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Member State Report on Nuclear Safety of Nuclear Installations as Required Under Article 9.1 of Council Directive 2009/71/EURATOM (amended by Council Directive 2014/87/EURATOM)

Finland

stuk
SÄTEILYTURVAKESKUS
STRÅLSÄKERHETSCENTRALEN
RADIATION AND NUCLEAR SAFETY AUTHORITY

Contents

1 Introduction

This member state report as required under Article 9.1 of Council Directive 2009/71/EURATOM (amended by Council Directive 2014/87/EURATOM) is aimed to demonstrate how Finland is fulfilling the obligations of the Directive.

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). In addition, a new nuclear power plant unit (EPR) at the Olkiluoto site was granted operating license in March 2019 and is expected to start operation later in 2020. 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. Posiva was granted a construction licence for the spent nuclear fuel repository in 2015. The disposal facility is envisaged to be operational in 2024. 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). The Parliament ratified both granted DiPs in July 2010. The Decisions-in-Principle set a schedule for Fennovoima and TVO to submit the construction licence applications to the Government by mid 2015. After receiving the DiP, Fennovoima started bidding negotiations on plant alternative (AES 2006), which was not mentioned in Fennovoima's DiP application in 2009. Therefore, in March 2014, Fennovoima started a complementary DiP process. In May 2014, TVO started a complementary DiP process in order to extend the schedule for the submission of the construction licence application. The Government did decisions on both applications in September 2014. Government's Decision-in-Principle was positive for Fennovoima Hanhikivi 1 project and negative for extension of the validity time of the DiP applied by TVO for Olkiluoto 4. Hence, the Olkiluoto 4 project ended in June 2015 since TVO did not submit an application for construction licence. Fennovoima filed a construction license application for Hanhikivi 1 NPP in June 2015 but has not yet submitted all required licensing documentation for regulatory review.

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. The reactor was permanently shut down in the end of June 2015. VTT applied for a license for the decommissioning in June 2017. Before submitting the licence application, VTT performed environmental impact assessment (EIA). The EIA report and coordination authority's statement on the report were included in the application. Radiation and Nuclear Safety Authority

(STUK) gave its statement on VTT's application to the Ministry of Economic Affairs and Employment (MEAE) in April 2019. At present, the application is in process in the ministry. The research reactor will be the first decommissioned nuclear facility in Finland.

Table 1: List of the nuclear installations under the Directive 2009/71/EURATOM.*

Name	Operator	Type	Status	Location	Power	Start-up
FiR 1	VTT	TRIGA Mark II	Decommissioning licence application in process	Otaniemi, Espoo	250 kW	27 Mar 1962
Loviisa 1	Fortum	PWR	Operational	Loviisa	507 MWe	8 Feb 1977
Loviisa 2	Fortum	PWR	Operational	Loviisa	507 MWe	4 Nov 1980
Olkiluoto 1	TVO	BWR	Operational	Olkiluoto, Eurajoki	890 MWe	2 Sep 1978
Olkiluoto 2	TVO	BWR	Operational	Olkiluoto, Eurajoki	890 MWe	18 Feb 1980
Olkiluoto 3	TVO	PWR	Operating licence granted	Olkiluoto, Eurajoki	1600 MWe	-
Hanhikivi 1	Fennovoima	PWR	Construction license application in process	Hanhikivi, Pyhäjoki	approx. 1200 MWe	-

* 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.

Continuous safety assessment and enhancement approach is presented in the Finnish nuclear legislation. The Nuclear Energy Act (990/1987) 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 close to 30 times during the years it has been in force and, for instance to implement the Council Directive 2009/71/Euratom in 2011 and Council Directive 2014/87/ Euratom amending

Directive 2009/71/Euratom in 2017. In 2015 the Nuclear Energy Act was amended to provide STUK the mandate to issued binding regulations. STUK has since issued Regulations on the Safety of a Nuclear Power Plant (STUK Y/1/2018), on the Emergency Arrangements of a Nuclear Power Plant (STUK Y/2/2018), and on the Safety of Disposal of Nuclear Waste (STUK Y/4/2018). Issued regulations on the Security in the Use of Nuclear Energy (STUK Y/3/2016), and on the Safety of Mining and Milling Operations Aimed at Producing Uranium or Thorium (STUK Y/5/2016) are under revision and expected entering into force summer 2020.

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 regularly updates the regulatory guides based on advances in science and technology and on analysis of operational experience. The 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 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 Service) was carried out in October 2012 and follow-up mission in June 2015. The next IRRS mission has been requested for 2022. STUK has implemented improvements based on the results of the missions. Decree on STUK are under revision to include the obligations of the directive concerning arrangements for the education and training for staff and for management system promoting and enhancing effective safety culture. Otherwise 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 (amended by Council Directive 2014/87/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.

2 Summary

This member state report as required under Article 9.1 of Council Directive 2009/71/EURATOM (amended by Council Directive 2014/87/EURATOM) is aimed to demonstrate how Finland is fulfilling the obligations of the Directive. This report 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.

During recent years Finnish legislation, regulations and guides have been further developed. For instance, the Nuclear Energy Act has been amended to implement the Council Directive 2014/87/ Euratom amending Directive 2009/71/Euratom in 2017, the new European Basic Safety Standards Directive (BSS, 2013/59/Euratom) and to take into account the results of the IRRS missions. These amendments concerned for example:

- the government’s obligation to take into account STUK’s safety related proposals in licence decisions;
- STUK’s mandate to issue binding regulations;
- having decommissioning as a new licencing phase;
- transparency of activities and licensee’s obligation to provide information;
- licensee’s responsibility for subcontractors;
- involvement of the population in decision-making concerning licensing;
- international peer reviews.

Based on the Nuclear Energy Act amendment in 2015, STUK has issued the following regulations based on the previously existed Government Decrees:

- STUK Regulation on the Safety of Nuclear Power Plants (STUK Y/1/2018)
- STUK Regulation on Emergency Arrangements of a Nuclear Power Plant (STUK Y/2/2018)
- STUK Regulation on the Security in the Use of Nuclear Energy (STUK Y/3/2016, currently under revision, expected entering into force in summer 2020)
- STUK Regulation on the Safety of Disposal of Nuclear Waste (STUK Y/4/2018)
- STUK Regulation on the Safety of Mining and Milling Operations aimed at Producing Uranium or Thorium (STUK Y/5/2016).

STUK regularly updates the regulatory guides based on advances in science and technology, results of safety research and on analysis of operational experience. The 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 Act on STUK and in Decree on STUK. 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 units 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. VTT Technical Research Centre of Finland supports effectively the regulatory body in the safety assessment work for instance 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 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 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 STUK's safety performance 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 was 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 were identified and majority of the decided improvements have been implemented. 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 new NPP construction projects and other activities have required 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. The update of the competence review was carried on in 2017 to reflect the current changes in the operating environment. The final report of the updated competence review was published in 2018. 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 platforms 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 both in Finnish and in English.

The licensees are obliged by the Nuclear Energy Act to make information of the facility and the safety principles available to the public. In Decision-in-Principle phase, the Nuclear Energy Act obliges Ministry of Economic Affairs and Employment to organise public hearings, and in all licensing phase to provide the public the opportunity to give their opinions on the license application.

Articles 8a and 8b discuss the safety objectives of nuclear facilities. In Finland, the prevention and mitigation of accidents, including severe accidents and application of defense-in depth principle has been required already before the Fukushima Dai-chi accident. The utilities started to implement the severe accident mitigation measures already in the 80's. Severe accidents have been taken into account in the design of Olkiluoto 3 and Hanhikivi-1 from the beginning.

Regarding article 8c; in the Finnish licencing system, a licence is required for construction, operation and decommissioning. In the licensing process, the applicant is required to demonstrate the compliance with safety requirements. STUK verifies the compliance independently from the licence applicant. In addition, a periodic safety review is required at least every ten years (every 15 years for disposal facilities).

Article 8d is related to organisation of emergency preparedness. The Nuclear Energy Act obliges the licensee to have emergency response organization with specified duties, and to coordinate emergency arrangements and plans with other involved authorities. The arrangements are tested regularly in emergency exercises. STUK verifies the preparedness of the organisations operating nuclear power plants in yearly on-site inspections belonging to STUK's periodic inspection programme. Furthermore, 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.

The section regarding Article 8e discusses self-assessments and international peer reviews. The obligation to arrange self-assessments and invite international peer reviews has been included in the Nuclear Energy Act. STUK organised in 2009 a peer review of STUK's waste management related activities and conducted the first self-assessment of a kind. Since that, self-assessments have typically been conducted related by international peers., e.g. IAEA's IRRS (conducted in 2012, follow up in 2015), IPPAS (conducted in 2009, follow-up in 2012, next will be in 2021). In addition, STUK has conducted regular self-assessments related to relevant topics such as learning and measuring processes and safety culture. The next IRRS mission will be carried out in 2022. Also an ARTEMIS mission will take place in 2022. In the preparatory phase STUK will carry out a comprehensive self-assessment. Finland participated in the Topical Peer Review (TPR) "Ageing Management" under the Nuclear Safety Directive 2014/87/EURATOM, carried out in 2017–2019. A peer review covering the emergency preparedness (EPREV) will be invited for 2023. In addition, WANO and IAEA missions are regularly carried out at the licensees.

