and status of expertise and skills at STUK and at the licence holders.

The retirement of the pioneers who took part in setting up the Finnish nuclear energy industry, regulatory authority, nuclear energy education as well as nuclear energy research and development in 1960’s and 1970’s affects all organisations in the field, including STUK, the utilities and the spent fuel management company Posiva as well as organisations providing technical support and education to them. The second generation has taken active role in the development of the industry and the institutions within the nuclear energy sector. The plans for new NPP construction projects and other activities require additional manpower and efforts from the nuclear power utilities and the regulatory body as well as from technical support organisations. Thus, ensuring an adequate national supply of experts in nuclear science and technology and ensuring high quality research infrastructure are continuous challenges in Finland. During 2010-2012 a committee set up by the Ministry of Employment and the Economy worked on a report aiming at giving recommendations and steps to be taken until the 2020’s for ensuring competence and resources needed for the nuclear sector. In addition, the Ministry of Employment and the Economy set up at the end of January 2013 a working group to prepare a research and development strategy. This report was published by the Ministry at the end of April 2014. There is a joint education and training programme organized in co-operation with STUK, VTT, the licence holders and universities for those entering the nuclear field. Each organization also has their own induction programmes for newcomers.

The text dealing with Article 8 describes the legal requirements for making information available and how STUK provides information and communicates with the general public.

Due to the increasing interest in nuclear power in Finland, communication and information sharing on nuclear and radiation safety has become an increasingly important success factor for STUK and the utilities. Regulatory processes and decisions have to be clear and understandable to the general public. Interactions with the media are important since the media plays an important role in communication.

One of the STUK’s tasks is to inform about radiation and nuclear safety matters and participate in training activities in the area. STUK utilises many means to
communicate with the public and interested stakeholders, such as meetings, seminars, and training courses. In addition, STUK has special interest in using the internet to inform the public and interested stakeholders about nuclear and radiation safety in general, risks related to radiation and to the use of nuclear energy, safety requirements, roles and STUK's responsibilities and organization, current activities and operating experience, significant regulatory decisions taken, and safety research.

In conclusion, Finland has implemented the obligations of the Directive and also the objectives of the Directive are complied with. Legislation and regulatory guidance have been further developed taking into account nuclear safety research and advances in science and technology as well as the operating and construction experiences. Safety improvements have been annually implemented at the Loviisa and Olkiluoto nuclear power plants since their commissioning. Additional safety assessments and implementation plans for safety improvements have been made at the Loviisa and Olkiluoto NPPs based on the lessons learnt from the TEPCO Fukushima Dai-ichi accident. IRRS mission (IAEA's Integrated Regulatory Review Team) was carried out in October 2012 and STUK has developed its action plan for improvement on the basis of the IRRS mission results and the self-assessment. Follow-up mission will be conducted in June 2015. There exists no immediate need for additional improvements in the Finnish legislative, regulatory and organizational framework or the need to upgrade the safety of the Finnish nuclear power plants in the context of the Directive.
3 REPORTING ARTICLE BY ARTICLE

Article 4 – Legislative, regulatory and organisational framework

1. Member States shall establish and maintain a national legislative, regulatory and organisational framework (hereinafter referred to as the ‘national framework’) for nuclear safety of nuclear installations that allocates responsibilities and provides for coordination between relevant state bodies. The national framework shall establish responsibilities for:

(a) the adoption of national nuclear safety requirements. The determination on how they are adopted and through which instrument they are applied rests with the competence of the Member States;

(b) the provision of a system of licensing and prohibition of operation of nuclear installations without a licence;

(c) the provision of a system of nuclear safety supervision;

(d) enforcement actions, including suspension of operation and modification or revocation of a licence.

2. Member States shall ensure that the national framework is maintained and improved when appropriate, taking into account operating experience, insights gained from safety analyses for operating nuclear installations, development of technology and results of safety research, when available and relevant.

Article 4.1 – Overview of the national nuclear safety legislation

The current nuclear safety legislation in Finland is based on the Nuclear Energy Act originally from 1987. The Act has been amended more than 20 times during the years it has been in force: most changes are minor and originate from changes to other Finnish legislation. In 2008, nuclear energy legislation was updated to correspond to current level of safety requirements and the new Finnish Constitution which came into force in 2000. Together with a supporting Nuclear Energy Decree originally from 1988, the scope of this legislation covers e.g.

- the construction and operation of nuclear facilities; nuclear facilities refer to facilities for producing nuclear energy, including research reactors, facilities for extensive disposal of nuclear wastes, and facilities used for extensive fabrication, production, use, handling or storage of nuclear materials or nuclear wastes

- the possession, fabrication, production, transfer, handling, use, storage, transport, export and import of nuclear materials and nuclear wastes as well as the export and import of ores and ore concentrates containing uranium or thorium.

The current radiation safety protection legislation is based on the Radiation Act and Decree, both of which are from 1991 and take into account the ICRP Publication 60 (1990 Recommendations of the International Commission on Radiological Protection).
Section 2, General principles, and Chapter 9, Radiation work, of the Act are also applied to the use of nuclear energy.

In 2011 the Nuclear Energy Act was amended to implement the Nuclear Safety Directive (Council Directive 2009/71/EURATOM). These amendments included:

- licensee’s responsibility to provide adequate training for staff having responsibilities relating to the nuclear safety,
- prohibition to delegate the licensee’s responsibility of nuclear safety,
- the Ministry of Employment and the Economy’s responsibility to arrange periodic self-assessments and invite an international peer review according to the Article 9 of the Directive.

In addition, the Nuclear Energy Act was amended in 2011 to include provisions on mining and milling operations aimed at producing uranium or thorium. In 2012, the Nuclear Energy Act was amended with some minor clarifications and to extend the use of inspection organisations. In 2013, the Nuclear Energy Act and the Radiation Act were amended to implement the Directive 2011/70/EURATOM of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste.

In 2012, the Finnish regulatory framework for nuclear and radiation safety was reviewed in the IRRS (Integrated Regulatory Review Service) peer review process. According to the IRRS recommendations, some amendments need to be considered for the legislation concerning STUK’s independence and legal authorities in the licensing process and in setting binding regulations. The amendments to the Nuclear Energy Act and the Radiation Act are being prepared in 2014.

Based on the Nuclear Energy Act, the Government issued in 2008 and 2013 the following regulations:

- Government Decree on the Safety of Nuclear Power Plants (717/2013)
- Government Decree on the Security in the Use of Nuclear Energy (734/2008)
- Government Decree on Emergency Response Arrangements at Nuclear Power Plants (716/2013)

The Decrees 717/2013 and 716/2013 are applied to a nuclear power plant which is defined to be a nuclear facility equipped with a nuclear reactor for the purpose of electricity or heat production or a complex consisting of reactor units and other related nuclear facilities located on the same plant site. The regulations are also applied to other nuclear facilities to the extent applicable. The previously existing Decrees were amended in 2013 mainly due to tightening of safety requirements after the TEPCO Fukushima Dai-ichi accident and new WENRA Safety objectives. Decree 734/2008 is applied to all use of Nuclear Energy, i.e., it covers all nuclear facilities and activities. A Government Decree on the safety of mining and milling operations aimed at producing uranium or thorium is being prepared in 2014.

At the same time with the international negotiations to update the Paris and Brussels Conventions on Nuclear Liability also the Finnish Nuclear Liability Act was reviewed by a special governmental committee already in 2002. The financial provisions to cover the
possible damage and resulting costs caused by a nuclear accident have been arranged according to the Paris and Brussels Conventions. A remarkable increase in the sum available for compensation of nuclear damage is expected in the future since international negotiations about the revision of the Paris/Brussels agreements on nuclear liability were successfully completed in 2004. As the ratification of the 2004 Protocols has been delayed, Finland made a temporary amendment in the Finnish Nuclear Liability Act in 2012, implementing the provision on unlimited liability and requirement of insurance coverage for a minimum amount of 700 million euros by the operator. The temporary law came into force in January 2012 and will be repealed when the 2004 agreement takes effect.

National organisational framework and responsibilities are discussed, e.g., under Articles 4.1 (b), 5.1, 5.2, and 6.1. See also Figures 2 and 3.

Article 4.1 (a) – Provision of regulatory guidance

According to Section 7 r of the Nuclear Energy Act, STUK shall specify detailed safety requirements concerning the implementation of safety level in accordance with the Act. These requirements are presented in the Finnish regulatory guides called YVL Guides. STUK shall specify the safety requirements it sets and publish them as part of the regulations issued by STUK.

The safety requirements of STUK are binding on the licensee, while preserving the licensee’s right to propose an alternative procedure or solution to that provided for in the regulations. If the licensee can convincingly demonstrate that the proposed procedure or solution will implement safety level in accordance with the Nuclear Energy Act, STUK may approve this procedure or solution.

The most important references considered in Finnish regulations for nuclear safety are the IAEA safety standards, especially the Requirements documents, and WENRA (Western European Nuclear Regulators’ Association) Safety Reference Levels. Also the WENRA Safety Objectives for new reactors and the WENRA positions on some key technical issues are considered. Other sources of safety information are worldwide cooperation with other countries using nuclear energy, e.g. OECD/NEA, MDEP (Multinational Design Evaluation Programme) and VVER Forum. The Finnish policy is to participate actively in the international discussions on developing safety standards and adopt or adapt the new safety requirements into national regulations. The regulatory guides are updated based on advances in science and technology, results of safety research and on analysis of operational experience. The Finnish regulatory guides have been continuously re-evaluated for updating.

After amending the nuclear safety legislation in 2008, the revision of all YVL Guides was commenced to reflect the enhanced safety requirements. The thorough revision and update of the YVL guides aimed for more goal-based and more user-friendly set of requirements. The updating integrated the lessons learned from the regulatory oversight and especially from the Olkiluoto 3 project. The set of YVL Guides covers safety, security and safeguards. The project involved about 50 man-years at STUK and served also for knowledge management purposes. The re-structured system of the regulatory YVL Guides is shown in Figure 1.
### Structure of the new YVL guides

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**Figure 1:** The re-structured system of the regulatory YVL Guides.

Considering the WENRA Safety Reference Levels published in 2007 and 2008, the Finnish policy was to include all of them in the revised YVL Guides. This was done during the work through a systematic approach to earmark all the Reference Levels to certain YVL Guides.
After the TEPCO Fukushima Dai-ichi accident it was decided to include lessons learnt from the accident into the revised YVL Guides, which delayed the completion of the new guides. For this purpose, a detailed plan was prepared in the beginning of 2012. Available information and evaluation reports concerning the accident were considered in the preparation of the plan. Also the IAEA Action Plan and the draft WENRA report on Safety of new NPP designs were considered. The plan was revised in the end of 2012. In this revision the results of the European stress tests and the outcomes of the Extraordinary Meeting to the Convention on Nuclear Safety were considered. The most important changes that were included in the new YVL Guides due to the TEPCO Fukushima Dai-ichi accident, deal with the removal of residual heat from the reactor core and spent fuel storages, consideration of severe external hazards and with the requirements concerning on-site emergency preparedness including multi-unit accidents.

Most of the new YVL Guides (40/44) were issued on December 1, 2013. Three of the still missing guides can not be issued due to some changes needed in the legislation. One of the missing guides is in the final phases of preparation.

The procedure to apply new guides to existing nuclear facilities is such that the publication of a YVL Guide does not, as such, alter any previous decisions made by STUK. After having heard those concerned, STUK makes a separate decision on how a new or revised YVL Guide applies to operating nuclear power plants, or to those under construction, and to licensee’s operational activities as well as to other nuclear facilities related to nuclear waste management and disposal and to the research reactor. To new nuclear facilities, however, the YVL Guides apply as such.

**Article 4.1 (b) – System of licensing**

The licensing process is defined in the legislation. The construction and operation of a nuclear facility is not allowed without a licence. The licences are prepared by the Ministry of Employment and the Economy and granted by the Government. The conditions for granting a licence are prescribed in the Nuclear Energy Act.

Before a Construction Licence for a new nuclear reactor, nuclear waste handling and disposal facility, or other significant nuclear facility can be applied, a Decision-in-Principle by the Government is needed. A condition for granting the Decision-in-Principle is that the operation of the facility in question is in line with the overall good of the society. The municipality of the intended site of the nuclear facility has to be in favour of constructing the facility. There shall also be sufficient prerequisites for constructing the facility according to the Nuclear Energy Act: the use of nuclear energy shall be safe; it shall not cause injury to people, or damage to the environment or property.

The Decision-in-Principle coming into force requires that it will be confirmed by the simple majority of the Parliament. The Parliament can not make any changes to the Decision; it can only approve it or reject it as it is. The parties involved in the Decision-in-Principle process and their tasks are described in Figure 2. In Decision-in-Principle phase STUK prepares a statement on safety and a preliminary safety assessment concerning the applicant, the proposed plant designs and plant sites. In its preliminary
safety assessment, STUK must also include a statement from the Advisory Commission on Nuclear Safety.

For the Construction and Operating Licence applications, the Ministry of Employment and the Economy (MEE) asks STUK’s statement on safety. Construction and Operating Licence documents to be submitted to STUK for approval are defined in Sections 35 and 36 of the Nuclear Energy Decree. STUK asks also statements, e.g., from the Advisory Commission on Nuclear Safety and from the Ministry of the Interior. After receiving all statements for the Construction or Operating Licence, the Government will make its decision.

In accordance with Section 108 of the Nuclear Energy Decree, the different phases of construction of a nuclear facility may be begun only after STUK has, on the basis of the Construction Licence application documents and other detailed plans and documents it requires, verified in respect of each phase that the safety-related factors and safety regulations have been given sufficient consideration.

In accordance with Section 109 of the Nuclear Energy Decree, STUK oversees the construction of the facility in detail. The purpose is to ensure that the safety and quality requirements, regulations for pressure equipment and approved plans are complied with and that the nuclear facility is constructed in other respects in accordance with the regulations. In particular, the oversight is aimed to verify that working methods ensuring high quality are employed for the construction.

![Diagram of licensing process](image)

**Figure 2:** The parties involved in the licensing of nuclear facilities in Finland.
Before loading fuel into the reactor, an Operating Licence is needed. The Operating Licences are granted for a limited period of time. When the length of the term is considered, particular attention shall be paid to ensuring safety and to the estimated duration of operations. Periodic safety review shall be carried out at least every ten years.

The licence shall include the licence conditions necessary for implementing the general principles referred to in chapter 2 of Nuclear Energy Act and for implementing the safety requirements in accordance with this Act. The licence conditions may be amended in order to maintain the prerequisites regarding the general principles and the granting of a licence laid down in this Act. When amending licence conditions, the same procedure shall be followed, as appropriate, as when the licence was granted. Typically, licence conditions include the thermal power of the reactor, the dates for the next periodic safety reviews, and the amount of spent fuel and plant waste which can be stored at the site. More detailed safety requirements are given by STUK which supervises their compliance according to the Nuclear Energy Act. The current operating licences are valid for the Loviisa units 1 and 2 until the end of 2027 and 2030, respectively, and for Olkiluoto units until the end of 2018, but periodic safety reviews (PSRs) are required as a condition of continued operation.

The authority that has granted a licence shall cancel it wholly or partly, if the implementation of the general principles for the use of nuclear energy as laid down in the Nuclear Energy Act is essentially endangered. When cancelling a licence, the same procedure shall be followed, as appropriate, as when the licence was granted.

**Article 4.1 (c) – System of nuclear safety supervision**

The legislation provides the regulatory control system for the use of nuclear energy. According to the Nuclear Energy Act, STUK is responsible for the regulatory oversight of the safety of the use of nuclear energy. The rights and responsibilities of STUK are provided in the Nuclear Energy Act. Safety review and assessment as well as inspection activities are covered by the regulatory oversight.

**Oversight during operation**

STUK’s oversight during plant operation includes periodic inspection programme, continuous oversight performed by STUK’s resident inspectors, review and approval of safety significant plant modifications, reviewing licensee’s regular reporting and reporting of events, and oversight performed at the plant site during operation and maintenance outages. An overall safety assessment is conducted annually on each nuclear facility dealing with the attainment of radiation protection objectives, the development of defence in depth, and the organisations operating nuclear facilities and providing services to them. On the basis of the safety assessments during operation, both the licensee and STUK evaluate the need and potential for safety improvements.

STUK’s periodic inspection programme is focused on the licensee’s main working processes and covers the most relevant areas of nuclear power plant safety. The objective of the inspection programme is to assess the safety level at the plants as well as safety management. Possible problems at the plants and in procedures of the operating organisations are to be recognised. Each year STUK defines the programme for the next
year, including additional inspections as necessary. In addition to the periodic inspection programmes, STUK conducts unannounced inspections.

STUK has put special emphasis on the management of the entire inspection programme, including the timely conduct, resource allocation and accurate reporting of results, but there are some issues which can be further improved. Periodic inspection programme was assessed in the IRRS mission conducted in Finland in October 2012. The IRRS mission team suggested that STUK can further enhance the effectiveness of its inspection activities by enhancing the focus of inspection on the most safety-significant areas, by defining more concrete criteria for reactive inspections and conducting higher number of unannounced inspections. STUK updated the internal guidance of the periodic inspection programme in the beginning of 2014 taking into account the IRRS recommendations and suggestions.

In the event review, the safety significance of the event is first evaluated based on the information given by the operator and STUK’s resident inspectors. Later operating experience is reported to STUK as an event report, which STUK evaluates and may require additional information or actions. STUK maintains internal database for events which disseminates operating experiences and provides easy access to operational event reports. STUK may assign own investigation team for events deemed to have special importance, especially when the operations at the nuclear power plant have not been performed as planned and expected. It is also possible to nominate an investigation team to investigate a number of events together in order to look for possible generic issues associated with the events.

STUK’s review and assessment of plant modifications is described in Article 6.2.  

**Oversight during construction**

In accordance with Section 108 of the Nuclear Energy Decree, the different phases of construction of a nuclear facility may be begun only after STUK has, on the basis of the construction licence documents and other detailed plans and documents it requires, verified in respect of each phase that the safety-related factors and safety regulations have been given sufficient consideration. STUK’s pre-approval of the detailed design is usually needed prior to starting the manufacturing of structures and components. Review of the detailed design of structures and equipment can begin after STUK has found that the plant and system-level design data of the system concerned are sufficient and acceptable.

In accordance with Section 109 of the Nuclear Energy Decree, STUK oversees the construction of the facility in detail. Oversight consists of inspections within the frame of the Construction Inspection Programme and inspections on manufacturing and construction of systems, structures and components important to safety. In addition, STUK has resident inspectors overseeing the construction, installations and commissioning work at the construction site. Licensee reports regularly about the progress of the construction.

To oversee the licensee's performance in a construction project, STUK has established a Construction Inspection Programme. The purpose of the programme is to verify that the performance and organisation of the licensee ensure high-quality construction and
implementation in accordance with the approved designs while complying with the regulations and official decisions. The Construction Inspection Programme is divided into two main levels: the upper level assesses the licensee’s general operations to manage the construction, such as safety management and safety culture, organisation, corrective actions programme, the licensee’s expertise and use of expertise and project quality management. The next level, known as the operation level, assesses, e.g., project quality assurance, training of the operating personnel, utilisation of the PRA, radiation safety issues, and licensee’s review and assessment process for system, structure and component-specific design reviews and inspections in the various fields of technology. Furthermore, the emergency response arrangements during construction, physical protection, fire protection and nuclear waste treatment are subjects of the Construction Inspection Programme as far as the scope is considered necessary by STUK. In addition to the above-mentioned inspections, of which the licensee is informed in advance, STUK carries out inspections without prior notice at its discretion. Construction Inspection Programme was also assessed in the IRRS mission and the recommendations and suggestions given for the periodic inspection programme of the operating plants concern also the Construction Inspection Programme. STUK updated the internal guidance of the Construction Inspection Programme in 2014.

STUK performs inspections on manufacturing of pressure equipment and construction of buildings, concrete and steel structures as specified in YVL Guides. Inspections are determined in detail when STUK reviews component or structure specific construction plans. Inspections are defined either as hold or witness points. In lower safety classes inspections are performed by accredited inspection organisations that are authorized by STUK. Licensee is responsible for inviting STUK to perform the inspection at the right time. The goal of the inspections is to verify that manufacturer, vendor and licensee have performed their duties as expected and that the quality control results of manufacturing and construction are acceptable. In addition, STUK performs inspections on installation and commissioning of systems, structures and components. The safety class of systems, structures and components (SSCs) as well as the complexity of the SSCs are taken into account when determining the scope of inspections.

**Article 4.1 (d) – Enforcement**

The Nuclear Energy Act Sections 65-69 define the enforcement system and rules for suspension, modification or revocation of a licence. The enforcement system includes provisions for executive assistance if needed and for sanctions in case the law is violated. The enforcement tools and procedures of the regulator are considered to fully meet the needs.

In practice, STUK’s enforcement tools include: oral notice or written request for action by the STUK’s inspector, and written notice or order for actions by STUK. Actions can include shutting down the plant operation immediately or decrease of reactor power for unlimited time. Legally stronger instruments would be 1) setting a conditional imposition of a fine, 2) threatening with interruption or limiting the operation, and 3) threatening that STUK enforces the neglected action to be made at the licensee’s expense.
Article 4.2 – Continuous improvement

Continuous safety assessment and enhancement approach is presented in the nuclear legislation. Nuclear Energy Act Section 7 a states that the safety of nuclear energy use shall be maintained at as high a level as practically possible. For the further development of safety, measures shall be implemented that can be considered justified considering operating experience and safety research and advances in science and technology. The implementation of safety improvements has been a continuing process at both Finnish nuclear power plants since the commissioning of the operating reactor units.

STUK is regularly updating the regulatory guides (YVL Guides) based on advances in science and technology, results of safety research and response to operational experience as discussed above. The practice in Finland is that the new or updated regulatory guides are applied as such to new nuclear facilities and a separate decision will be made concerning the implementation at the operating nuclear facilities or facilities under construction. All reasonably practicable improvement measures shall be made.

After issuing a new or revised YVL Guide, STUK asks the licensees to assess whether the facility and the licensee operations are in compliance with the new requirements. In case of non-compliance the licensee is expected to propose plans and schedules for improvements. Exemptions from new requirements can be accepted if it is not technically or economically reasonable to implement respective modifications and if safety justification is considered adequate. Safety justification typically requires deterministic analyses supplemented with probabilistic risk assessment and engineering judgement.

Some examples of new YVL Guide requirements and required improvements are the backfitting measures for severe accident management carried out at the operating Finnish NPPs in the end of 1980’s and during 1990’s. In Finland, the severe accident management systems are required to be safety classified, independent and single failure tolerant. Some more recent examples of plant modifications include ongoing projects for building emergency control rooms in Loviisa and Olkiluoto NPPs. New YVL guide requirements shall also be taken into account in large plant modifications according to STUK's plant specific decisions, e.g., spent fuel interim storage in Olkiluoto NPP will be protected against large civil aircraft crashes in the enlargement project.

Periodic safety review (PSR) shall be carried out at the Finnish NPPs at least every ten years. The requirements concerning the PSR process are presented in the Guide YVL A.1 and they follow the procedures of IAEA Safety Guide SSG-25. PSR is carried out by the licensee and the results are submitted to STUK for review. The last PSR of Lovisa NPP was submitted to STUK in 2006 and Olkiluoto NPP PSR in 2008. Possible safety improvements are also discussed during the PSR and an action plan to improve safety at the NPPs is agreed between the licensee and STUK as a result of the periodic safety review.

New urgent safety information might also lead to direct improvement measures. One example is the action plan including safety improvements both at the Finnish NPPs and on national level based on the lessons learnt from the TEPCO Fukushima Dai-ichi accident.
Plant modifications improving safety have also been carried out continuously at the Finnish NPPs based on the results of probabilistic risk assessment (PRA). Examples include safety system improvements, fire safety improvements and implementation of a major modernisation programme in mid 1990’s at the both Finnish NPPs. By means of these modifications risks have been decreased and the risk topography of the plant has been balanced. Technical solutions of the modifications have also been often justified with PRA. More information concerning probabilistic risk assessment is given under Article 6.

Continuous improvement of the functions of STUK is ensured by actions made based on internal and external assessments. Internal assessments include, e.g., internal audits, self-assessments, management reviews and staff surveys. External assessments are typically conducted by international peers. Full-scope IRRT mission (IAEA’s International Regulatory Review Team) was carried out in 2000 with a follow-up mission in 2003. IAEA’s International Physical Protection Advisory Service (IPPAS) mission was carried out in Finland in 2009 with the follow-up in 2012. IRRS mission (IAEA’s Integrated Regulatory Review Service) was carried out in October 2012. In its preparations to the IRRS mission, STUK carried out a comprehensive self-assessment. IRRS mission resulted in 8 recommendations, 21 suggestions and 10 good practices. STUK has developed and published its action plan for improvement on the basis of the IRRS mission results and the self-assessment. These actions have been included in STUK’s strategy, operating programmes and annual plans. Follow-up mission will be in June 2015.

**Article 5 – Competent regulatory authority**

1. *Member States shall establish and maintain a competent regulatory authority in the field of nuclear safety of nuclear installations.*

2. *Member States shall ensure that the competent regulatory authority is functionally separate from any other body or organisation concerned with the promotion, or utilisation of nuclear energy, including electricity production, in order to ensure effective independence from undue influence in its regulatory decision making.*

3. *Member States shall ensure that the competent regulatory authority is given the legal powers and human and financial resources necessary to fulfil its obligations in connection with the national framework described in Article 4(1) with due priority to safety. This includes the powers and resources to:*

   (a) *require the licence holder to comply with national nuclear safety requirements and the terms of the relevant licence;*

   (b) *require demonstration of this compliance, including the requirements under paragraphs 2 to 5 of Article 6;*

   (c) *verify this compliance through regulatory assessments and inspections; and*
(d) carry out regulatory enforcement actions, including suspending the operation of nuclear installation in accordance with conditions defined by the national framework referred to in Article 4(1).

Article 5.1 – Legal basis and responsibilities of STUK

According to the Nuclear Energy Act, the overall authority in the field of nuclear energy is the Ministry of Employment and the Economy. The Ministry prepares matters concerning nuclear energy to the Government for decision-making. Among other duties, the Ministry of Employment and the Economy is responsible for the formulation of a national energy policy.