In conclusion, Finland has implemented the obligations of the Directive and the objectives of the Directive are complied with. Legislation and regulatory regulations and 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 and based on results of the first Topical Peer Review on Ageing Management. STUK has implemented improvements based on the results of IRRS missions. The Act on STUK and Decree on STUK are under revision to include the obligations of the directive concerning arrangements for the education and training for staff and for management system promoting and enhancing effective safety culture. Otherwise there exists no immediate need for additional improvements in the Finnish legislative, regulatory and organisational 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

In this chapter, the implementation of each of the Articles 4 to 8 of the Directive is separately evaluated as required under Article 9.1 of Council Directive 2009/71/EURATOM. This chapter demonstrates how Finland is fulfilling the obligations of the Directive.

3.1 Article 4 – Legislative, regulatory and organisational framework

3.1.1 Article 4.1 – Overview of the national nuclear safety legislation

1. Member States shall establish and maintain a national legislative, regulatory and organisational framework ("national framework") for the nuclear safety of nuclear installations. The national framework shall provide in particular for:

(a) the allocation of responsibilities and coordination between relevant state bodies;

(b) national nuclear safety requirements, covering all stages of the lifecycle of nuclear installations;

(c) a system of licensing and prohibition of operation of nuclear installations without a licence;

(d) a system of regulatory control of nuclear safety performed by the competent regulatory authority;

(e) effective and proportionate enforcement actions, including, where appropriate, corrective action or suspension of operation and modification or revocation of a licence

The current nuclear safety legislation in Finland is based on the Nuclear Energy Act originally from 1987. The Act has been amended close to 30 times during the years it has been in force: most changes are minor and originate from implementation of EU directives and 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 the supporting Nuclear Energy Decree (161/1988) originally from 1988, the scope of this legislation covers e.g.

- the construction, commissioning, operation and decommissioning 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.

Based on the Nuclear Energy Act, the Government issued in 2008 Government decrees on the Safety of Nuclear Power Plants, on the Security in the Use of Nuclear Energy, on Emergency Response Arrangements at Nuclear Power Plants and on the Safety of Disposal of Nuclear Waste. The Decrees on the Safety of Nuclear Power

Plants and on Emergency Response Arrangements were amended in 2013 mainly due to updating of safety requirements after the TEPCO Fukushima Daiichi accident and new WENRA Safety objectives.

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 and regulator's authority to investigate an abnormal event or procedure in the use of nuclear energy. 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 peer review process. According to the IRRS recommendations, some amendments concerning STUK's independence and legal authorities were made to the Nuclear Energy Act and the Radiation Act that entered into force in 2015. The amendments gave STUK a mandate to issue binding regulations concerning the areas of previous Government Decrees; safety of nuclear power plants, safety of the disposal of nuclear waste, emergency arrangements at nuclear facilities, security arrangements in the use of nuclear energy, and a new area concerning mining and milling operations aimed to produce uranium or thorium. STUK issued the regulations on 1st January 2016. Updates of three (STUK Y/1/2018, STUK Y/2/2018 and STUK Y/4/2018) out of five STUK regulations were published and came into force on 15th December 2018. Two Regulations (STUK Y/3/2016 and STUK Y/5/2016) will be updated and published later in 2020.

STUK Regulations and their explanatory memorandums are published in Finnish and Swedish which are official ones. Link to Finlex:
https://www.finlex.fi/fi/viranomaiset/normi/555001/

English translations are also published but their status is unofficial. Link to Stuklex:
https://www.stuklex.fi/en/maarays

On 5th of May 2017 an amendment to the Nuclear Energy Act due to the amendment (2014/52/EU) of Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment game into force as an annex act to the new national Environmental Impact Assessment Act (252/2017).

The Nuclear Energy Act was amended in 2017 for implementation of the Council Directive 2014/87/Euratom amending Directive 2009/71/Euratom establishing a

Community framework for the nuclear safety of nuclear installations. The amendment of the Nuclear Energy Act entered into force on 1st of January 2018 and supplemented also the former implementation (2013) of the Nuclear Waste Directive (2011/70/Euratom) due to the additional questions by the Commission. The most significant changes caused by the directives concerned transparency of activities, licensee's obligation to provide information and responsibility for subcontractors, involvement of the population in decision-making concerning the nuclear facility licensing and international peer reviews. At the same time, the provisions of the act regarding pressure equipment were updated due to the new Pressure Equipment Act (1144/2016) that entered into force on 1st of January 2017. In addition, national legislation was deemed to require disambiguation on matters related to the decommissioning of nuclear facilities and nuclear waste management, which is why further specifications were entered in the act regarding these matters, and the decommissioning licence was added as a new licensing phase for nuclear facilities, and changes were made regarding waste management.

The Nuclear Energy Act amendment proposals concerning security arrangements in the use of nuclear energy were started in conjunction with the preparation for the amendment that entered into force in the beginning of 2018 but extracted from the Nuclear Energy Act amendment bill following the commentary phase. The amendment proposal concerns e.g. more detailed requirements for the security standing order, powers of security personnel, use of dogs in guarding tasks, and the point of time when security organisation must be established. New topic in the amendment proposal is the issue concerning the doctor's and health care personnel's rights to notify about health concerns of the two groups of persons working at nuclear power plants in the tasks which are significant for safety (e.g. operators in the control room and security personnel). New topics are also proposals for regulating powers for operator's security personnel to detect and response to flying model planes and drones in site area of nuclear facilities. The bill was presented by the Ministry of Economic Affairs and Employment to the Government in the plenary session on 13th of February 2020. Government approved the bill to be submitted to the Parliament for its review. Thereafter the decision for approval of the bill will be taken by the President of the Republic. The entry into force was meant to be 1st of April 2020, but the Finnish Government had to prioritize several temporary amendments to laws due to the coronavirus outbreak.

On 15th of December 2018, the new Radiation Act the Government Decree on ionising radiation (1034/2018), the Decree of the Ministry of Social Affairs and Health on ionising radiation (1044/2018) and the Decree of the Ministry of Social Affairs and Health on limiting public exposure to non-ionising radiation (1045/2018) entered into force. The new radiation legislation implemented the EU radiation safety directive (BSS, 2013/59/Euratom). The requirements of the BSS directive concerning the use of nuclear energy were implemented through the amendment to the Nuclear Energy Act (862/2018), which entered into force as an annexed act to the Radiation Act.

The Nuclear Energy Decree has been amended more than 10 times during the years it has been in force. An amendment of the Decree which entered into force on 1 January 2016 based on the amendment of the Act and giving STUK mandate to provide regulations. The latest amendment of the Decree entered into force on 1 January 2018 due to the amendments made to the Nuclear Energy Act and due to

the new Act on Environmental Impact Assessment Procedure Act (252/2017). Due to the amendments made to the Nuclear Energy Act provisions further specifying the licensing procedure regarding decommissioning of nuclear facilities and oversight by STUK were added to the Decree. Provisions regarding the minimum contents of the national nuclear waste management programme were also added to the decree. The amendment of the decree due to the changes in Nuclear Energy Act and new radiation legislation are under preparation and is meant to enter into force on 1st of April 2020.

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. In Finland, the finishing off the international ratification process of the convention amendments without any undue delay is considered to be extremely important.

3.1.2 Article 4.1 (a) Allocation of responsibilities

According to the Nuclear Energy Act (Section 54), the overall authority in the field of nuclear energy is the Ministry of Economic Affairs and Employment (MEAE). The Ministry prepares matters concerning nuclear energy to the Government for decision-making. Among other duties, MEAE is responsible for the formulation of a national energy policy.
The mission of 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 responsible for the supervision of the safe use of nuclear energy. In addition, STUK is responsible for attending to the supervision of physical protection and emergency planning, and for the necessary control of the use of nuclear energy to prevent proliferation of nuclear weapons. The responsibilities and rights of STUK regarding the regulation of the use of nuclear energy and use of radiation are provided in the Nuclear Energy Act and Decree and also in the Radiation Act and Decree. The duties of STUK are given in an Act and Decree of STUK.

STUK is administratively under the Ministry of Social Affairs and Health. Interfaces to ministries and governmental organisations are described in Figure 1. It is emphasised 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.