The mission of the Radiation and Nuclear Safety Authority (STUK) is ‘to protect people, society, environment, and future generations from harmful effects of radiation’. STUK is an independent governmental organisation for the regulatory control of radiation and nuclear safety as well as nuclear security and nuclear materials. The current Act on STUK was given in 1983 and the Decree in 1997. According to the Decree, STUK has the following duties:

- regulatory oversight of safety of the use of nuclear energy, emergency preparedness, security and nuclear materials
- regulatory control of the use of radiation and other radiation practices
- monitoring of the radiation situation in Finland, and maintaining of preparedness for abnormal radiation situations
- maintaining national metrological standards in its field of activity
- research and development work for enhancing radiation and nuclear safety
- informing on radiation and nuclear safety issues, and participating in training activities in the field
- producing expert services in the field of its activity
- making proposals for developing the legislation in the field, and issuing general guides concerning radiation and nuclear safety
- participating in international co-operation in the field, and taking care of international control, contact or reporting activities as enacted or defined.

STUK has the legal authority to carry out regulatory oversight. The responsibilities and rights of STUK, as regards the regulation of the use of nuclear energy, are provided in the Nuclear Energy Act. They cover the safety review and assessment of licence applications, and the regulatory oversight of the construction, operation and decommissioning of a nuclear facility. The regulatory oversight of nuclear facilities is described in detail in the Guide YVL A.1. STUK has also legal rights to require modifications to nuclear power plants, to limit the power of plants and to require shutdown of a plant when necessary for safety reasons, as described in Article 4.
Article 5.2 – Independence of STUK

STUK is administratively under the Ministry of Social Affairs and Health. Interfaces to ministries and governmental organisations are described in Figure 3. It is emphasized that the regulatory control of the safe use of radiation and nuclear energy is independently carried out by STUK. No Ministry can take for its decision-making a matter that has been defined by law to be on the responsibility of STUK. STUK has no responsibilities or duties which would be in conflict with regulatory control.

STUK does not grant any construction or operating licences for nuclear facilities. However, in practice no such licence would be issued without STUK’s statement where the fulfilment of the safety requirements is confirmed as described in Article 4.

STUK’s Advisory Committee was established in March 2008. Advisory Committee helps STUK to develop its functions as a regulatory and expert organisation in such a way that the activities are in balance with the society’s expectations and the needs of the citizens. Advisory Committee can also make assessments of the STUK’s actions and give recommendations to STUK.

An Advisory Commission on Nuclear Safety has been established in 1988 by a Decree. This Commission gives advice to STUK on important safety issues and regulations. The Commission also gives its statements on licence applications. The Commission has now two international committees, one for reactor safety and one for nuclear waste safety issues. In addition, an Advisory Committee on Radiation Safety has been established for advising the Ministry for Health and Social Affairs. The members of the Advisory Commission on Nuclear Safety and the Advisory Committee on Radiation Safety are nominated by the Government.

To assist STUK’s work in nuclear security, an Advisory Committee on Nuclear Security was established in 2009. The members of the committee come from various Finnish authorities, and also the nuclear licensees have their representatives. The duties of the committee include the assessment of the threats in the nuclear field as well as consultation to STUK in important security issues. The committee also aims to follow and promote both the international and internal co-operation in the field of nuclear security.

As already discussed in Article 4, STUK received some IRRS recommendations concerning STUK’s independence and legal authorities in the licensing process and in setting binding regulations. The amendments to the Nuclear Energy Act and Radiation Act are being prepared in 2014.
Article 5.3 – Legal powers and human and financial resources of STUK

STUK’s position as the regulatory authority in the field of the use on nuclear energy and STUK’s legal powers are conferred in the Nuclear Energy Act and the Government Decrees based on it. STUK as a governmental organisation is founded by the Act on Radiation and Nuclear Safety Authority (1069/1983) and the Government Decree on Radiation and Nuclear Safety Authority (618/1997).

In Section 7 r of Nuclear Energy Act (990/1987), the mandate for the Radiation and Nuclear Safety Authority (STUK) is given to make detailed requirements:

*The Radiation and Nuclear Safety Authority (STUK) shall specify detailed safety requirements concerning the implementation of safety level in accordance with this Act.*

*Further, the Radiation and Nuclear Safety Authority (STUK) shall specify the safety requirements it sets in accordance with the safety sectors involved in the use of nuclear energy, and publish them as part of the regulations issued by the Radiation and Nuclear Safety Authority (STUK).*

*The safety requirements of the Radiation and Nuclear Safety Authority (STUK) are binding on the licensee, while preserving the licensee’s right to propose an alternative procedure or solution to that provided for in the regulations. If the licensee can convincingly demonstrate that the proposed procedure or solution will implement safety standards in accordance with this Act, the Radiation and Nuclear Safety Authority (STUK) shall*
Authority (STUK) may approve procedure or solution by which the safety level set forth is achieved.

The new regulatory guides apply to future NPP units to be built in Finland as such. According to the principle of continuous improvement of nuclear safety, the regulatory guides shall be applied to existing reactor units to the extent possible. The applicability of the new requirements, as well as their fulfilment, for the existing units is evaluated separately.

According to the Section 55.2 of the Nuclear Energy Act (990/1987), STUK shall supervise the observance of licence conditions as well as set detailed requirements concerning the operations referred to in the licence and issue detailed regulations, if necessary, and supervise compliance therewith. Based on Section 63 of the Nuclear Energy Act STUK has the right to inspect and control operations in nuclear facilities and for this purpose have access to any place where such an operation is being carried out, as well as to carry out measurements required for supervision, to take and to receive samples and to install equipment necessary for such supervision.

The responsibilities of STUK are further defined in Chapter 15 of the Nuclear Energy Decree (161/1988).

STUK contributes to the processing of applications for licences under the Nuclear Energy Act, controls compliance with the licence conditions, and formulates the detailed requirements. STUK also lays down qualification requirements for personnel involved in the use of nuclear energy and controls compliance with these requirements. In addition, STUK submits proposals for legislative amendments and issues general guidelines concerning radiation and nuclear safety according to section 7 r of Nuclear Energy Act, as described above.

STUK's oversight of operating nuclear facilities ensures that the condition of the facilities is and will be in compliance with the requirements, the facilities function as planned and that they are operated in compliance with the regulations. The regulatory activities cover the operation of the facility, its systems, components and structures, as well as the operations of the organisation. STUK’s oversight during nuclear facility construction and operation as well as STUK’s enforcement powers are described under Article 4. On the basis of the safety assessment during operation, both the licensee and STUK evaluate the need and potential for safety improvements. An overall safety assessment is conducted annually on each nuclear facility dealing with the attainment of radiation protection objectives, the development of defence in depth, and the organisations operating nuclear facilities and providing services to them.

The organisational structure and the responsibilities within STUK are described in the Management System of STUK. Also processes for regulatory oversight and other activities of STUK are presented in the Management System.

The expertise of STUK covers all the essential areas needed in the oversight of the use of nuclear energy. At the end of 2013, the total number of staff at STUK was 347 and in the department of Nuclear Reactor Regulation 113. New personnel have been recruited since 2003 mainly for the safety review and assessment and inspection activities related to the Olkiluoto unit 3 under construction. The annual volume of the oversight for the
operating Loviisa units 1 and 2 was about 15 person years in 2013 and for operating Olkiluoto units 1 and 2 approximately 11 person years. The oversight of the Olkiluoto unit 3 construction required about 26 person years in 2013. Starting from 2003, inspection organisations have been performing construction inspections in lower safety classes. New plant projects (Olkiluoto unit 4 and Fennovoima’s unit 1) required altogether some person years in 2013.

STUK has also increased the number of personnel in the areas of security of nuclear facilities as well as in activities related to nuclear waste management and disposal. In 2009, a separate unit for security with three experts was founded in the department of Nuclear Reactor Regulation and in the end of 2013, 4 experts worked in this unit.

If needed, STUK orders independent analyses, review and assessment from technical support organisations to complement its own review and assessment work. The main technical support organisation of STUK is VTT, Technical Research Centre of Finland, but also Lappeenranta University of Technology (LUT) and Aalto University (former Helsinki University of Technology) are important. Also international technical support organisations and experts have been used, especially to support review and inspection activities related to Olkiluoto unit 3.

STUK receives about 33% of its financial resources through the government budget. However, the costs of regulatory oversight are charged in full to the licensees. The model of financing the regulatory work is called net-budgeting model and it has been applied since 2000. In this model the licensees pay the regulatory oversight fees directly to STUK. In 2013, the costs of the regulatory oversight of nuclear safety were 18.3 million euros.

STUK has currently adequate resources to fulfil its responsibilities. The net-budgeting model makes it possible to increase for example personnel resources based on needs in a flexible way. Expertise and resources in nuclear field in Finland are discussed also under Article 7.

Article 6 – Licence holders

1. Member States shall ensure that the prime responsibility for nuclear safety of a nuclear installation rests with the licence holder. This responsibility cannot be delegated.

2. Member States shall ensure that the national framework in place requires licence holders, under the supervision of the competent regulatory authority, to regularly assess and verify, and continuously improve, as far as reasonably achievable, the nuclear safety of their nuclear installations in a systematic and verifiable manner.

3. The assessments referred to in paragraph 2 shall include verification that measures are in place for prevention of accidents and mitigation of consequences of accidents, including verification of the physical barriers and licence holder’s administrative procedures of protection that would have to fail before workers and the general public would be significantly affected by ionizing radiations.
4. Member States shall ensure that the national framework in place requires licence holders to establish and implement management systems which give due priority to nuclear safety and are regularly verified by the competent regulatory authority.

5. Member States shall ensure that the national framework in place requires licence holders to provide for and maintain adequate financial and human resources to fulfil their obligations with respect to nuclear safety of a nuclear installation, laid down in paragraphs 1 to 4.

Article 6.1 – Prime responsibility

The responsibility for the safety rests with the licensee as prescribed in the Nuclear Energy Act. According to Section 9 of the Act, it shall be the licensee’s obligation to assure the safe use of nuclear energy. This obligation cannot be transferred. Furthermore, it shall be the licensee’s obligation to assure such physical protection and emergency planning and other arrangements, necessary to ensure limitation of nuclear damage, which do not rest with the authorities.

The financial provisions to cover the possible damage to third parties caused by a nuclear accident have been arranged in Finland according to the Paris and Brussels Conventions. Related to the revision of the Paris and Brussels Conventions in 2004, Finland has decided to enact unlimited licensee’s liability by law. The revised law will also have some other modifications, such as extending the claiming period up to 30 years for victims of nuclear accidents. As the international ratification of the 2004 Protocols has been delayed, Finland made a temporary amendment in the Finnish Nuclear Liability Act in 2012, implementing the provision on unlimited liability and requirement of insurance coverage for a minimum amount of 700 million euros. The temporary law came into force in January 2012 as described under Article 4.1.

Article 6.2 – Assessment and verification of safety

Regulatory approach to safety assessment

The prerequisite of the Construction and Operating Licences is that the licence applicant has made its own safety assessment. The fulfilment of the safety requirements is demonstrated in the Construction and Operating Licence documentation. STUK makes an independent safety assessment concerning the application and this assessment is required in the Nuclear Energy Act. Conditions for granting a Licence are provided in the Nuclear Energy Act. For example, there is a general requirement that the use of nuclear energy must be safe. In Section 20 of the Act it is further stated that the operation of the nuclear facility shall not be started until STUK has ascertained that the nuclear facility meets the prescribed safety requirements.

The Nuclear Energy Decree requires that when applying for a construction licence, the applicant must submit to STUK the following documents: a Preliminary Safety Analysis Report, a design phase Probabilistic Risk Assessment, a proposal for a safety classification document, a description of Quality Management during the construction of the nuclear facility, preliminary plans for the arrangements for security and emergency preparedness, and a plan for arranging the safeguards control. For the operating licence, the applicant must submit to STUK: the Final Safety Analysis Report, the Probabilistic
Risk Assessment, the safety classification document, the quality management programme for the operation of the nuclear facility, Operational Limits and Conditions, a programme for periodic inspections, security and emergency plans, a description on administrative rules for safeguards, a programme for radiation monitoring in the environment of the nuclear facility, a description of how the safety requirements are met, and a programme for the management of ageing. In addition, the Decree gives STUK a possibility to ask other documents considered necessary for safety demonstration.

Design of the facility is described in the Preliminary (PSAR) and Final (FSAR) Safety Analysis Reports. The reports are submitted to STUK for approval with the applications for Construction and Operating Licences, respectively. PSAR/FSAR forms the basis to STUK’s safety assessment which is required before granting the Construction/Operation Licence. According to the Nuclear Energy Decree, FSAR has to be continuously updated, and changes to FSAR have to be submitted to STUK for approval. Requirements for the plant modification process are presented in the Guide YVL B.1, “Safety design of a NPP”. The main principle in plant modification process is that conceptual design plans and system-specific pre-inspection documents of Safety Class 1, 2 and 3 systems must be submitted to STUK for approval. STUK reviews and approves the modification prior to its implementation at the plant. In connection with a system modification, the Final Safety Analysis Report shall be amended accordingly without delay. Principles of continuous improvement are discussed in more detail under Article 4.2.

The general design bases for nuclear fuel have been defined in the Guide YVL B.4, “Nuclear fuel and reactor”. The design objective is that the probability of fuel failure is low during normal operational conditions and anticipated operational transients, and that during a postulated accident the extent of fuel failures remains low and the fuel remains in a coolable state. Detailed requirements for the design, quality management and control, handling, storage and transport of fuel are specified in the Guides YVL B.4, YVL D.2, YVL D.3 and YVL E.2.

The Government Decree on the Safety of Nuclear Power plants (717/2013) requires that nuclear power plant safety and the technical solutions of its safety systems shall be substantiated by using experimental and calculation methods. These include among others analyses of operational occurrences and accidents, strength analyses, failure mode and effect analyses, and probabilistic risk assessments. Analyses shall be maintained and revised if necessary, taking into account operating experience, the results of experimental research, plant modifications and the advancement of calculation methods. The calculation methods employed for demonstrating compliance with safety regulations shall be reliable and well qualified for the purpose. They shall be applied so that the resulting system design bases meet the acceptance criteria with high certainty. Any uncertainty in the results shall be assessed and considered when defining safety margins. STUK’s review of these analyses includes independent safety analyses.

Detailed requirements concerning transient and accident analyses are presented in the Guide YVL B.3 "Deterministic safety analyses for a nuclear power plant". Requirements for probabilistic risk assessments are given in the Guide YVL A.7, “Risk Management of a NPP”. Acceptance criteria for the analyses are presented in Guides YVL B.4 “Nuclear fuel and reactor” and YVL B.6 “Containment of a nuclear power plant”. Government Decree 717/2013 sets limits for doses and radioactive releases.
Deterministic safety assessment

Detailed requirements concerning transient and accident analyses, including sensitivity analyses, are presented in the Guide YVL B.3 “Deterministic safety analyses for a nuclear power plant.

Fortum submitted with the licence renewal documentation in 2005–2007 the revised Final Safety Analysis Report, including the transient and accident analyses of the Loviisa units 1 and 2. Fortum has revised the analyses taking into account plant modifications implemented at both units as well as new regulatory requirements. The analyses presented in the Safety Analysis Report cover anticipated operational transients, category 1 and 2 postulated accidents, and severe accidents. The analyses cover all operating states and include accident analyses for the storages of spent fuel and reactor waste. Fortum has supplemented the deterministic safety analyses in 2008 by analyses of design extension conditions.

STUK assessed the submitted analyses for the Loviisa NPP and methods applied in the analyses. STUK contracted VTT Technical Research Centre of Finland to carry out independent analyses to verify the results given in the licence renewal documentation and to conduct sensitivity analyses. STUK concluded that the plant behaviour in different transient and accident situations has been analysed comprehensively and that the methods used in the analyses are properly validated to describe the operation of the Loviisa plant.

Accident and transient analyses of the Olkiluoto units 1 and 2, as well as the analysis methods, have been updated and developed throughout the operation of the plant. TVO revised completely the accident and transient analyses in conjunction with the application for the renewal of its operating licence in 1995–1998. The analyses were at that time carried out for nuclear fuel that is no longer being used at the Olkiluoto 1 and 2 units. For the periodic safety review in 2007–2009, TVO updated the accident analyses using the SVEA-96 Optima 2 as a reference fuel. The plant modifications carried out after the renewal of the operating licence in 1998 were also taken into account in the update. Since renewal of the operating licence in 1998, Guides YVL 2.2 and YVL 6.2 were revised and a requirement regarding analyses of design extension conditions was introduced. When TVO updated its analyses for periodic safety review, the new regulation was taken into account. Since Olkiluoto 1 and 2 periodic safety reviews, Guides YVL B.3, YVL B.4 and YVL B.6 have replaced the Guides YVL 2.2 and YVL 6.2.

The calculation methods used for analysing the plant normal operating conditions, transients and postulated accidents were developed by the supplier of the Olkiluoto plant units. The methods have been validated to an extent corresponding to international standard. STUK reviewed the updated analyses and the calculation methods used. The conclusion was that the analyses of transients and accidents of the Olkiluoto units 1 and 2 were conducted as referred to in Section 3 of the former Government Decree on Nuclear Safety (733/2008). However, STUK required updating of the loss of coolant analyses assuming a level of system availability specified in the Guide YVL 2.2. TVO submitted the required updates in 2010.

The preliminary analyses of Olkiluoto unit 3 were presented to STUK in PSAR and the Topical Reports appended to PSAR with the application for the construction licence.
STUK contracted technical support organisations to carry out independent analyses to verify the results. STUK approved the PSAR of Olkiluoto unit 3 in January 2005 just before the construction licence was granted by the Government. TVO has submitted updated analyses for the Final Safety Analysis Report in 2008–2013. The analyses will be reviewed by STUK as a part of the evaluation of the forthcoming Olkiluoto unit 3 operating licence application.

**Probabilistic risk assessment**

In the Nuclear Energy Decree, probabilistic risk assessment (PRA) has been included since 1988 in the list of documents to be submitted to STUK for the review of the operating licence application. Since 2008 the preliminary design phase PRA has been in the list of documents to be submitted to STUK for the review of the construction licence application according to the Nuclear Energy Decree, but a limited preliminary PRA has been required in regulatory YVL Guides since 1996. PRA for construction licence application is based on preliminary design information and generic reliability data for components. PRA for operating licence application is based on essentially final design information and vendor specific component reliability data, where available, and system modelling is also more detailed. PRA shall be kept up-to-date during operation and it shall also be included into periodic safety reviews.

According to the Government Decree on Nuclear Safety, PRA shall be maintained and revised if necessary, taking into account operating experience, the results of experimental research, plant modifications and the advancement of calculation methods. The detailed requirements on the use of PRA are set forth in the Regulatory Guide YVL A.7. Detailed requirements on risk-informed applications are included in several other YVL Guides.

STUK required in 1984 that the Finnish utilities Fortum (previously Imatran Voima Oy) and TVO shall make extensive probabilistic risk assessments for the Loviisa and Olkiluoto nuclear power plants. The objective of the study was to determine the plant-specific risk topographies of the essential accident sequences. Another important objective was to enhance the plant personnel's understanding of the plant and its behaviour in different situations. Therefore STUK also required that the PRAs are performed mainly by the utility personnel and external consultants are used only for special topics.

In 1987 STUK published the Regulatory Guide YVL 2.8 on PRA. The Guide was updated in 1996, 2003 and 2013 (the updated guide is called YVL A.7). Currently the Guide requires a full-scope PRA (including internal events, fires, floods, seismic events, harsh weather and other external events) for power operation and low-power and shut-down states. PRA shall cover the analysis of the probability of core damage (Level 1) and large release of radioactive substances (Level 2). PRA shall be updated continuously to reflect plant and procedure modifications and changes in reliability data (Living PRA).

Guide YVL A.7 includes the following probabilistic safety goals:

- Core damage frequency less than $1 \cdot 10^{-5}$/year
- Large radioactive release ($> 100$ TBoq Cs-137) frequency less than $5 \cdot 10^{-7}$/year.

In addition, there is the following requirement on containment function: The accident sequences, in which the containment function fails or is lost in the early phase of a
severe accident, shall have only a small contribution to the reactor core damage frequency.

The release assessments shall take into account all of the nuclear fuel located at the plant unit. Spent nuclear fuel storage external to the plant unit is considered a separate nuclear facility for whose analysis the aforementioned criteria apply.

These safety goals apply as such to new plant units. For operating units, instead of the numerical safety goals, the SAHARA (safety as high as reasonably achievable) principle and the principle of continuous improvement are applied.

The guide YVL A.7 includes requirements on several risk informed applications, such as analysis of plant modifications, risk-informed in-service inspections and testing, development of emergency operating procedures and training programmes and review of safety classification and Operational Limits and Conditions. In comparison to the older guide on PRA (i.e. YVL 2.8), requirements on the use of PRA in the decommissioning phase have been added and the list of applications and documents to be submitted to STUK have been specified.

For a new plant unit, a preliminary PRA covering Levels 1 and 2 shall be submitted to STUK for the review of the construction licence application (design phase PRA) and the updated and complemented PRA (Levels 1 and 2) shall be submitted for the review of the operating licence application.

Computer models applied in PRAs shall be made available to STUK. STUK uses PRA routinely to support its decision making, for example, in review of plant modifications and applications for exemption from Operational Limits and Conditions and in analysis of operating events.

**Probabilistic risk assessment of the Loviisa NPP**

Fortum provided STUK with Level 1 PRA in 1989. Since 1990 Fortum has extended PRA by analysing risks related to fires, floods, earthquakes, severe weather conditions and outages, as well as by conducting Level 2 PRA. Plant modifications have been carried out continuously at the Loviisa NPP, including safety system improvements, fire safety improvements, implementation of Severe Accident Management systems and a major modernisation programme in mid 1990’s. By means of these modifications risks have been decreased and the risk topography of the plant has been balanced. Technical solutions of the modifications have also been often justified with PRA.

The development of the core damage frequency from 2000 to 2012 is shown in Figure 4. Figure 5 shows the relative contribution to the annual core damage frequency from different groups of initiating events in 2012. At the end of 2013 the calculated estimate for the total probability of reactor core damage was about $2.3 \cdot 10^{-5}$ per reactor year. The Loviisa plant has full-scope PRA covering Levels 1 and 2. The latest extension of the scope included fire risk analysis for shutdown states in 2011.
Figure 4: Development of the annual core damage frequency estimate for the Loviisa NPP in 2000–2012. The increase in the core damage frequency in 2003 was due to extension of the PRA scope with non-seismic external events during shutdown states. The preliminary conservative analyses showed relatively high risk due to exceptionally high outside air temperature and oil spills in the Gulf of Finland in cold shutdown states. Later the risk estimate was decreased due to plant modifications and more realistic analyses.

Fortum has also provided STUK with the Level 2 PRA, in which the integrity of the containment and the release of radioactive materials from the plant to the environment are evaluated. In the latest update in 2012, it was estimated that the total probability of a large release to the environment is about $8.0 \times 10^{-6}$ per year. The estimate includes a detailed study for internal events, fires, floods and severe weather conditions at power states and at outages, whereas some specific events (seismic, shutdown fires, heavy load drop, loss of DC power, etc.) are based on rough estimates on the accident progression. Recent modifications which have decreased core damage frequency and large release frequency include: renewal of auxiliary service water system, modifications in power distribution for some containment systems, renewal of Pressuriser Overpressure Protection Valve (PORV), renewal of pressuriser spray system and new procedures for sump recirculation in shutdown states.

The results of STUK’s review show that Fortum has applied in its analyses commonly accepted methods in modelling transient and accident situations of the plant and in collecting and analysing reliability data. The reviews also show that the assessments provide an adequate basis for risk informed decision making.
Figure 5: Relative contribution of different initiating event types to the annual core damage frequency in 2012 for Loviisa NPP. The most significant internal initiating events at full power (power operation, PO) are the small interfacing system LOCAs and the loss of instrumentation room ventilation. At shutdown (SD) the most significant internal initiating events are drop of heavy loads and reactivity accident due to boron dilution. Note: "Flood" includes only internal flooding from process systems and external flooding is included in "Weather".

PRA has been used by the licensee in the risk-informed applications required by the Guide YVL A.7, for example in the evaluation of plant modifications, review of safety classification, development of Risk-Informed In-Service Inspection programme. The risk informed review of the Operational Limits and Conditions, including optimisation of testing intervals, and optimisation of Operational Limits and Conditions (allowable outage times) is under way. The Loviisa NPP has also introduced a Risk-Informed In-Service Inspection programme for piping. The number of inspections was increased but the focus shifted from high safety classes to lower safety classes. This shift is due to the fact that some lower safety class pipings have relatively large risk significance as they belong to vital support systems, or leaks in lower class pipelines may lead to consequential damage to safety systems. The radiation doses to inspection personnel will decrease as a result of the new inspection programme.

Probabilistic risk assessment of the Olkiluoto units 1 and 2

TVO submitted to STUK the first version of Level 1 PRA in 1989. Since then, the PRA has been updated several times and the scope has been extended. TVO has now practically full-scope PRA covering levels 1 and 2 for full power operation and for low power and shutdown states.
Annual core damage frequency from 2000 to 2012 is shown in Figure 6. Plant modifications have been carried out continuously at the Olkiluoto plant, including backfitting with severe accident management systems and power uprate and modernisation in the 1990’s.

Figure 6: Development of the annual core damage frequency estimate for Olkiluoto units 1 and 2 in 2000–2012. The decrease in seismic risk in 2008 is due to plant modifications allowing improved handling of spurious activation of isolations due to relay chatter. The risk estimate increase in 2009 is due to a more detailed analysis of the capacity of decay heat removal by diverse systems. The risk estimate increase in 2011 is due to the change of the method used to determine fire ignition frequencies and update of external hazards study that contains a new man-made hazard “marine oil-spill”.

Figure 7 shows the relative contributions to annual core damage frequency from different groups of initiating events in 2012. At the end of 2013 the overall core damage frequency of Olkiluoto units 1 and 2 was approximately $1.2 \times 10^{-5}$ per reactor year, including all operating states and all groups of initiating events.

In 1996, TVO submitted to STUK the Level 2 PRA. The analysis has been updated a few times since then. According to the living PRA model at the end of 2013 the frequency of the large release to the environment (>100 TBq Cs-137) was $1.5 \times 10^{-6}$ per reactor year, which was approximately one tenth of the core damage frequency. The large release frequency has decreased in the updates mainly due to the decrease of the core damage frequency.