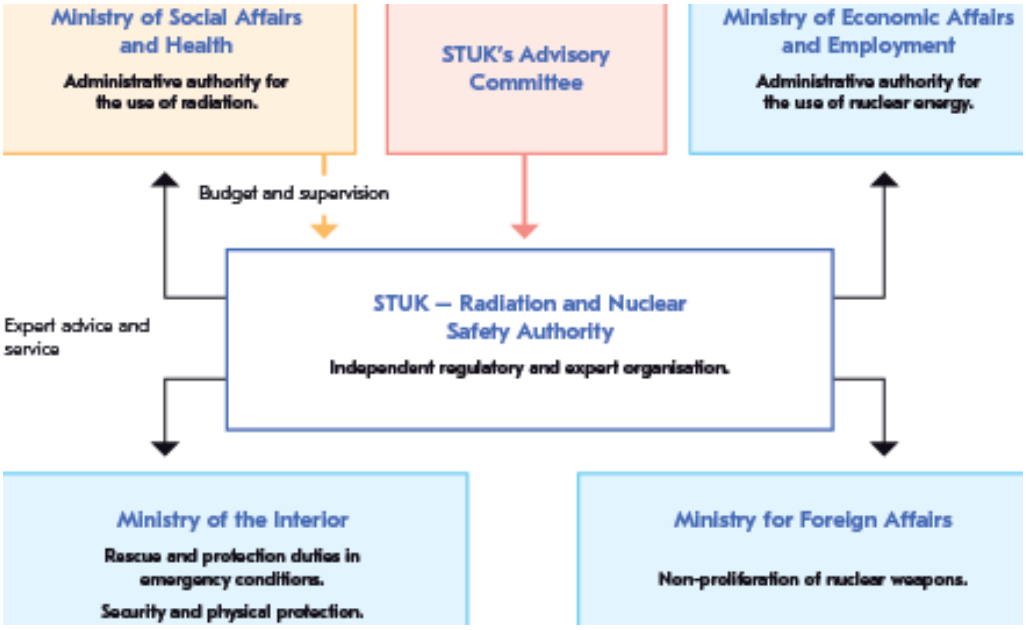

Figure 1: Co-operation and interfaces between STUK and Ministries and other organisations.

3.1.3 Article 4.1 (b) – Safety requirements

According to Section 7 q of the Nuclear Energy Act, STUK shall issue further regulations on matters specified in the section.

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 presented in the YVL Guides are binding on the licensee, while preserving the licensee's right to propose an alternative procedure or solution to that provided for in the YVL Guides. If the licensee can convincingly demonstrate that the proposed procedure or solution will implement the same safety level, STUK may approve this procedure or solution.

New YVL Guides are applied to new nuclear facilities as such. The procedure to apply new guides to existing nuclear facilities and to facilities under construction is such that the publication of an YVL Guide does not, as such, alter any previous decisions made by STUK. Before an implementation decision is made by STUK the licensees are requested to evaluate the compliance with the new guide. In case of non-compliances, the licensee has to propose plans for improvement and schedules for achieving compliance. After having heard those concerns, STUK makes a separate decision on how a new or revised YVL Guide applies to operating nuclear facilities, or to those under construction. STUK can approve exemptions from new requirements if it is not technically or economically reasonable to implement

respective modifications and if the safety justification is considered adequate. This is a case by case decision. For example, Finnish operating NPPs are granted exemptions from the requirements concerning protection against large airplane crashes.

In compliance with the national strategy and with expectations of IAEA the 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 co-operation 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. If there is not any immediate need for corrections or updates of YVL guides (e.g. EU directives, new international requirements or update of pertinent national legislation) there are criteria in STUK's management system guidance for the review and updating of the regulations. The preparation process of the regulatory guides includes internal and external commenting of STUK and the stakeholders and hearings of relevant advisory committees. The public participation is made possible through the website of STUK where the drafts for external commenting are available.

After amending the nuclear safety legislation in 2008, the revision of all YVL Guides was commenced to reflect the enhanced safety requirements. The re-structured system of the regulatory YVL Guides is shown in Figure 2.

A Safety management of a nuclear facility	B Plant and system design	C Radiation safety of a nuclear facility and environment	D Nuclear materials and waste	E Structures and equipment of a nuclear facility
A.1 Regulatory oversight of safety in the use of nuclear energy	B.1 Safety design of a nuclear power plant	C.1 Structural radiation safety at a nuclear facility	D.1 Regulatory control of nuclear safeguards	E.1 Authorised inspection body and the licensee's in-house inspection organisation
A.2 Site for a nuclear facility	B.2 Classification of systems, structures and components of a nuclear facility	C.2 Radiation protection and exposure monitoring of nuclear facility workers	D.2 Transport of nuclear materials and nuclear waste	E.2 Procurement and operation of nuclear fuel and control rods
A.3 Leadership and management for safety	B.3 Deterministic safety analyses for a nuclear power plant	C.3 Limitation and monitoring of radioactive releases from a nuclear facility	D.3 Handling and storage of nuclear fuel	E.3 Pressure vessels and piping of a nuclear facility
A.4 Organisation and personnel of a nuclear facility	B.4 Nuclear fuel and reactor	C.4 Assessment of radiation doses to the public in the vicinity of a nuclear facility	D.4 Predisposal management of low and intermediate level nuclear waste and decommissioning of a nuclear facility	E.4 Strength analyses of nuclear power plant pressure equipment
A.5 Construction and commissioning of a nuclear facility	B.5 Reactor coolant circuit of a nuclear power plant	C.5 Emergency arrangements of a nuclear power plant	D.5 Disposal of nuclear waste	E.5 In-service inspection of nuclear facility pressure equipment with non-destructive testing methods
A.6 Conduct of operations at a nuclear power plant	B.6 Containment of a nuclear power plant	C.6 Radiation monitoring at a nuclear facility	D.6 Production of uranium and thorium in the mining and milling industry	E.6 Buildings and structures of a nuclear facility
A.7 Probabilistic risk assessment and risk management of a nuclear power plant	B.7 Provisions for internal and external hazards at a nuclear facility	C.7 Radiological monitoring of the environment of a nuclear facility	D.7 Release barriers of spent nuclear fuel disposal facility	E.7 Electrical and I&C equipment of a nuclear facility
A.8 Ageing management of a nuclear facility	B.8 Fire protection at a nuclear facility			E.8 Valves of a nuclear facility
A.9 Regular reporting on the operation of a nuclear facility				E.9 Pumps of a nuclear facility
A.10 Operating experience feedback of a nuclear facility				E.10 Emergency power supplies of a nuclear facility
A.11 Security of a nuclear facility				E.11 Hoisting and transfer equipment of a nuclear facility
A.12 Information security management of a nuclear facility				E.12 Testing organisations for mechanical components and structures of a nuclear facility
				E.13 Ventilation and air conditioning equipment of a nuclear facility

Figure 2: The structure of Regulatory Guides (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 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. The most important changes deal with the design of NPPs and spent fuel storages, consideration of severe external hazards and with the requirements concerning on-site emergency preparedness including multi-unit accidents. STUK participated WENRA's work on the update of the Safety Reference Levels after the Fukushima accident and most of the updated Reference Levels were already taken into account in the revised YVL guides.

The new set of YVL guides was published on December 1, 2013. The publication of 2 guides out of 45 guides took place during 2016. These were left to wait for publication due to the needed changes in the legislation and upper level regulations.

Using numbered requirements enables systematic requirement management. STUK uses a commercially available software (Polarion). In the tool, each requirement has attributes (links to higher level legislation, in which phase of a life cycle of the facility the requirement is relevant etc). The attributes enable performing different searches. Furthermore, the information about the fulfilment of the requirements at the facilities and the possible approved exemptions are recorded in the tool.

With regard to operating nuclear facilities and those under construction, the Guides shall be implemented through a separate decision to be taken by STUK. After publishing the new YVL guides at the end of 2013 STUK asked in January 2014 licensees to make their assessments concerning fulfilment of requirements. STUK's target was to create a common view on application of requirements in new YVL Guides for existing nuclear facilities and store the information in the requirement management system to be utilised in STUK's oversight activities in future. The implementation decisions were given by the 1st of October 2015 for operating plants and by the 1st of January 2016 for the research reactor and for Olkiluoto 3 the revised YVL guides entered into force as the operating license was granted on 7th March 2019.

The revised guides did not contain notable technical modification needs with regard to operating facilities since several plant improvements were already initiated after the Fukushima accident. Several plant modifications had also been implemented during last decades or were under implementation based on previously updated regulatory requirements, probabilistic risk assessment (PRA) results and periodic safety review (PSR) results.