TVO has used PRA in the risk-informed applications required by the Guide YVL A.7, for example in evaluation of plant modifications, review of safety classification, development of Risk-Informed In-Service Inspection programme, optimisation of testing intervals, and optimisation of Operational Limits and Conditions (allowable outage times).
Figure 7: Relative contribution of different initiating event types to the annual core damage frequency in 2012 for Olkiluoto units 1 and 2. The most significant internal initiating events at full power are the loss of off-site power and loss of feedwater. Note: “Flood” includes only internal flooding from process systems and external flooding is included in “Weather”.

**Probabilistic risk assessment of Olkiluoto unit 3**

The vendor of Olkiluoto unit 3 conducted a design phase PRA, which TVO submitted in 2004 to STUK for the review of the construction licence application as required by the Nuclear Energy Decree. The design phase PRA includes analysis of internal initiating events, internal hazards and external hazards for power operation and refuelling outage. STUK approved the Olkiluoto 3 PRA for the construction licence in January 2005. The PRA of Olkiluoto 3 has been continuously updated by the plant vendor during the construction phase and STUK has closely followed the completion of the PRA.

Olkiluoto unit 3 preliminary PRA covers seismic events and other external events (harsh weather, organic material in seawater etc.). According to the preliminary results, Olkiluoto unit 3 fulfils with a wide margin the probabilistic safety goals set forth in the Guide YVL A.7. The contributions of seismic and other off-site external events are less than 1% and 10% of the total core damage frequency, respectively. The most important external events are strong wind with snowfall and the loss of the ultimate heat sink due to oil spill, organic material in seawater or frazil ice.

Preliminary results of level 2 PRA show that large release frequency of Olkiluoto unit 3 is very small. Either the release magnitude or frequency of the estimated severe accident sequences has a wide margin to the unacceptable limits set forth in the Guide YVL A.7. Future refinement of the analyses is not expected to change the magnitudes of releases.

PRA has been used by TVO and plant vendor in the risk-informed applications required by the Guide YVL A.7, for example in evaluation of system design, review of safety
classification, development of Risk-Informed In-Service Inspection programme, optimisation of testing intervals, optimisation of Operational Limits and Conditions (allowable outage times), and planning of plant commissioning tests.

Safety assessment of Finnish NPPs in the light of TEPCO Fukushima Dai-ichi accident

Following the accident at the Fukushima Dai-ichi nuclear power plant on the 11th of March in 2011, safety assessments in Finland were initiated after STUK received a letter from the Ministry of Employment and the Economy on March 2011. The Ministry asked STUK to carry out a study on how the Finnish NPPs have prepared against loss of electric power supply and extreme natural phenomena in order to ensure nuclear safety. STUK asked the licensees to carry out assessments and submitted the study report to the Ministry of Employment and the Economy on May 2011. Although immediate actions to ensure safety of public and environment were not considered necessary, STUK required the licensees to carry out additional assessments and present action plans for safety improvements. Assessments were conducted and reported by the Finnish licensees to STUK on December 2011. STUK has reviewed the results of national assessments, and made licensee-specific decisions in 2012 on the suggested safety improvements and additional analyses.

Finland also participated in the EU Stress Tests and submitted the national report to European Commission at the end of 2011. An EU level peer review on the report was completed by April 2012. The recommendations of the EU peer review have been taken into account in the regulatory decisions and will be considered in the development of national regulations. A National Action Plan was prepared addressing the measures initiated on a national level and at the Finnish nuclear power plants in the light of the TEPCO Fukushima Daichii accident. The National Action Plan was sent to the European Nuclear Regulators Group (ENSREG) and peer reviewed in April 2013. In addition, Finland participated in the second Extraordinary Meeting of the Convention of Nuclear Safety (CNS) in August 2012 and prepared a report introducing all Fukushima related actions. All STUK’s related decisions, the national report to European Commission, the report to the Extraordinary meeting of CNS, and the Finnish National Action Plan have been published on STUK’s website.

Based on the results of assessments conducted in Finland to date, it is concluded that no such hazards or deficiencies have been found that would require immediate actions at the Finnish NPPs. However, areas where safety can be further enhanced have been identified and there are plans on how to address these areas. The experiences from the TEPCO Fukushima Dai-ichi accident have also taken into account in renewal of the Finnish Regulatory Guides (YVL Guides) and in the nuclear safety research programme SAFIR 2014.
Verification of safety

Verification programmes

Government Decree 717/2013 includes several requirements which concern the verification of the physical state of a nuclear power plant. For instance, in all activities affecting the plant operation and the availability of components, a systematic approach shall be applied for ensuring the operators’ continuous awareness of the state of the plant and its components. The reliable operation of systems and components shall be ensured by adequate maintenance as well as by regular in-service inspections and periodic tests. General requirements on verification programmes and procedures are provided in the YVL Guides (e.g. Guide YVL A.6, YVL A.8, YVL E.3, YVL E.5).

Main programmes used for verification of the state of a nuclear power plant are

- periodic testing according to the Operational Limits and Conditions
- maintenance and condition monitoring programmes
- in-service inspection programme
- periodic inspections of pressure equipment and piping
- surveillance programme of reactor pressure vessel material
- programmes for evaluating the ageing of components and materials.

Activities for verifying the physical state of a power plant are carried out in connection with normal daily routines and with scheduled inspections, testing, preventive maintenance etc. Activities are performed by the licensee and in the case of certain inspections by contractors approved separately. Detailed programmes and procedures are established and approved by the licensee. They are also reviewed and, when needed, approved by STUK. The results of tests and inspections are documented in a systematic way and used through a feedback process to further develop the programmes. The Operational Limits and Conditions are approved by STUK. In general, the role of STUK is to verify that the licensees follow the obligations imposed on them and carry out all activities scheduled in verification programmes.

Comprehensive evaluations related to the state and operation of the Loviisa and Olkiluoto plants were carried out in the periodic safety reviews by Fortum in 2005–2007 and TVO in 2007–2009. These activities were controlled by STUK.

Inspection qualification

According to international experience and the Guide YVL E.5, STUK has recognised the qualification of non-destructive testing systems and procedures as an issue of high importance. This issue requires high priority at both nuclear power plants. The implementation of qualified NDT systems has been started in 1990's.

General requirements on inspection qualification are provided in the Guide YVL E.5. The document "European methodology for qualification" drawn up by the European Network for Inspection and Qualification (ENIQ) shall be used as the minimum requirement level for qualification of inspection systems to be used in in-service inspection, and it shall be complemented by the ENIQ Recommended Practices. In the content of licensees’ guidelines published by the qualification body, the requirements presented in the Guide
YVL E.5, in the European Methodology for Qualification (EUR 17299) and in its recommendations have been taken into account.

The licensees Fortum and TVO have established the Steering Committee for Qualification and nominate its members on annual basis. The Steering Committee for Qualification is guiding and supervising the practical qualification work with the help of a separate Technical Support Group nominated and supervised by the Steering Committee.

Based on a contract with the licensees, Inspecta Certification is nominated as the qualification body for qualification management, implementation, control and assessment as well as the issuing of qualification certificates in Finland. The Finnish qualification body is a qualification body of type 1, which is an independent third party organisation as defined by ENIQ Recommended Practice 7. When needed Inspecta Certification uses also experts outside of its own organisation for individual qualifications. Most of the qualifications have already been performed and approved by STUK.

STUK ordered in 2009 an assessment of the current qualification activities in Finland from an independent expert organisation. The purpose was to assess whether Finnish inspection qualification practice leads to reliable and effective in-service inspection of safety critical components. Review was performed in two parts: 1) review of the inspection qualification system as specified in the Guide YVL E.5 and the national qualification guideline documents issued by the qualification body and 2) review of the inspection qualification practices. As a conclusion of the assessment it was reported that the qualification system meets the Finnish requirements, is effective and provides confidence in the inspections of safety critical components.

In-service inspections

The condition of the pressure-retaining components of the Loviisa and Olkiluoto NPPs is ensured with regular in-service inspections. The components of the primary circuit are inspected by means of non-destructive examination methods. These regularly repeated examinations are carried out during outages according to the Guide YVL E.5. The results of the in-service inspections are compared with the results of the previous inspections and of the pre-service inspections which have been carried out before the commissioning.

The in-service inspection plans are submitted to STUK for approval before each individual in-service inspection. Programmes and related inspection procedures are changed when necessary, taking into account the development of requirements and standards in the field, the advancement of examination techniques and inspection experiences as well as operating experiences in Finland and abroad.

Guide YVL E.5 and the latest revisions of the ASME Code, Section XI are applied as approval bases for the in-service inspection programmes and procedures. ASME Code, Section XI, Appendix R and ENIQ European Framework Document for Risk-informed In-service Inspection are used as approval bases for the risk-informed in-service inspection programmes.
The reliability of the non-destructive examination methods for the primary circuit piping and components has been essentially improved after the commissioning of the both Loviisa and Olkiluoto NPPs. Guide YVL E.5 calls for the qualification of the entire NDT-system; equipment, software, procedures and personnel. Most of the inspection systems are already qualified at the both plants. STUK follows the development and implementation of the plans.

A risk-informed inspection programme has been introduced and approved by STUK at the Loviisa units 1 and 2 for the in-service inspections of safety-critical pipelines. The deployment of risk-informed inspection methods for targeting inspections has been developed in Finland by STUK, Fortum, TVO and VTT. The objective of risk-informed in-service inspection programmes is to allocate inspection resources to the targets that are most critical from the point of view of risk. Using this approach, it is possible to ensure that the current inspection objects are well-justified, identify new objects and omit certain less safety-critical objects from the existing inspection programme. According to experts' view, the programme is the most extensive risk-informed in-service inspection programme so far implemented in Europe.

The length of the inspection period of the regular inspections (e.g. ASME Code, Section XI) is normally ten years. Inspection programmes have been complemented with additional inspections as regards the reactor pressure vessel and the primary circuit piping, and the length of the inspection period of the reactor pressure vessel has been reduced to eight years. The length of the inspection period of the objects susceptible to thermal fatigue is typically three years.

At the Olkiluoto plant, attempts have been made to focus the inspections on areas where faults are most likely to emerge. These include, for example, items susceptible to fatigue due to temperature variations or items susceptible to stress corrosion cracking. The selection of inspection items is under continuous development. For this purpose, a risk-informed in-service inspection procedure has been developed for the Olkiluoto units 1 and 2 and it has been approved by STUK. Inspections and inspection schedules will be optimised on the basis of risk-informed methods when the next inspection interval programmes are drawn up.

The frequency of the non-destructive examinations performed at regular intervals is usually ten years at the Olkiluoto NPP. The inspection frequency for items susceptible to thermal fatigue is three years, and the inspection frequency for items susceptible to stress corrosion cracking is three to five years.

In addition to the inspections mentioned above, physical inspections concerning the condition and reliability of pressure equipment are carried out as regular pressure equipment inspections according to the Finnish pressure equipment legislation. Such inspections are a full inspection, an internal inspection and an operational inspection. These inspections include non-destructive examinations as well as pressure and tightness tests. The inspections of piping have been defined in the system-specific monitoring programmes. These periodic inspections are dealt with in the Guides YVL E.3, YVL E.8, and YVL E.9. The periodic inspection programmes of the Loviisa and Olkiluoto NPPs fulfil the requirements of YVL Guides, as regards the number and techniques of inspections.
Ageing management

According to the Government Decree (717/2013), the design and construction of a nuclear power plant shall include provision for the ageing of systems, structures and components (SSCs) important to safety. Their condition shall be monitored to ensure operability and conformity in design-basis conditions. The needed replacements, repairs and modifications, shall be carried out in a systematic manner. In order to have control of SSCs' obsolescence, adoptable safety requirements and technology shall be assessed regularly and actions shall be taken accordingly. Continuous availability of spare parts and technical support shall be ensured, too.

The regulatory oversight of ageing in operating plants focuses on operating licence renewals and Periodic Safety Reviews (PSRs) where the conformance to the relevant Government Decrees and YVL Guides, including experiences with ageing and its management, is investigated. STUK’s findings from other regulatory control practices, particularly the periodic inspection programme, are used as verification. The periodic inspections are done on plant site according to annual planning and tackle both the technical aspects of each discipline and the process of ageing management. STUK also receives annual reports from each nuclear power plant unit on ageing management activities within each technical discipline.

An expert group dedicated to ageing management has been established within STUK to oversee how the licensees perform their duties in the ageing management of SSCs. The group, which consists of mechanical, electrical, I&C, civil and human resource experts and resident inspectors, looks into such events and observations at the Finnish nuclear plants that may be related to inadequate ageing management. If shortcomings are found, for example in condition monitoring or maintenance, the group calls the licensee for further clarifications or corrective actions. The group also follows up findings from other countries and evaluates their possible linkage to the ageing management of the Finnish nuclear plants. In the overall renewal of the STUK’s regulatory guides, a dedicated regulatory guide is developed for ageing management, i.e. YVL A.8.