After the renewal of YVL Guides in 2013 nearly all IAEA Safety Requirements documents have been revised. Just because of TEPCO Fukushima Dai-ichi accident IAEA had updated several requirements documents. The updated WENRA Safety Reference Levels for Existing Reactors taking into account the lessons learnt and the insight from the EU stress tests were published in fall 2014. The updated international requirements were reviewed and assessed by STUK to clarify the need for further modifications of STUK's regulations and regulatory guides. In this connection also the new requirements of Council Directive (2014/87/Euratom) amending Nuclear Safety Directive (2009/71/Euratom) and BSS directive (Basic Safety Standards Directive, 2013/59/ Euratom) were reviewed and assessed their impact on the Finnish nuclear safety regulations. The YVL Guide update work began in 2017. In most of the YVL Guides only minor changes were needed and they are mainly clarifications. Updated YVL Guides and their explanatory memorandums are published on web (Stuklex and Finlex) in Finnish and English by the fall of 2020. Until now (June 2020) 42 YVL Guides are already published.

3.1.4 Article 4.1 (c) – System of licensing

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

Before a Construction Licence can be applied for a new nuclear reactor, nuclear waste handling and disposal facility, or other significant nuclear facility, 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 cannot make any changes to the Decision; it can only approve it or reject it as it is. 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 Committee on Nuclear Safety.

For the Construction, Operating and Decommissioning Licence applications, MEAE asks STUK's statement on safety. 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 Committee on Nuclear Safety and from the Ministry of the Interior. After receiving all statements for the Construction, Operating or Decommissioning Licence, the Government will make its decision.

STUK's statement on safety is based on safety assessment. In the assessment, STUK evaluates the compliance with the requirements laid down in the regulations and regulatory guides. The safety assessment of the licensing documentation is supported by other oversight, e.g. inspections or observation of different activities like commissioning tests. Furthermore, to support its assessment, STUK orders studies and assessments from outside expert organisations, for example independent comparative analyses on various accident situations.

The parties involved in the licensing process are described in Figure 3.

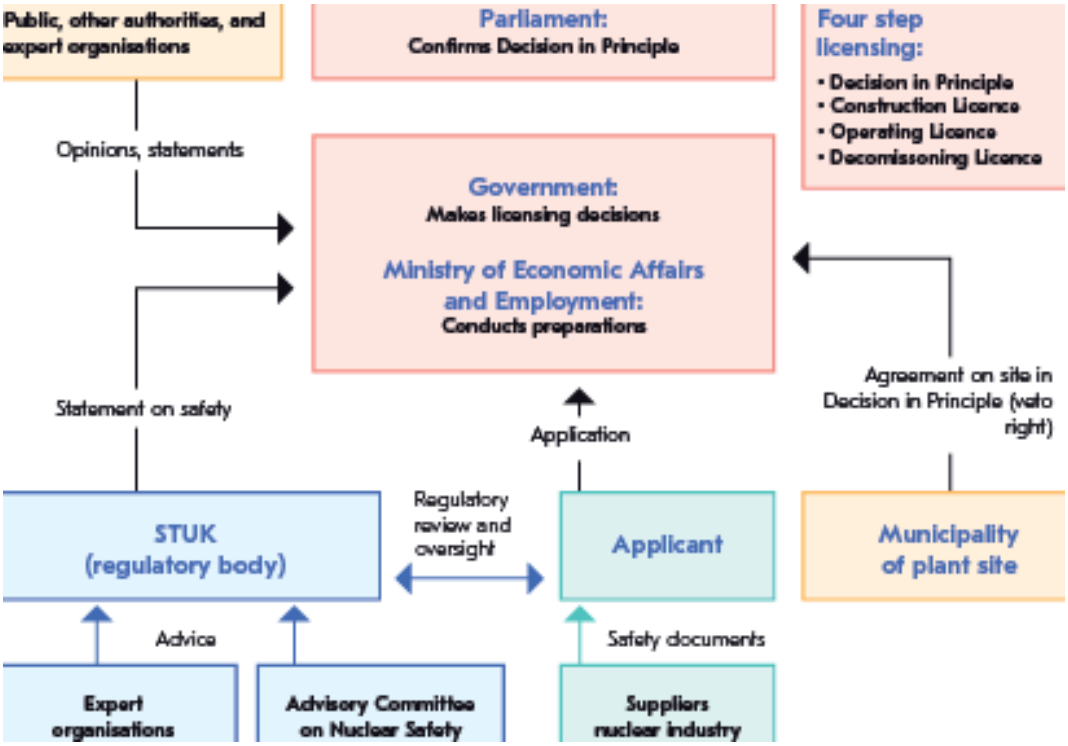

Figure 3: The parties involved in the licensing of nuclear facilities in Finland.

3.1.5 Article 4.1 (d) – System of regulatory control

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 safe use of nuclear energy. The rights and responsibilities of STUK are provided in the Nuclear Energy Act (Section 55). Safety review and assessment as well as inspection activities are covered by the regulatory oversight.

Oversight during operation

According to Section 111 of Nuclear Energy Decree, STUK controls the operation of a nuclear facility to ensure that the operation of the facility is safe and complies with the licence conditions and the approved plans and that the operation also in other respects adheres to the Nuclear Energy Act and to the regulations issued by virtue of the Act. The control of the operation of a nuclear facility also involves the maintenance, repairs, inspections and tests of the nuclear facility systems, structures and components.

STUK's oversight during plant operation includes a periodic inspection programme, continuous oversight performed by STUK’s resident inspectors, regular reporting and reporting of events by the licensee and oversight performed at the plant site during operation, as well as refuelling and maintenance outages.

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 inspections within the programme for the next year, including additional inspections as necessary.

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 has modified the inspection programme during the years. Latest changes were made in 2015, when the whole inspection programme was re-assessed and the internal guidance was updated taking into account the recommendations and suggestions of IRRS mission. According to updated internal guide, many of the yearly conducted inspections have been decided to be carried out every two years. The inspections focusing on the most safety-significant areas are still carried out annually. In addition, reactive inspections can be carried out based on the oversight results and proactive inspections can be added focusing on ongoing or coming activities at the plant. The aim is to have more flexible inspection programme to optimize its effectiveness and focus and to be able to conduct inspections in the areas and at times considered necessary. In addition, unannounced inspections are included in the annual inspection programme, e.g. inspection focusing on the conduct of operations is always carried out unannounced.

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. The operating experience is reported to STUK later 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 safety importance, especially when the operations at the nuclear power plant have not been performed as planned or 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. These inspections are usually conducted by a leadership of the STUK's event investigation manager, and an investigation team includes normally 3–5 experts from STUK or from external organisations nominated on case-by-case basis.

Numbers of operational events are followed through STUK's plant performance indicator system. Risk significance of operational events is followed by PRA based indicators.

STUK's oversight and safety assessment concerning plant modifications is described under Article 6.1 c.

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 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 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.

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, utilization 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 has updated the internal guidance of the Construction Inspection Programme in 2014 to take into account the recommendations of IRRS mission. In 2017, the guidance was supplemented to include inspection program covering the period of construction license application review.

STUK performs construction inspections of pressure equipment, mechanical components as well as steel and concrete structures as specified in the YVL Guides. These inspections are performed according to structure or component specific construction plans that have been assessed and approved before start of manufacturing. The objective of the inspections is to verify that manufacturer, vendor and the licensee have performed their duties as expected and that QC results of

manufacturing and construction are acceptable. The licensee is responsible for inviting STUK to perform the inspection at a right time.

In addition, STUK performs inspections on installation and commissioning of systems, structures and components. Safety significance of systems, structures and components are taken into account when determining the scope of inspections. STUK inspects safety class 1 and most safety important cases in safety class 2–3. Authorised Inspection Organisations (AIO) performs other inspections in safety class 2 and 3.

Oversight during decommissioning

In accordance with Section 112 b of the Nuclear Energy Decree, STUK oversees the decommissioning of the facility. The purpose is to ensure that the conditions of the decommissioning licence and the approved plans are complied with and that the nuclear facility is decommissioned in accordance with regulations.

In accordance with Section 112 b of the Nuclear Energy Decree, the different phases of decommissioning may be begun only after STUK has, on the basis of the Decommissioning 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. The different phases can be parallel with each other.

No facilities have yet been decommissioned in Finland. Licence application for decommissioning phase of a TRIGA Mark II research reactor, operated by VTT, is in process in MEAE. The research reactor will be the first decommissioned nuclear facility in Finland.

3.1.6 Article 4.1 (e) – Enforcement

The Nuclear Energy Act Sections 64–69 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.

According to Nuclear Energy Act STUK can require changes in the construction and use of a nuclear facility in order to secure the safe use of nuclear energy, to maintain appropriate security or emergency arrangements or to fulfil obligations under Finland’s international contractual obligations. STUK shall, upon consulting the licence holder, oblige it to carry out the necessary changes. In similar manner, if the requirements for safety, security or emergency arrangements are not complied with, STUK shall oblige the licence holder to take necessary measures to correct the situation.