Ageing management at the Loviisa NPP

Radiation embrittlement of the reactor pressure vessels (RPV) and the related surveillance and mitigation actions dominated the ageing management in Loviisa NPP since the early years of operation. This was more relevant to Loviisa unit 1 whose girth weld at the level of the reactor core has a higher content of impurities. In 1996, the brittle weld joint of the Loviisa 1 reactor pressure vessel was heat-treated to improve the ductility properties of the welding material. In this connection the reactor pressure vessel was subject to thorough non-destructive tests. Embrittlement rate has been reassessed based on the new surveillance programme representing the critical weld. STUK has granted the operating licences of the RPVs for the Loviisa units 1 and 2 until 2027 and 2030, respectively. For both units, deterministic and probabilistic safety analyses are required to be updated in the Periodic Safety Reviews (by end of 2015 and 2023) in order to justify continued service of the RPVs. In addition, new findings from domestic and international inspection and research programmes may require updating of the RPV analysis results.
In the mid-1990's, Fortum implemented their systematic plant-wide ageing management programme. The SSCs are assigned to categories A through D based on their technical and economical replaceability. SSC failures in category A would limit plant lifetime and thus deserve a part-assembly-wise break-down of ageing related remedies. Category A comprises the main primary components. Data indicative of plant status and trends are collected with operation, maintenance and inspection IT systems, R&D activities and via experience exchange. The consequent ratings of operability, remaining service life and necessary actions for each SSC are stored on the plant database.

In 2006 the operating utility Fortum submitted to the Government an application to continue the operation of Loviisa units 1 and 2 until the end of 2027 and 2030, respectively, meaning a 20-year extension to the original design lifetime. Among the ageing-related justification were the main fatigue analyses, updated to cover the whole 50 years’ life span with consideration of the environmental effects. Documents on In-Service Inspection Summary Programme, Ageing Management Programme Principles and Implementation, and SSC Status and Service Life Extensibility were also submitted.

For electrical and I&C components it was noted that massive projects are underway to replace cables in containment due to its detected considerable ambient temperature rise, and for plant-wide replacing of obsolete protection and plant I&C systems and components. In its review, STUK made a general point that the state-of-the-art permitted a quantitative life-time evaluation only in case of ageing by fatigue. However, other potential mechanisms have been identified and resources are in place to monitor, inspect, mitigate and repair as needed. The operating organisation has also strong technical support which has convincingly resolved forthcoming ageing issues in the past, and the history records are well preserved. The Government granted the applied operating licences on condition that two PSRs are undertaken during the licence period.

**Ageing management at the Olkiluoto NPP**

The ageing management activities at the Olkiluoto units 1 and 2 arose from wide-spread indications of inter-granular stress corrosion cracking (IGSCC) in reactor auxiliary system piping. Early replacement of entire piping systems, achievable with modest doses to maintenance staff, considerably mitigated IGSCC and led the way to the utility’s strategy of seeing to the critical SSCs so that a remaining plant life-time of 40 years (design life-time) could be always demonstrated.

Since 1991, the AGE Group, with assistance of several technical discipline related expert groups, has taken care of these activities by gathering information of possibly needed future actions from several sources and by preparing and updating a table of recommended major modifications, replacements, repairs and overhauls. The modernisation and power uprating of the Olkiluoto units 1 and 2 by 16% in 1994–1996 evolved from these recommendations and was completely carried out by the utility's technical support organisation residing on plant site. The associated significant renewal campaigns of obsolete electrical and instrumentation systems and components largely contributed to current 20-year operating licence periods terminating in 2018. Efforts to enhance the reliability and good performance of the plant components, and to ensure the spare part and support service availability have continued until recent years. The major foreseeable modifications until decommissioning have been identified.
Systematic maintenance planning is an integral part of ageing management at the Olkiluoto units 1 and 2. Nominated owners of equipment groups, characterised by a common type or location, analyse the entire maintenance programme and its experiences, and assist in selection of the most effective maintenance works. Annual findings from each equipment group are stored into a relational data base on the plant computer.

STUK reviewed TVO’s clarification on the actual condition and ageing implications of the main SSCs in connection to the Periodic Safety Review (PSR) carried out in 2007–2009. Supporting assessment has been done in several periodical inspections on plant site. The main components were generally found to be in good condition, but the appearance of IGSCC in Nickel-based alloys could not be excluded and it possibly explains an indication reported from the safe-end weld of the main feedwater nozzle, made from Alloy 182. The indication has, however, remained unchanged as evaluated by NDT-inspections during annual outages. The PSR also referred to a completed pilot project for updating fatigue analyses of selected systems to incorporate the environmental effect as required in the implementation process of the Guide YVL 3.5. Based on recommendations from expert consultancy of VTT Technical Research Centre of Finland, more refined modelling is employed now that the utility is renewing all fatigue analyses to justify a prospective relicensing of the Olkiluoto units 1 and 2 for an operating life of 60 years.

At the Olkiluoto unit 3, the ageing management is taken into account at the design phase. The most severe operating conditions and long-term influences, under which an individual component is expected to serve as a part of a process system, are used to determine the design basis requirements for that component. With known design basis requirements and defined life times of SSCs, their materials, fabrication and other ageing management related issues are specified accordingly. This includes precautions against foreseeable degradation mechanisms with state-of-the art technology, and provision for inspections, overhauls, testing and replacements as needed while respecting the ALARA principle. The anticipated life-span of the main technologies and independence from single technologies are particularly considered in I&C system and component design. The design and fabrication of SSCs are verified with qualified analyses, inspections and testing, overseen by STUK, in order to demonstrate fulfilment of quality and performance requirements set by the design specifications. During Olkiluoto unit 3 operation, the ageing of SSCs and retaining the design margins will be managed by dedicated programmes and monitoring tools, and by in-service inspections to whose planning risk-informed methods are applied.

Article 6.3 – Measures for prevention of accidents and mitigation of consequences

Regulatory requirements on implementation of defence-in-depth

According to the Government Decree 717/2013, several independent defence levels have to be provided in the design of a nuclear power plant. The defence-in-depth principle shall extend to the operational and structural safety of the plant. Safety functions in accordance with the operational principle of defence-in-depth shall be assured through five successive levels of protection. In order to prevent the dispersion of radioactive materials, the structural defence-in-depth safety principle shall be
implemented by means of successive barriers: the fuel and its cladding, the reactor cooling circuit and the containment building.

The design of the nuclear facility and the technology used is assessed by STUK when reviewing the applications for a Decision-in-Principle, Construction Licence and Operating Licence. Design is reassessed against the advances in science and technology, when the Operating Licence is renewed and in the periodic safety reviews. The design of Loviisa plant units was reassessed by STUK in 2005–2007 in the licence renewal and Olkiluoto plant units in 2007–2009 in the periodic safety review process. Design of the Olkiluoto unit 3 has been assessed for the construction licence (2005) and during the construction phase. It will be reassessed when reviewing the plant’s operating licence application. In addition, the operation of the nuclear facilities is overseen by means of Periodic Inspection Programme.

According to the Government Decree 717/2013 proven or otherwise carefully examined high quality technology shall be employed in the design, construction and operation of the plant, to prevent operational transients and accidents and to mitigate their consequences. A nuclear power plant shall encompass systems by means of which operational transients and accidents can be quickly and reliably detected and the aggravation of any event prevented. Effective technical and administrative measures shall be taken for the mitigation of the consequences of an accident. The design of a nuclear power plant shall be such that accidents leading to extensive releases of radioactive materials must be highly unlikely.

In ensuring safety functions, inherent safety features attainable by design shall be made use of in the first place. If inherent safety features cannot be made use of, priority shall be given to systems and components which do not require an external power supply or which, as a consequence of a loss of power supply, will settle in a state preferable from the safety point of view (passive and fail-safe functions).

In order to prevent accidents and mitigate the consequences thereof, a nuclear power plant shall be provided with systems for shutting down the reactor and maintaining it in a subcritical state, for removing decay heat generated in the reactor, and for retaining radioactive materials within the plant. Redundancy, separation and diversity principles must be applied in designing the systems in question to ensure the implementation of these safety functions even in the event of a malfunction. The safety functions necessary for transferring the plant to and maintaining a controlled state must be accomplished, even if any individual system component needed to fulfil the safety function (including the necessary supporting or auxiliary functions) is inoperable and if any other component needed for the function is simultaneously out of use due to required repair or maintenance. Common-cause failures shall only have minor impacts on plant safety. A nuclear power plant shall have reliable on-site and off-site electrical power supply systems. The execution of safety functions shall be possible by using either of the two electrical power supply systems.

According to the Government Decree 717/2013 the nuclear power plant shall have equipment and procedures by which decay heat removal from the reactor and from the spent fuel pools can be ensured for 72 hours independent of the electricity or water
supply from off-site sources in events caused by rare external events or disturbances in the plant internal electricity distribution.

The plant shall also be provided with systems, structures and components for controlling and monitoring severe accidents. These shall be independent of the systems designed for operational conditions and postulated accidents. Systems necessary for ensuring the integrity of the containment building in a severe accident shall be safety-classified and capable of performing their safety functions, even in the case of a single failure of an active component.

Special attention shall be paid to the avoidance, detection and correction of any human errors during design, construction, operation and maintenance. The possibility of human errors shall be taken into account in the design of the nuclear power plant and in the planning of its operation and maintenance, so that human errors and deviations from normal plant operations due to human errors do not endanger plant safety. The impacts of human error shall be reduced by using various safety design methods, including defence-in-depth, redundancy, diversity and separation.

Detailed requirements on the implementation of operational defence-in-depth are given in Guide YVL B.1 “Safety design of a NPP”. Requirements for structural defence-in-depth are given in Guides YVL B.4 ”Nuclear fuel and reactor”, YVL B.5 ”Reactor coolant circuit of a nuclear power plant” and YVL B.6 ”Containment of a nuclear power plant”.

**Operation manuals and guidelines**

Requirements for operation manuals and guidelines are given in the Guide YVL A.6 “Conduct of operations at a nuclear power plant”. The operating procedures shall cover all aspects of plant operations. The operating procedures for emergencies and transients and severe accident management guidelines shall be kept up-to-date at all times to ensure that they remain fit for their purpose.

Adequate procedures for transient conditions covering anticipated operational occurrences shall be prepared to prevent the escalation of a transient into a situation endangering safety. Emergency operating procedures covering design basis accidents and design extension conditions shall be prepared for nuclear power plants. These procedures shall provide instructions for bringing the plant to a controlled state. Procedures shall be specified for bringing the plant from a controlled state to a safe state. Guidelines for managing severe accidents shall be prepared.

The emergency operating procedures for design basis accidents and design extension conditions shall be symptom-based or a combination of symptom-based and event-based procedures. If safety functions cannot be maintained with the procedures, symptom-based procedures shall be put to use. The severe accident management guidelines shall be symptom-based.

The operating procedures for emergencies and transients and severe accident management guidelines shall be verified and validated to ensure that they are administratively and technically correct for the nuclear power plant unit concerned, and are compatible with the environment in which they will be used. Instructions shall be drawn up for the field actions defined in the procedures and guidelines.
At both Finnish nuclear power plants, procedures for anticipated operational occurrences and accidents are in use. For instance, Olkiluoto units 1 and 2 have event-based operating procedures for events within the scope of the design and to cope with the emergency conditions beyond design, including severe accidents, a set of symptom-based emergency operating procedures is available. To the extent found necessary, the procedures have been verified during operator training at the plant simulators. STUK has independently evaluated the appropriateness and comprehensiveness of the procedures for anticipated operational occurrences and accidents.

**Emergency arrangements**

Regulations concerning emergency preparedness and response arrangements at the NPPs are given in the Nuclear Energy Act, the Nuclear Energy Decree and the Government Decree on Emergency Arrangements at Nuclear Power Plants (716/2013). According to the Government Decree 716/2013 “The emergency response arrangements shall be planned in such a way that emergency situations can be brought under control efficiently, the safety of people at the power plant site is ensured, and the measures to prevent or limit the radiation exposure of the population in the emergency planning zone are initiated rapidly. The planning shall take account of a simultaneous emergency situation at all nuclear facilities within the power plant site, as well as any consequences that are considered possible, particularly radiation situations at the facility site and the vicinity, as well as access to the area. The planning shall take into account that the duration of an emergency situation may be long. The planning shall be based on analyses of the progress over time of severe accident scenarios resulting in a potential release. In such a case, variations in the state of the plant, the development of events as a function of time, the radiation situation at the plant, radioactive releases, radioactive release routes and weather conditions shall be taken into account. Furthermore, planning shall take account of events that compromise safety, the extent to which they can be controlled and the severity of the consequences, as well as threats related to unlawful action and the potential consequences thereof.” Detailed requirements and STUK’s oversight procedures are given in the Guide YVL C.5 (former Guide YVL 7.4).

The licensees, Fortum and TVO, have analysed accident and safety-impairing events at the Loviisa and Olkiluoto NPPs. These analyses are documented in the safety analysis reports of the plants and have been used as the basis for planning the Finnish nuclear power plant emergency arrangements. Emergencies are classified and described briefly in the plant's emergency plan, which is approved by STUK. The notifications and alarms to plant personnel and authorities required by different classes of emergencies, as well as the scope of operations of the emergency response organisation pertaining to the type of emergency, are described in the emergency procedures.

A person responsible for emergency arrangements has been appointed both for the Loviisa and Olkiluoto nuclear power plants. Due to the updated Nuclear Energy Act also the nominated deputies for the persons responsible for emergency arrangements have been appointed by the licensees and approved by STUK. The emergency response organisation has been described in the emergency plan and procedures, updated with regard to personnel changes once a year. The more limited staffing of the emergency response organisation required for alert is defined in the shift supervisor guides for the emergency response.
The facilities of the emergency response organisation at the Loviisa and Olkiluoto nuclear power plants include a system for displaying data directly from the process computer. Several hundred parameters are transmitted also to the STUK's emergency response centre.

Emergency training and exercises are annually arranged for the emergency response organisation of the nuclear power plants. The emergency response training has included classroom and group-specific practical training as well as special training, such as first aid, fire and radiation protection training. In addition to severe accidents, emergencies covered by the emergency response exercises also included conditions classified as alert. The content and scope of the training as well as feedback obtained from the training are assessed in the inspections of the STUK's periodic inspection programme.

STUK verifies the preparedness of the organisations operating nuclear power plants in yearly on-site inspections belonging to STUK's periodic inspection programme. Emergency preparedness at the Loviisa and Olkiluoto power plants meet the key regulatory requirements. The objects of the inspection include the emergency response organisation's personnel resources, facilities and equipment, training and alert arrangements, revision of the structure and content of emergency instructions, radiation measurements in the surroundings and meteorological measurements on-site.

In addition to the on-site emergency plans established by the licensees, off-site emergency plans required by the rescue legislation (379/2011) are prepared by regional authorities. The requirements for off-site plans and activities in a radiation emergency are provided in the Decree of the Ministry of Interior (406/2011). The off-site plans include provisions to inform the population in the case of an accident. Written instructions on radiological emergencies, emergency planning and response arrangements have been provided to the population living within the 20 km Emergency Planning Zone. These instructions are regularly updated and distributed. The regulations and guides are tested in large scale off-site emergency exercises conducted every third year for each NPP. These exercises may contain also scenarios which combine illegal activities and a technical emergency situation at the plant.

The rescue planning is strengthened in a co-operation between the nuclear power plant, regional rescue services, regional police departments and STUK. Permanent coordination groups have been established for both Loviisa and Olkiluoto NPPs in order to ensure coordinated and consistent emergency plans, to improve and develop emergency planning and arrangements and to share lessons from the exercises, regulations and other information. Also extensive training is arranged by these groups.

**Radiation protection**

The main regulations governing radiation protection at nuclear power plants are the Radiation Act (592/1991), Radiation Decree (1512/1991), Government Decree on Safety of NPPs (717/2013) and YVL Guides, Group C. Radiation Decree stipulates that the effective dose caused to a worker shall not exceed an average of 20 millisieverts (mSv) per year in any five years period, nor 50 mSv in any single year. The limit for the annual dose of an individual in the population, arising from the normal operation of a nuclear power plant, is 0.1 mSv. Based on this, STUK shall upon application confirm the release limits for radioactive materials during the normal operation of a nuclear power plant.
ALARA requirement is issued in the Radiation Act and more in detail implementation requirements are given in the YVL Guides both for NPP workers and release abatement.

STUK carries out annual radiation protection inspections on-site according to the periodic inspection programme, e.g. covering the resources, expertise and operation of the radiation protection organisation, dosimetry, radiation measurements in the plant, radioactivity measurements of effluents, and monitoring of radiation in the environment. STUK carries out on-site inspections related to radiation protection also during annual maintenances. The inspections at the Loviisa and Olkiluoto NPPs have shown e.g. that the plants have introduced technical and IT administration improvements in the field of radiation protection, which made it possible to enhance the control of occupational radiation doses and contamination.

In international comparison (e.g. the ISOE radiation dose database of the NEA, the Nuclear Energy Agency of the OECD countries), the Olkiluoto units 1 and 2 have been among the best boiling water reactors when comparing both individual and collective radiation doses of workers. The long-term planning of annual maintenance operations has made it possible to keep their duration short, which usually reduces the amount of work carried out and hence also the exposure to radiation. Loviisa NPP has succeeded in decreasing the collective dose of the personnel and is well in comparison with different type of PWRs.

**Radioactive effluents**

STUK confirms upon the licensee’s application the release limits for radioactive materials during the normal operation of a nuclear power plant. Operational Limits and Conditions have more stringent requirements applicable for the radioactive substances of primary coolant (fuel integrity), thus practically preventing releases. Both nuclear power plants have efficiently implemented measures to reduce the releases of radioactive substances into the environment. STUK concludes that both utilities (Fortum and TVO) apply the BAT (Best Available Techniques) principle in the abatement of radioactive discharges of their power plants.

**Article 6.4 – Management systems**

**Regulatory requirements regarding safety culture and safety management**

The importance of a good safety culture is emphasized in the Nuclear Energy Act and in the Government Decree on the Safety of Nuclear Power Plants (717/2013, Sections 21, 28 and 29), which state that when designing, constructing, operating and decommissioning a nuclear power plant, a good safety culture must be maintained by making sure that the decisions and activities of the entire organisation reflect commitment to safety. Licensee has to ensure that these requirements are applied in all organisations that participate in safety significant activities. An open working atmosphere must be promoted to encourage identification, reporting and elimination of factors endangering safety, and the personnel must be given opportunity to contribute to the continuous enhancement of safety. According to the Nuclear Energy Act, a responsible director has to be appointed for the construction and operation of a nuclear power plant. The appointment is subject to approval by STUK. The responsible director has a duty to ensure the safe use of nuclear energy and to see that the arrangements for
physical protection and emergency preparedness and the safeguards control are
complied with. The responsible director must have real possibilities to take effectively
care of this duty.

According to Section 29 of the Government Decree on the Safety of Nuclear Power Plants
(717/2013), the organisations participating in the design, construction, operation, and
decommissioning of a nuclear power plant are required to employ a management
system. The quality management system must cover all functions influencing plant
safety, and the licensees are further required to ensure that all their suppliers, sub-
suppliers and other partners participating in the functions that affect nuclear and
radiation safety adhere to the quality management system. Along with the management
system, the Decree sets requirements for the documentation of the lines of management
and monitoring of the operations.

STUK's Guide YVL A.3 sets general requirements for management systems. The guide
YVL A.3 is based on IAEA GS-R-3. The management system must support the
characteristics of the organisational culture that promote good safety culture, and the
management must express its commitment to safety. Safety culture expertise must be
available for developing the safety culture. The development of the safety culture must
be target oriented and systematic. The procedures used must strengthen a vigilant,
questioning and initiative attitude at all levels of the organisation. The management
system must also contain procedures for identification and continuous promotion of
safety culture. The licensee has to also establish a process to measure, assess and
improve its' safety culture.

STUK has a new YVL guide concerning nuclear facility construction and modifications,
i.e., YVL A.5. Also in this guide there are requirements concerning safety culture and risk
management. The management systems of the licensees and applicants are subject to
approval by STUK. During construction and modifications the licensee must ensure that
the contributing parties are able to perform according to safety requirements and there
must be training on safety culture issues for the personnel taking part in the activities.
The licensee must have procedures for evaluating and developing the safety culture of
the contributing parties.

Measures taken by licence holders

Loviisa NPP

Fortum has in the management system established documented quality and safety
policies for the Loviisa NPP. The management system aims at filling all the requirements
stated in the YVL guides and is continuously developed. The development of Loviisa
NPP’s quality management system is based on the principle of continuous improvement
in accordance with the observations and remarks made in quality audits and quality
assessments. Loviisa NPP has also made organisational changes that aim at promoting
the safety and safety culture development. There is a unit especially dedicated for
operational experience and safety culture. In addition, the Loviisa NPP has an
independent advisory body for safety issues, i.e., a nuclear safety committee with
external expert members.
Fortum has continued having international evaluations of safety management and procedures at the Loviisa NPP in order to improve its own operations and management system. IAEA carried out an OSART safety review in Loviisa in March 2007, with a follow-up review in July 2008. WANO peer review was performed in March 2010, with a follow-up review in April 2012. In the latest WANO follow-up review, WANO stated that most development actions were completed whereas a couple of them are still in progress, although they have been appropriately started. Fortum has clearly defined the responsibilities for developing the management system and reformed the management procedures for reviewing the system.

**Olkiluoto NPP**

TVO has also documented quality and safety policies for the Olkiluoto NPP that are binding for all persons working for the NPP. TVO is actively developing the management system towards a process based management system due to the growing organisation and the need for systematic and efficient operations throughout the organisation. TVO has also defined so called 'Management Expectations' flyers, where the managers communicate very clearly their expectations for safe working and safety attitudes. The Olkiluoto NPP has worked several years with safety culture evaluation and development. The operator TVO has founded a special safety culture team that is independent from operations and construction. This team meets regularly about 10 times a year and the objective is to form a comprehensive view of the safety culture situation in the whole TVO and report and give suggestions for improvement actions to the top management of the organisation.

TVO has assessed the safety culture of the Olkiluoto NPP employing several methods. The safety culture issues have been regularly discussed in the internal safety committee. The self-assessment is repeated approximately every third year. Personnel surveys and the peer review method of the World Association of Nuclear Operators (WANO) have also been utilised actively. TVO has continued using and developing the safety culture promotion and assessment methods concerning the Olkiluoto unit 3 project and the contributing parties. Assessment method consists of a questionnaire, interviews and analysis of safety observations, authority inspections and non-conformance records.

**Regulatory oversight**

STUK has continued to regularly inspect the management systems of both licensees (Fortum and TVO) to ensure that they are fulfilling the requirements of the legislations and the Guide YVL A.3 (former YVL 1.4). Based on the inspections, there is still need for development actions to fulfil the requirements especially concerning the process based management and supply chain management. The safety culture and safety management are also included as topics in the STUK’s periodic inspection programme. During 2010-2014, the inspections have especially dealt with safety culture evaluation methods and management commitment for safety culture and the responsibility for the management to define and communicate the requirement for a good safety culture. There are two special top level inspections in the periodic inspection programme, “Management and Safety Culture” KTO A1 and “The Functionality of the Management System” KTO A3. KTO A1 includes an assessment of safety culture issues, management and leadership and KTO A3 include evaluation of management system, processes and quality management.
Additionally, safety culture issues are included in quality assurance audits and event analyses. Safety culture related findings from different inspections are discussed in regular meetings in STUK and between the senior management of the nuclear power plants and the regulatory body.

STUK has developed a special inspection tool for gathering information about issues related to Human and Organisational Factors (HOF) within periodic inspection programme for operating NPPs. The tool was implemented during 2012. Based on the findings according to four predefined areas, i.e. personnel planning, communication, handling of non-conformances and process management, STUK can obtain an overall picture of the licensee’s situation concerning these HOF topics. STUK developed also in 2012 a special database for collecting HOF related findings made during the oversight of the Olkiluoto NPP unit 3. The IRRS mission team suggested that STUK should consider the development and implementation of a more systematic method for the collection and assessment of indications of the licensee’s safety culture. STUK will continue developing the collection and analysis of all HOF related findings by expanding the database for both operating NPPs and NPPs under construction.

**Article 6.5 – Financial and human resources**

**Financial resources**

Nuclear Energy Act defines as a condition for granting a Construction or Operating Licence that the applicant has sufficient financial resources, necessary expertise and, in particular, that the operating organisation and the competence of the operating staff are appropriate. According to the Nuclear Energy Act, the licensee shall also have adequate financial resources to take care of the safety of the plant. In addition, Nuclear Energy Act provides detailed regulations for the financial arrangements for taking care of nuclear waste management. The Act on Third Party Liability provides regulations on financial arrangements for nuclear accidents, taking into account that Finland is a party to the Paris and Brussels conventions (see also, e.g., Article 4.1).

The financial preconditions are primarily assessed by authorities other than STUK (mainly the Ministry of Employment and the Economy). The financial position and business environment of the licensee also affect the safety of plants, and STUK therefore follows licensees’ plans to improve safety of nuclear power plants, as well as organisational reforms, safety research conducted by the licensees, the number of employees and the competence of personnel. The annual reports of Fortum and TVO provide financial information on the utilities. Both utilities have annually invested typically about 40–50 million euros for the plant maintenance and for improving safety. For example, TVO has recently made a decision to renew all emergency diesel generators where the overall investment is more than 100 million euros.

A state controlled financing system for the costs of future waste management and decommissioning exists to ensure that the producers of nuclear waste bear their full financial liability on the coverage of those costs and that the costs can be covered even in case of insolvency of the waste generator. The pertinent licence-holders submit every three years for regulatory review the technical plans and cost calculations on which the liability estimates are based. After confirmation of the financial liabilities, the licensees pay fees to a State controlled Nuclear Waste Management Fund and provide securities
for the liability not yet covered by the funded money. At the end of 2013, the funded money (2 270 million euros) covered the most part of the whole liability (about 2 300 million euros). Under the Nuclear Energy Act, nuclear companies supplemented the fund by payment of 91 million euros at the end of March 2014.

**Human resources**

The licensee has the prime responsibility for ensuring that all the employees are qualified and authorised to their jobs. The regulatory requirements for human resources are stated in the Nuclear Energy Act (Sections 7 and 20), the Government Decree on the Safety of Nuclear Power Plants (717/2013) and STUK’s Guide YVL A.4. The Nuclear Energy Act Section 7 was modified during 2012 with a demand to appoint also deputies for the responsible persons for emergency preparedness, security and safeguards. According to Section 30 of the Government Decree 717/2013, significant functions with respect to safety within nuclear power plants must be designated, and training programmes must be prepared for development and maintenance of professional qualifications of the persons working in these positions. Adequate command of the functions in question must also be verified. The Guide YVL A.4 sets requirements for NPP operator competence, for training and qualifications of personnel working in functions that are important for plant safety.