STUK can use of coercive measures in some cases. STUK may reinforce its order by a conditionally imposed fine, or a threat to interrupt or limit the operation or to have the neglected obligation fulfilled at the expense of the neglecting party.

According to Nuclear Energy Act STUK may, after having consulted the licence holder, interrupt the operation or limit it in case of an immediate danger, or if there is a justified cause for suspecting that the operation presents such a danger. Said operations may be interrupted or limited until the reason for the issuance of the provision no longer exists. STUK shall have the same right, if supervision hereunder cannot be implemented otherwise, or if the licence holder has failed to comply with regulations issued by STUK, based on the provisions of the Nuclear Energy Act or issued under the Act, or if the licence holder has failed to comply with its obligations under the Nuclear Liability Act.

The repertoire of these tools together with some practical examples for implementing them has been presented in an internal policy document as part of STUK's Quality System.

3.1.7 Article 4.2 – Continuous improvement

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.

Continuous safety assessment and enhancement approach is presented in the nuclear legislation. Nuclear Energy Act Section 7a 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 safety requirements and measures for ensuring safety shall be graded and targeted so as to be commensurate with the risks in the use of nuclear energy." 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 re-evaluating the regulatory guides (YVL Guides) for updating. The new or updated regulatory guides are applied as such to new nuclear facilities and a separate decision is made concerning the implementation at the operating nuclear facilities or to facilities under construction. Please see Article 4.1(b).

Experiences from the Fukushima accident were taken into account in the renewal of the YVL Guides. Changes were aimed at decreasing the dependency on the plants' normal electricity supply and distribution systems. Now the capability is required to remove decay heat for 8 h without the need to replenish diesel fuel tanks, refill the water tanks or to charge batteries. Decay heat removal shall be possible for 72 h without any external help from outside the plant. This implies that sufficient diesel fuel must be stored at the plant area for 72 h.

Some recent examples of plant modifications include renewal of the safety automation and polar cranes in Loviisa NPP, the main circulation pumps in Olkiluoto NPP, and ongoing projects for renewing the refueling machines both in Loviisa and Olkiluoto NPPs and emergency diesel generators in Olkiluoto NPP. In addition, steam turbine driven auxiliary feed water systems have been installed at the Olkiluoto NPP to ensure residual heat removal in the case of total loss of AC power and/or loss of

the ultimate heat sink due to external or internal events. Furthermore, a modification in the auxiliary feed water system is enabling cooling of the components by demineralised water in addition to sea water-based cooling chain. By this modification system can remain operational for a significant period of time even during the loss of the primary ultimate heat sink (sea water). In Loviisa, two air-cooled cooling units per plant unit powered by an air-cooled diesel-generator have been installed to ensure the long-term decay heat removal in case of loss of seawater. Concerning spent fuel pools, in Olkiluoto measures to inject water into the spent fuel pools and monitoring the conditions of the pool have been implemented, in Loviisa completing the measures is expected during 2020. 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 was protected against large civil aircraft crashes in the enlargement project. The new YVL guides required that nuclear facilities have to withstand more severe natural phenomena and power failures.

The Fukushima accident highlighted the possibility of a severe accident in several reactors on the same site at the same time. STUK has requested the licensees to ensure the applicability of procedures and the availability of personnel and material resources in case of a multi-unit accident situation in extreme external conditions. In particular, water reserves on the site shall be sufficient for 72 hours even when all reactors on the same site are in an emergency. More consideration will be given to training exercises with multi-unit accidents and long-duration events.

The Council Directive 2014/87/Euratom did not cause many changes to Finland's legislation. STUK regulations and YVL guides were already in line with the new directive for almost all parts.

Article 8c of the directive requires periodic safety reviews at least every 10 years. The requirement of regular periodic safety reviews was already in the Nuclear Energy Act, but the frequency was not specified, so the 10-year interval was added. In practice the periodic safety reviews have been performed every 10 years, so the change in the law did not change the current practice. 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 Loviisa NPP was submitted to STUK in 2015 and the one for Olkiluoto NPP in 2016 as part of the license renewal project. 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 improvements on safety systems, better provisions against internal and external hazards, and implementation of a major modernization program in mid

1990's at the both Finnish NPPs. By means of these modifications, risks of reactor core damage as well as large or early releases have been significantly reduced. Technical solutions of the modifications have also been often justified with PRA. More information concerning probabilistic risk assessment is given under Article 6.

STUK's management system documents include safety and quality policy, description of the management system, organisation and management, roles and responsibilities, personnel policy as well as description of processes and procedures. Continuous improvement of the functions of STUK is ensured by actions made based on internal and external assessments.

Internal assessments include internal audits, self-assessments, management reviews, staff surveys and personnel questionnaires. In addition, NRR has recently developed its internal procedure and a supporting tool further to improve regulatory processes and functions based on regulatory experience gathered from various sources.

External assessments and their utilization are reported under Article 8e.

3.2 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 the effective independence from undue influence of the competent regulatory authority in its regulatory decision-making. For this purpose, Member States shall ensure that the national framework requires that the competent regulatory authority:

(a) is functionally separate from any other body or organisation concerned with the promotion or utilisation of nuclear energy, and does not seek or take instructions from any such body or organisation when carrying out its regulatory tasks;

(b) takes regulatory decisions founded on robust and transparent nuclear safety-related requirements;

(c) is given dedicated and appropriate budget allocations to allow for the delivery of its regulatory tasks as defined in the national framework and is responsible for the implementation of the allocated budget;

(d) employs an appropriate number of staff with qualifications, experience and expertise necessary to fulfil its obligations. It may use external scientific and technical resources and expertise in support of its regulatory functions;

(e) establishes procedures for the prevention and resolution of any conflicts of interest;

(f) provides nuclear safety-related information without clearance from any other body or organisation, provided that this does not jeopardise other overriding interests, such as security, recognised in relevant legislation or international instruments.

3. Member States shall ensure that the competent regulatory authority is given the legal powers necessary to fulfil its obligations in connection with the national framework described in Article 4(1). For this purpose, Member States shall ensure that the national framework entrusts the competent regulatory authorities with the following main regulatory tasks, to:

(a) propose, define or participate in the definition of national nuclear safety requirements;

(b) require that the licence holder complies and demonstrates compliance with national nuclear safety requirements;

(c) verify such compliance through regulatory assessments and inspections;

(d) propose or carry out effective and proportionate enforcement actions.

3.2.1 Article 5.1 – Competent regulatory authority

Please see Chapter discussing Article 4.1 (a).

3.2.2 Article 5.2 – Effective independence

3.2.3 Article 5.2 (a) – Separation

As described under Article 4.1 STUK is administratively under the Ministry of Social Affairs and Health and interfaces to ministries and governmental organisations are described in Figure 1. In 2012, this Finnish regulatory framework for nuclear and radiation safety was reviewed in the IRRS peer review process. According to the IRRS recommendations, some amendments were made to the legislation to increase the independence of STUK and to extend its authorities: The Government, when making a Decision-in-Principle (DiP), and the licensing authority as giving a license, were obligated to take into account STUK's safety proposals; STUK's mandate was expanded in radiation monitoring in the immediate vicinity of nuclear facilities and STUK was provided a mandate to issue binding regulations.

It is emphasised 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.

3.2.4 Article 5.2 (b) – Decision-making based on robust and transparent requirements

Nuclear regulatory decisions in Finland are made by the Government, MEAE and STUK, and there is a clear allocation of responsibilities between these bodies (see Article 4.1). No Ministry can take for its decision-making a matter that has been defined by law to be on the responsibility of STUK.

Both MEAE and STUK use advisory committees to support their work. The MEAE has an advisory committee linked with nuclear energy research and co-operation as a permanent expert body to support decision-making in national questions related to the nuclear energy. STUK uses Advisory Committee on Nuclear Safety, with two committees: Reactor Safety Committee and Nuclear Waste Safety Committee also as a support in decision-making. There are also separate Advisory Committees for nuclear security and radiation protection and one general Advisory Committee to STUK. STUK's Advisory Committee helps STUK to develop its functions as a regulatory, research and expert organisation in such a way that the activities are in balance with the society's expectations and the needs of the citizens.

PRA is routinely used by STUK to support its decision making, for example, in the review of plant modifications and applications for exemption from Operational Limits and Conditions and in the analysis of operating events.

The processes for regulatory oversight and decision-making of STUK are presented in STUK's Management System.

For the safety-related requirements that are the basis of the decision-making, please see also Articles 4.1 and 4.1(b). The Nuclear Energy Act lays down general principles for the use of nuclear energy. The Nuclear Energy Decree specifies and

complements the act. In addition to the Regulations, STUK publishes regulatory guides on nuclear safety (the YVL Guides). They are binding, but the licensees have the right to propose an alternative solution, and STUK may approve it if the licensee can convincingly demonstrate that the same safety level is achieved.