Human resource planning at the Loviisa NPP is based on a ten-year plan, which is subject to annual management review and updating. Loviisa NPP has taken into use a project management procedure which includes a resource management approach that will support the NPP in evaluating and following up the resources needed for accomplishing the projects.

TVO has updated the personnel plan regularly according to the phases of Olkiluoto NPP unit 3 construction and also considering the planning of the fourth reactor Olkiluoto unit 4, for which TVO got the Government Decision in Principle in 2010. TVO has also started a trainee program for developing young recruits for a career at TVO. TVO has also during 2012 actively started to seek solutions for planning resources efficiently between projects and day to day operations.

Personnel and human resources related issues are included in STUK’s periodic and construction inspection programmes at the nuclear power plants. A top level inspection of the periodic inspection programme, “Human Resources and Competence” KTO A2, includes assessment of human resource management, competence development and training programmes. It also covers the licensee’s procedures for managing human resources and competence of suppliers, sub-suppliers and other partners participating in functions affecting safety. During the years 2010-2014 STUK has paid attention especially to personnel planning and ensuring resources in development and modification projects. STUK also participates in the arrangement of examinations for shift personnel, where the operators working in the control rooms show that they are conversant with all salient matters related to plant operation and safety. STUK further approves the appointment of certain key persons, such as the responsible director and his/her deputies.
Article 7 – Expertise and skills in nuclear safety

Member States shall ensure that the national framework in place requires arrangements for education and training to be made by all parties for their staff having responsibilities relating to the nuclear safety of nuclear installation in order to maintain and to further develop expertise and skills in nuclear safety.

According to Section 53 of the Nuclear Energy Act, licensees shall be obliged to participate in financing research aimed at ensuring that, should such new factors concerning safe operation of nuclear facilities emerge that could not be foreseen, the authorities have such sufficient and comprehensive nuclear engineering expertise and other facilities at their disposal that can be used, when necessary, to analyse without delay the significance of such factors. The required funds collected from the licensees are allocated to the national nuclear safety research and by that means the national expertise on nuclear safety is build up.

According to Section 30 of the Government Decree 717/2013, significant functions with respect to safety within nuclear power plants must be designated, and training programmes must be prepared for development and maintenance of professional qualifications of the persons working in these positions. Adequate command of the functions in question must also be verified. The Guide YVL A.4 sets requirements for training and qualifications of personnel working in functions that are important for plant safety.

Ensuring an adequate national supply of experts in nuclear science and technology and high quality research infrastructure is recognised as a continuous challenge in Finland because of the retirement of the pioneers who took part in setting up the Finnish nuclear energy industry, as well as due to the ongoing Olkiluoto unit 3 construction project and the new reactors that got the government Decision in Principle in May 2010. In addition to the measures to maintain and develop the capabilities and amount of professional staff of STUK and the utilities, VTT Technical Research Centre of Finland, which acts as the main technical support organisation to STUK, aims at maintaining and developing the human resources in the nuclear energy sector. Appropriate measures to develop the educational resources in technical and other high-level universities in Finland are also important.

VTT Technical Research Centre of Finland is the largest research organisation in the field of nuclear energy in Finland. At VTT, about 200 experts are working in the field of nuclear energy, about half of them full-time. The total volume of the nuclear energy research in Finland in 2013 was about 75 million euros (estimate of the Ministry of Employment and the Economy). This figure includes research related to use of nuclear energy made in all the stakeholder organisations. Two thirds of the national nuclear energy research is focused on the final disposal of the spent fuel. The largest individual organizations are VTT, LUT (Lappeenranta University of Technology), GTK (Geological Survey of Finland), and Aalto University (previously Helsinki University of Technology, HUT). STUK and the Finnish Meteorological Institute are involved with the research related to emergency preparedness and radiation protection.

The nuclear safety research projects in the national SAFIR research programme are selected so that they support and develop the competences in nuclear safety and to
provide expertise available for the regulator to be able to respond on emerging and urgent safety issues. The topics of the most recent nuclear safety research programme phase (SAFIR2014) coordinated by VTT are organisation and human factors, automation and control room, fuel and reactor physics, thermal hydraulics, severe accidents, structural safety of reactor circuit, construction safety, probabilistic safety analysis and development of research infrastructure. The amount of money collected from the licensees in 2013 was about 5.6 million euros for nuclear safety research. The research projects have also additional funding from other sources. The total volume of the programme in 2013 was 10.3 million euros. As a result of the TEPCO Fukushima Dai-ichi accident, a reassessment was made how this type of accident should be taken into account in case of Finnish NPPs, and the research programme was supplemented with research topics related to natural hazards and multiple failure events, the adequacy and scope of nuclear power plant design basis, mitigating the impact of accidents (e.g. high concentration of boron in the reactor circuit, hydrogen formation and transport, amounts of fission products released in core melt accidents), and the overall life cycle of nuclear fuel including spent fuel storage pools. The framework programme for the next national SAFIR research (SAFIR2018) programme is under development.

During 2010-2012 a committee set up by the Ministry of Employment and the Economy worked on a report aiming at giving recommendations and steps to be taken until the 2020's for ensuring competence and resources needed for the nuclear sector. One of the recommendations of the committee was that the future needs and the focus areas of Finnish nuclear energy sector research must be accurately defined and a long-term strategy must be drawn up for further development of research activities. This called for a separate joint project among research organisations and other stakeholders in the field. The report can be found on https://www.tem.fi/files/33402/Report_of_the_Committee_for_Nuclear_Energy_Competence_in_Finland.pdf

At the end of January 2013, the Ministry of Employment and the Economy set up a working group to prepare the research strategy for the nuclear energy. The objectives of the working group included the following tasks: (1) definition of main development lines for the Finnish research activities in the area of nuclear energy (vision until 2030, road maps, nuclear energy research in general, nuclear safety research, research on advanced nuclear reactor concepts, research on nuclear fusion technology); (2) identification of priority areas for nuclear energy research taking into account future research needs and the required knowledge base; (3) definition of the needs for the development of research infrastructure covering the needs of different actors in the nuclear energy sector; (4) optimization of the management of the national research programmes as well as the provision of funding to the research programmes; and (5) enable more significant Finnish participation on the international nuclear energy research activities than at present.

The working group was chaired by a representative of the Ministry of Employment and the Economy. The Ministry also provided secretariat to the working group. The nominated members of the working group included experts from STUK, VTT, Finnish Academy, Aalto University, Technical University of Lappeenranta, University of Helsinki, Fortum, TVO and Posiva. The work was done in the steering group and six subgroups: 1) Nuclear safety; 2) Nuclear waste management; 3) Researcher training in the nuclear field; 4) Future nuclear energy technologies and basic physics; 5) Nuclear energy and
social sciences; and 6) From research to business in the nuclear energy. More than 100 persons participated on the work.

The report was published by the Ministry at the end of April 2014. The recommendations are following: 1) The areas on focus in nuclear energy research must be compiled into wide-ranging national programmes; 2) The scientific level of the Finnish nuclear energy research needs to be raised; 3) Active participation is needed in international research that is important for Finland through broad-based national multidisciplinary collaboration; 4) To secure the quality and quality of researcher education, a broad and comprehensive doctoral programme network needs to be established for the nuclear energy field; 5) Building, maintaining, and utilising infrastructure requires coordination at the national level. Financing needs to be considered strategically and the roles of national financiers need to be clarified; 6) In research activities, input is needed into the development of innovations. The growth of business operations and internationalisation are supported by bringing the players together under Team Finland; 7) It is proposed that an advisory committee is set up in connection with Ministry of Employment and the Economy linked with nuclear energy research and operation as a permanent expert body to support decision-making in national questions related to the nuclear energy.

Measures taken by licence holders

The training activities and procedures at the Loviisa NPP are constantly developing. Much responsibility is given to the line manager and the individual defining the qualification and training needs. The training unit can support the line organisation with their expertise, but the responsibility for developing the specialist competence lies on the line organisation. The training unit’s main responsibility is to develop the human resource management procedures and organise the general training sessions. The training organisation has been strengthened with experts in behavioural sciences. Fortum has a procedure for setting up individual development plans for all newcomers and for persons changing positions.

TVO has revised their training program and procedures taking into account the commissioning of the Olkiluoto unit 3 and the increasing need for systematic and strategic competence management due to the growing organisation (Olkiluoto 3 and 4). TVO uses an IT-system that supports the managers e.g. in defining and following up individual development plans. TVO has defined training requirements for each position or job that automatically will be included in the new recruited person’s development plan.

Measures taken by regulator

The management of STUK highlights the need for competent workforce. STUK has adopted a competence management system and nuclear safety and regulatory competencies are also emphasized in STUK’s strategy. Implementation of the strategy is reflected into the annual training programmes, on the job training and new recruitments. The national nuclear safety and waste management research programmes have an important role in the competence building of all essential organisations involved in nuclear energy activities. These research programmes have two roles: for the first ensuring the availability of experts and for the second ensuring the on-line transfer of
the research results to the organisations participating to the steering of the programmes and fostering the expertise. STUK has an important role in the steering of these programmes.

Most of the professional staff of STUK conducting safety assessments and inspections has a degree of university level. The average experience of the staff is about 15 years in the nuclear energy field. The competence analysis is carried out on regular basis and the results are used as the basis for the training programmes and the new recruitments. The training programme includes internal courses as well as courses organised by external organisations. On an average 5% of the annual working hours has been used to enhance the competence. An induction programme is set up at STUK for all new recruited inspectors. In addition to administrative issues, the induction programme includes familiarisation with legislation, regulatory guidance and regulatory oversight practices. Programme is tailored to each new inspector and followed by the manager.

STUK has participated in the preparation and execution of a basic professional training course on nuclear safety with other Finnish organisations in the field. The first 6-week course commenced in September 2003 and the 12th basic professional training course begins in autumn 2014. At the moment, over 700 newcomers and junior experts, of whom more than 80 have been from STUK, have participated in these courses. The content and structure of the course has been enhanced according to the feedback received from the participants.

**Article 8 – Information to the public**

*Member States shall ensure that information in relation to the regulation of nuclear safety is made available to the workers and the general public. This obligation includes ensuring that the competent regulatory authority informs the public in the fields of its competence. Information shall be made available to the public in accordance with national legislation and international obligations, provided that this does not jeopardise other interests such as, inter alia, security, recognised in national legislation or international obligations.*

The Decree on STUK defines STUK’s tasks. One of the tasks is to inform about radiation and nuclear safety matters and participate in training activities in the area. STUK utilises many means to communicate with public and interested stakeholders, such as meetings, seminars, and training courses. All these are tailored and targeted to different stakeholders and stakeholder groups.

Act on the Openness of Government Activities (621/1999) applies to the documents and information delivered to STUK and those prepared by STUK. Under the Act everyone has the right to obtain information from official documents in the public domain. Official documents are in the public domain unless specifically otherwise provided for. The provisions on the secrecy of documents and information on the use of nuclear energy are set out in the Openness Act and in Section 78 of the Nuclear Energy Act. A document or information shall be kept secret when it’s necessary to protect e.g. security arrangements, preparations for emergency conditions or private economic interests.
In addition, the Openness Act also requires authorities to produce data material describing their activities, such as publications, brochures and statistics as well as information on their socially significant decisions. The authorities shall also ensure that documents pertinent to their activities are easily accessible for example in data networks and libraries. The Openness Act also imposes on the authorities the obligation to inform the public of their activities.

In 2013, Finland joined the Open Government Partnership (the global Open Government Partnership initiative aims at promoting more transparent, effective and accountable public administration) in order to get a new boost to continuous work towards active citizen participation and open government. The first national action plan started the first of July 2013 and STUK is implementing it from its own part. Clear Language as a working-area has stood out as a critical enabler of open government in Finland and in STUK.

STUK puts special interest in internet to inform public and interested stakeholders about nuclear and radiation safety in general, risks related to radiation and use of nuclear energy, safety requirements, roles and responsibilities of STUK, STUK’s organization, current activities and operating experience, significant regulatory decisions taken, and safety research. STUK web pages can be found (www.stuk.fi) in Finnish, Swedish and in English. STUK has also made itself available in social media (facebook, twitter and YouTube).

What comes to radiation emergencies and hazards, according to the Rescue Act and the Decree of the Ministry of the Interior concerning informing public during nuclear or radiological emergencies, the authority in charge is responsible for informing public on protective measures and other activities to be carried out. Authorities at governmental, provincial, and municipal level provide information on their own activities and give instructions regarding their own sphere of responsibility. In case of a nuclear power plant accident there are many organisations providing information. Thus special attention needs to be paid to coordination of timing and content.

Further improvement of arrangements for the coordination of information to the public and media during emergencies is needed to ensure that the messages issued by different authorities are consistent. Guidelines for co-operation among authorities have been written in a guidebook published by the Ministry of Interior in November 2012. To help the implementation of guidelines seminars and workshops are organised from the beginning of 2013. Even more general principles and guidance of coordination or public communication during emergencies are given in the guidance by prime ministers office. This guidance was updated in 2013.

In an accident situation the principal information route of warnings to the public is FM radio, TV and internet. The first outdoor warning to the public close the NPP is given by general warning signal via sirens or loudspeakers. By arrangement with broadcasting companies, urgent RDS-notifications can be transmitted promptly over the FM-radio and TV. There is a new specific law for warning messages via radio and TV. Law entered into force on 1st June 2013.