The preparation process of STUK's regulations and regulatory guides includes internal and external commenting of STUK and the stakeholders and hearings of relevant advisory committees. The public participation is made possible for STUK regulations through a public website, lausuntopalvelu.fi, which can be used by all organizations of public administration. Statements and comments can be given by all organizations and members of public. Drafts of STUK's regulations for the use of nuclear energy and YVL guides as well are available for external commenting also through the website of STUK. Link: https://ohjeisto.stuk.fi/.

3.2.5 Article 5.2 (c) – Budget of the regulatory body

In 2019 STUK received about 40% of its financial resources through the government budget. This sum has varied during the recent years; 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 2019, the costs of the regulatory oversight of nuclear safety were 18,3 million €.

STUK has 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.

3.2.6 Article 5.2 (d) – Staff of the regulatory body

The management of STUK highlights the need for competent workforce. STUK has adopted a systematic approach to competence management and e.g. nuclear and radiation safety and regulatory competencies are also emphasised in STUK's strategy. One of the strategic targets is to enhance STUK's ability to understand complex entities. Implementation of the strategy is reflected into the annual training programmes, on-the-job-training and new competence-driven workforce planning and recruitments. On an average 5% of the annual working hours are used to enhance the competencies.
The competence analysis is carried out on regular basis and the results are used as the basis for the training and competence development programmes and e.g. to support the new recruitments.

At STUK, new personnel have been recruited since 2003 mainly for the safety review and assessment and inspection activities related to the Olkiluoto unit 3 and for provision for retirements. At the end of 2019, number of staff in the department of Nuclear Reactor Regulation (NRR) of STUK was 123. Most of the NRR's professional staff conducting safety assessments and inspections have a university level degree. The average experience of the staff is about 15 years in the nuclear field.

An introduction training programme is prepared for all new recruited inspectors at STUK. The introduction training programme is tailored to each new inspector and its

implementation is followed by the supervisor of the newcomer. STUK has also participated in the preparation and execution of a basic professional training course on nuclear safety with other Finnish organisations in the field (YJK course). During the past few years the national training courses on nuclear safety and on nuclear waste management have been harmonized and combined as one joint training course.

The expertise of NRR covers all the essential areas needed in the oversight of the use of nuclear energy. As needed NRR 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 the VTT Technical Research Centre of Finland Ltd. STUK co-operates with VTT also on safety culture related research. The researchers have carried out research e.g. concerning safety culture and governance of large projects in the nuclear domain. Also, Lappeenranta University of Technology (LUT) and Aalto University (former Helsinki University of Technology) are important technical support organisations. International technical support organisations and experts have also been used, especially to support review and inspection activities related to Olkiluoto unit 3 and Fennovoima Hanhikivi unit 1.

The national nuclear safety and waste management research programmes have an important role in the competence building of the nuclear energy industry in Finland. These research programmes ensure the availability of the latest research results, the high-level expertise and the development of tools for e.g. regulatory oversight. Furthermore, ensuring the online transfer of the research results to the organisations participating in the steering of the programmes – and fostering the expertise. STUK has an important role in the steering of these research programmes.

3.2.7 Article 5.2 (e) – Prevention of conflict of interest

This matter is dealt in many laws and guidance. The Act on Public Officials in Central Government (750/1994) is applied to all civil servants. It addresses and gives provisions for waiting period of six months in case of rotation of civil servants (44 §). The Act on the Openness of Government Activities (621/1999) addresses obligation to maintain secrecy and The Criminal Code of Finland (39/1889) deals with revealing information with/without rights. The Administrative Act (434/2003) addresses the management of conflict of interest of Civil Servants and says that a civil servant may not deal or attend dealing issues when being incapacitated and gives also the reasoning for defining to be incapacitated (§27–28). Act on Information Management in Public Administration (906/2019) addresses reliability of civil servants. Ministry of Finance guidelines say that civil servants should not deal with matters that belong to his previous employer or to his partner or competitor which jeopardize his confidence in his impartiality. This has to be taken into account for at least half-year period of the beginning of the employment (after that The Act on Public Officials in Central Government (750/1994) and The Criminal Code of Finland (39/1889) are still valid and applied).

Further, the terms of reference between STUK and STUK's Advisory Commission and Committees say that the members of the commissions should be independent of licensees and that particular attention should be paid to potential conflicts of interest.

The terms of references refer to the Administrative Act, which, in particular addresses the management of conflict of interest of Civil Servants. Each member of the Commission/Committees have to make a declaration tracking potential conflicts of interest. The members of the commissions are formally appointed by the Government, except that the members of STUK's Commission are appointed by STUK. The proposals for appointment are made by STUK and are made public before the official appointment.

The Act on Public Procurement and Concession Contracts (1397/2016) basing on EU directives (2014/23/EU, 2014/24/EU and 2014/25/EU) gives provisions for providing services (including TSO services) and addresses also dealing with conflict of interests. In addition, the Administrative Act (434/2003, §27–28) addresses more on civil servants' incompetence due to the likelihood of bias when ordering such procurements. STUK's Management Manuals (STUK 8.11, 8.12 and YTV 8.d) guide how to apply these regulations into practice. Also, Management Manual STUK 3.1 states the basic principles of regulation of the use of radiation and nuclear energy.

3.2.8 Article 5.2 (f) – Sharing of information

STUK is an independent bureau and regulator, whose status and tasks are described in the Act (22.12.1983/1069) and degree (27.6.1997/618) which also sets communication on radiation and nuclear safety as one of the key-tasks of the bureau. Director General of STUK has the ultimate responsibility over communications as well as other operations. STUK is organizationally independent from any other body or organization and it does not require – nor does it ask – prior approval or consent from any other body or organization when it publishes safety-related information.

STUK carries out its communications pro-actively, transparently and even-handedly. In practice STUK utilises many means to communicate with public and interested stakeholders. Press releases and communication materials are available at STUK website and shared in social media. Also, STUK's oversight reports, covering both operating facilities and facilities under construction, are published three times a year. Other essential documentation is also made available at STUK website. As required by Act on the Openness of Government Activities (621/1999) all documents produced by the STUK are by default public and available from STUK registry, unless there is a legal basis to withhold information.

In addition, the Openness Act also requires authorities to produce 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.

3.2.9 Article 5.3 – Legal powers

3.2.10 Article 5.3 (a) – Definition of requirements

Please see also Article 4.1 (b) and Article 5.2 (b).

According to the Section 55 Subsection 2 (6) of the Nuclear Energy Act, STUK shall provide expertise for other authorities. Based on this starting point STUK submits proposals for legislative amendments to the ministry.

STUK shall issue binding STUK Regulations by virtue of Nuclear Energy Act and Radiation Act. According to Nuclear Energy Act, STUK shall issue general regulations and impose detailed safety requirements.

3.2.11 Article 5.3 (b) – Compliance with requirements

According to Nuclear Energy Act, STUK shall supervise the observance of license conditions as well as set detailed requirements concerning the operations referred to in the license and issue detailed regulations, if necessary, and supervise compliance therewith. 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.

STUK also lays down qualification requirements for personnel involved in the use of nuclear energy and controls compliance with these requirements. STUK shall also give detailed regulations as necessary and oversee compliance with these regulations.

3.2.12 Article 5.3 (c) – Verifying compliance

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

Please see Article 4.1 (d) for oversight during construction, operation and decommissioning of a facility.

3.2.13 Article 5.3 (d) – Enforcement actions

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. Enforcement proceedings are mainly concerned in a situation where the operator or licencee is indifferent to an obligation, failure to comply with which does not constitute an immediate threat to safety. The procedure is relatively time consuming. On the other hand, the coercive procedure, when used correctly, is an effective means of correcting negligent conduct.

The repertoire of the tools together with some practical examples for implementing them has been presented in an internal policy document as part of STUK's Management System (Guide STUK 3.1).

A police authority shall provide executive assistance to STUK when needed in matters relating to supervision of the observance of the Nuclear Energy Act and the provisions issued thereunder.

Please see also Article 4.1 (e) and 8a (1) and (2b).

The guiding principle of continuous safety improvement "The safety of nuclear energy use shall be maintained at as high a level as practically possible" was adopted in Finland already in the 1970's and included in 2008 to the Nuclear Energy Act (Section 7a) and the Government Degree on the Safety of Nuclear Power Plants, currently STUK Regulation Y/1/2018. Finland's regulatory guides, YVL Guides, are continuously re-evaluated for updating, considering operating experience, research, and advances in technology. The revised regulatory guides are applied as such for new nuclear facilities. For the existing facilities and facilities under construction, separate facility specific implementation decisions are made. Before an implementation decision is made by The Radiation and Nuclear Safety Authority (STUK), the licensees are requested to evaluate the compliance with the new requirements. In case of non-compliances, the licensee has to propose plans for improvement and schedules for achieving compliance. After having heard those concerned, STUK makes a separate decision on how a new or revised YVL Guide applies to operating nuclear facilities, or to those under construction. STUK can approve exemptions from new requirements if it is not technically or economically reasonable to implement respective modifications and if safety is justified and considered adequate. This is case by case decision.

Timely implementation of safety improvements is also an important aspect. The justified safety improvements should be implemented as soon as reasonably practicable. On the other hand, all plant modifications need careful planning and assessment of possible risks caused by planned modifications (configuration management). The status of implementation is checked annually and in connection of Periodic Safety Reviews (PSR). New urgent information from accidents, operating experiences and research might also lead to direct improvements measures (e.g. the

plant safety modifications originating from the lessons learnt from the Fukushima Dai-ichi accident). Periodic safety assessments and use of probabilistic risk assessment (PRA) can bring new sights for safety improvement needs when looking the overall picture of the plant safety.

Finnish regulations require also that licensees maintain an up-to-date and comprehensive plant-specific probabilistic risk assessment (PRA) and that they use the PRA to enhance nuclear facility safety, to identify and prioritise plant modification needs and to compare the safety significance of alternative solutions. Other aspects to be considered when assessing the justifications for safety improvements include radiation doses to workers (doses received during the plant modification or decreased doses after the modification) or to the public (normal operation or accident conditions). There can also be some risks related to the plant modification itself which needs to be considered. Systematic quantitative cost-benefit analysis is not used in Finland because of its uncertainties. Licensees can compare the costs of the plant modification to the gained safety improvement and for example propose alternative solutions based on the PRA results and overall safety of the plant.

3.3 Article 6 – Licence holders

1. (a) the prime responsibility for the nuclear safety of a nuclear installation rests with the licence holder. That responsibility cannot be delegated and includes responsibility for the activities of contractors and sub-contractors whose activities might affect the nuclear safety of a nuclear installation;

1. (b) when applying for a licence, the applicant is required to submit a demonstration of nuclear safety. Its scope and level of detail shall be commensurate with the potential magnitude and nature of the hazard relevant for the nuclear installation and its site;

1. (c) licence holders are to regularly assess, verify, and continuously improve, as far as reasonably practicable, the nuclear safety of their nuclear installations in a systematic and verifiable manner. That shall include verification that measures are in place for the prevention of accidents and mitigation of the consequences of accidents, including the verification of the application of defence-in-depth provisions;

1. (d) licence holders establish and implement management systems which give due priority to nuclear safety;

1. (e) licence holders provide for appropriate on-site emergency procedures and arrangements, including severe accident management guidelines or equivalent arrangements, for responding effectively to accidents in order to prevent or mitigate their consequences. Those shall in particular:

> *(i) be consistent with other operational procedures and periodically exercised to verify their practicability;*
>
> *(ii) address accidents and severe accidents that could occur in all operational modes and those that simultaneously involve or affect several units;*
>
> *(iii) provide arrangements to receive external assistance;*
>
> *(iv) be periodically reviewed and regularly updated, taking account of experience from exercises and lessons learned from accidents;*

1. (f) licence holders provide for and maintain financial and human resources with appropriate qualifications and competences, necessary to fulfil their obligations with respect to the nuclear safety of a nuclear installation. Licence holders shall also ensure that contractors and subcontractors under their responsibility and whose activities might affect the nuclear safety of a nuclear installation have the necessary human resources with appropriate qualifications and competences to fulfil their obligations.

3.3.1 Article 6.1 (a) – Prime responsibility

The responsibility for the safety rests with the licensee as prescribed in the Nuclear Energy Act Section 9:

- The license holder shall be under an obligation to ensure the safe use of nuclear energy. This obligation may not be delegated to another party. The license holder shall ensure that the products and services of contractors and subcontractors which affect the nuclear safety of the nuclear facility meet the requirements of this Act.
- It shall be the license holder's obligation to carry out such security and emergency arrangements and other arrangements necessary for the limitation of nuclear damage which do not rest with the authorities.
- A license holder whose operations generate or have generated nuclear waste (party with a waste management obligation) shall be responsible for all nuclear waste management measures and their appropriate preparation, as well as for their costs (waste management obligation).

In the Regulation STUK Y/1/2018 there are binding requirements for the licensees to ensure that the requirements concerning safety are applied in all organizations that participate in safety significant activities. According to the Nuclear Energy Act, the license holder shall ensure that contractors and subcontractors whose activities affect the nuclear safety of the nuclear facility have an adequate number of qualified and trained personnel suitable for the tasks.

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 programs established by STUK. The management systems of the main suppliers are reviewed and assessed and their implementation is verified through inspections and audits mainly by the licensee where STUK is taking part as an observer. STUK makes frequently visits on site with discussions, interviews and observations on safety management topics to follow up the development actions of the licensee also by other means than inspections.

For nuclear liability, please see Article 4.1.

3.3.2 Article 6.1 (b) – Demonstration of safety

The Nuclear Energy Act Section 7a sets forth the guiding principles for the use of nuclear energy on of which is grading: *The safety requirements and measures for ensuring safety shall be graded and targeted so as to be commensurate with the risks in the use of nuclear energy*. In addition, Section 7d sets forth that the probability of an accident must be lower, the more severe the consequences of such an accident would prove for people, the environment or property.

These principles are reflected in the more detailed regulatory requirements. According to the regulation on the Safety of a Nuclear Power Plant (STUK Y/1/2018), the safety functions of a nuclear facility shall be defined, and the related systems, structures and components classified on the basis of their safety significance. Requirements set for and the actions taken to ascertain the compliance with the requirements of the systems, structures and components implementing safety functions and connecting systems, structures and components shall be commensurate with the safety class of the item in question.

When applying a licence, the applicant must submit the licensing documentation for STUK's review. The documents are listed in Nuclear Energy Decree. The documents

include for example PSAR/FSAR, PRA, classification document, plans for security, safeguards and emergency arrangements, quality management documents, plans for different activities like ageing management, in-service inspections, decommissioning and radiation monitoring in the environment. The purpose of these documents is to describe the general design and safety principles of the nuclear facility, a detailed description of the site and the nuclear facility, a description of the operation of the facility, a description of the behaviour of the facility during accidents, a detailed description of the effects that the operation of the facility has on the environment, and any other information considered necessary by the authorities. Based on these documentation STUK prepares a safety assessment of the nuclear facility in concern in each licensing phase.

In addition, the Decree gives STUK a possibility to ask other documents considered necessary for safety demonstration. More detailed requirements for the scope and content of the documents are set in multiple YVL Guides.

The prerequisite for any licence is that the licence applicant has made its own safety assessments.

Please see also discussion under Articles 8c (a) and 8c (b).

3.3.3 Article 6.1 (c) – Assessment, verification and improvement of safety

Continuous improvement of safety is a fundamental principle set forth in the Nuclear Energy Act Section 7a: *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.*

According to the Nuclear Energy Act Section 7e, compliance with the requirements concerning the safety of a nuclear facility shall be reliably proven. The overall safety of a nuclear facility shall be assessed at least at 10-year intervals. The overall safety of a facility performing large-scale disposal of nuclear waste shall, however, be assessed at least at 15-year intervals. In addition, according to the Section 7f, *the condition and operating experiences of any nuclear facility shall be systematically monitored and assessed*.

Section 3 of Regulation STUK Y/1/2018 sets further details on continuous and periodic assessment of safety: *the safety of a nuclear facility shall be assessed when applying for a construction license and operating license, in connection with plant modifications, and at Periodic Safety Reviews during the operation of the plant. It shall be demonstrated in connection with the safety assessment that the nuclear facility has been designed and implemented in a manner that meets the safety requirements. The safety assessment shall cover the operational states and accidents of the plant. The safety of a nuclear facility shall also be assessed after accidents and, whenever necessary, on the basis of the safety research results*. This includes maintaining the analyses for demonstration of safety up to date: *the analyses shall be maintained and revised as necessary, taking into account operating experience from the plant itself and from other nuclear facilities, the results of safety research, plant modifications, and the advancement of calculation methods*.

Safety requirements on all levels of legislation, regulations and guides are based on the Defense-in-Depth principle. The principle is set forth in the Nuclear Energy Act and further detailed in the regulation STUK 1/Y/2018. Redundancy, separation and diversity principles shall be used in the safety design as means to enhance Defense-in-Depth. YVL guides, especially YVL B.1 “Safety design of a nuclear power plant”, apply these safety principles on the fundamental safety functions in further detail. Safety design requirements are further discussed under article 8b.

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 STUK’s assessment is required in the Nuclear Energy Act. Conditions for granting a licence are provided in the Nuclear Energy Act. 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.

Design of the facility is described in the Preliminary (PSAR) and Final (FSAR) Safety Analysis Reports. PSAR/FSAR forms the basis to STUK´s safety assessment which is required before granting the licence. According to the Nuclear Energy Decree, FSAR has to be continuously updated due to for example plant modifications, 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. The main principle in plant modification process is that conceptual design plans and system-specific pre-inspection documents of Safety Classes 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 FSAR shall be amended accordingly without delay.

According to the Nuclear Energy Act, the operating licence is granted for a fixed term. However, legislation has not prescribed the length of the term. The term is proposed by the licensee in the application and must be justified on the basis of the ageing and planned future operation of the nuclear facility. Particular attention is paid to licensee´s processes and activities and planned safety improvements to ensure safety for the estimated duration of operation. The procedure for operating licence renewal is in
general the same as in applying for an operating licence for a new nuclear facility. Renewal of the operating licence always involves a periodic safety review of the facility. If a licence is granted for a significantly longer term than ten years, STUK requires the licensee to carry out a periodic safety review within at least ten years of receiving the operating licence or of conducting the previous periodic safety review.

According to the STUK Regulation nuclear power plant safety and the technical solutions of its safety systems shall be assessed and substantiated analytically and, if necessary, experimentally. The analyses shall be maintained and revised as necessary, taking into account operating experience from the plant itself and from other nuclear power plants, the results of safety research, plant modifications, and the advancement of calculation methods. The analytical methods employed to demonstrate compliance with the safety requirements shall be reliable, verified and qualified for the purpose. The analyses shall demonstrate the conformity with the

safety requirements with high certainty. Any uncertainty in the results shall be considered when assessing the meeting of the safety requirements.

Detailed requirements concerning transient and accident analyses, including sensitivity analyses, are presented in the Guide YVL B.3 and requirements for failure tolerance analyses are presented in YVL B.1. Acceptance criteria for the deterministic analyses are presented in Guides related to reactor and nuclear fuel, primary circuit pressure boundary and containment (YVL B.4, YVL B.5 and YVL B.6). Requirements for probabilistic risk assessments are given in the Guide YVL A.7. Acceptance criteria for limitation of radioactive releases and public exposure in the environment of a nuclear power plant or other nuclear facility are given in the Nuclear Energy Decree (161/1988).

Accident and transient analyses of the operating nuclear power plants, as well as the analysis methods, have been updated and developed throughout the operation of the plants. Fortum has revised almost all of the safety analyses in connection with the I&C renewal, periodic safety review and renewed YVL guides. Deterministic assessment of extreme external events has been updated to correspond to renewed requirements and was submitted to STUK in early 2019. TVO revised the accident and transient analyses for Olkiluoto units 1&2 in conjunction with the application for the renewal of its operating licence which was granted in 2018. The analyses for design extension conditions without core melt were added to the scope due to the revised YVL Guides. The revised analyses of Olkiluoto unit 3 were presented to STUK in connection with the application for the operating licence. These analyses have been updated during construction and commissioning phase to correspond the as-built plant. The operating license was granted in early 2019. Until now, Fennovoima has submitted some of the deterministic analyses for construction license application of Hanhikivi 1 plant and they are under review.

Guide YVL A.7 guide requires a full-scope (including internal events, fires, floods, seismic events, harsh weather and other external events) PRA 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. For a new plant unit, a preliminary PRA shall be submitted to STUK for the review of the construction licence application (design phase PRA) and the updated and complemented PRA shall be submitted for the review of the operating licence application. Guide YVL A.7 also 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 addition to the risk informed applications based on regulatory requirements, the licensees use PRA in applications supporting their operating activities, for example availability analysis and reliability centered maintenance. Utilization of PRA in inspected regularly as part of the periodic inspection program.

Regulation STUK Y/1/2018 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 periodical tests. General requirements on verification programmes and procedures are provided in the YVL Guides (e.g. Guide YVL A.8 “Ageing management of a nuclear facility” and YVL E.5 “In-service inspection of nuclear facility pressure equipment with non-destructive testing methods”). Main programmes used for maintaining and verification of the operability of a nuclear power plant are

- periodic testing according to the Operational Limits and Conditions
- preventive and predictive maintenance programmes
- in-service inspection programmes for pressure retaining components
- time limited analyses and qualifications
- surveillance programme of reactor pressure vessel material research 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. 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.

3.3.4 Article 6.1 (d) – Management system

According to the Nuclear Energy Act Section 7j, a nuclear facility shall have a management system. According to Regulation STUK Y/1/2018, organizations participating in the design, construction, operation and decommissioning of a nuclear facility shall employ a management system for ensuring safety and the management of quality. The objective of such a management system shall be to ensure that safety is prioritized without exception, and that quality management requirements correspond to the safety significance of the activity and function. The management system shall be systematically assessed and further developed. 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 functions that affect nuclear and radiation safety adhere to the quality management system. Along with the management system, the STUK Regulation sets requirements for the documentation of the lines of management and monitoring of the operations.

STUK’s YVL Guides set more requirements on the management system. The YVL guide A.3 “Leadership and management for safety” sets general requirements for management systems regarding quality and safety management. Guide YVL A.3 refers to the ISO 9000:2015 definition of quality management according to which quality management consists of quality planning, quality control, quality assurance

and quality improvement. Guide YVL A.3 adheres to IAEA Safety Requirements GSR Part 2 Leadership and management for safety. Requirements for quality management of system design are established in the Guide YVL B.1. Further requirements related to specific technical areas are presented in the corresponding technical guides. STUK has during the period 2016–2018 revised the YVL requirements concerning management systems and quality management taking into account experiences, feedback and development of quality standards (e.g. ISO 19443).

The management systems of the licensees and applicants are subject to general approval by STUK. According to the Guide YVL A.3, any safety-significant revisions to the management system must be submitted for approval to STUK, but minor revisions are only submitted for information prior to their use. The verification of the licensee activities according to the management systems and regulatory requirements is carried out through continuous oversight, safety review and assessment as well as inspection programs established by STUK.

3.3.5 Article 6.1 (e) – Emergency procedures

According to Section 20 of Regulation STUK Y/1/2018, for operational occurrences and accidents, appropriate procedures for the identification and control of circumstances shall be available. Further requirements for operating procedures and guidelines are given in YVL Guide YVL A.6 “Conduct of operations at a nuclear power plant”. It is required that 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. The procedures and 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 operating nuclear power plants, procedures for anticipated operational occurrences and accidents are in use, as well as guidelines for managing severe accidents. STUK has independently evaluated the appropriateness and comprehensiveness of the procedures. The processes related to procedures (development, updating, validating, training etc) are inspected within the inspection programs. Exercises are arranged regularly. Considering multi-unit situations, in 2014 Loviisa NPP exercised for the first time a two unit’s simultaneous accident scenario and in 2016 TVO exercised for the first time accident scenario pertaining both operating NPP units and used fuel facility. See also discussion under articles 8d (1) and 8d (2).

STUK verifies the preparedness of the organisations operating nuclear power plants in yearly on-site inspections as well as supervising the licensee’s emergency training and exercises. Emergency preparedness at the Loviisa and Olkiluoto power plants meet the regulatory requirements.

3.3.6 Article 6.1 (f) – Financial and human resources of the licencee

The Nuclear Energy Act defines as a condition for granting a construction, operating or decommissioning license that the applicant has sufficient financial resources, necessary expertise and that the competence of the personnel is appropriate.

According to the Nuclear Energy Act, the licensee shall also have adequate financial resources to take care of the safety of the plant. 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. The financial preconditions are primarily assessed by authorities other than STUK (mainly MEAE). 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 organizational reforms, safety research conducted by licensees, the number of employees and the competence of personnel.

According the Nuclear Energy Act Section 7i the licensee shall have an adequate number of qualified personnel suitable for their tasks. The license holder shall arrange adequate training for maintaining and development of the expertise and skills of its personnel handling tasks relating to nuclear safety. According to the Nuclear Energy Act Section 7i the licensee shall ensure that contractors and subcontractors whose activities affect the nuclear safety of the nuclear facility have an adequate number of qualified and trained personnel suitable for the tasks.

According to Regulation STUK Y/1/2018, the licensee shall have a sufficient number of competent personnel suitable for the related tasks for ensuring the safety of the nuclear facility. Significant functions with respect to safety within nuclear power plants must be designated, and the competences of the persons working in such positions must also be verified. The operation of the organization shall be evaluated and continuously developed, and the risks associated with the organization's operation are to be evaluated regularly. The safety impacts of significant organizational changes are to be evaluated in advance.

STUK's Guide YVL A.4 "Organisation and personnel of a nuclear facility" gives further requirements for training, competence management and for qualifications of personnel working in functions that are important for plant safety. In this Guide there are specific requirements for positions, defined in the Nuclear Energy Act, i.e. responsible manager and persons responsible for nuclear safeguards, emergency arrangements and security arrangements and nuclear facility operators.

Personnel and human resources related issues are included in STUK's periodic and construction inspection programs at the nuclear power plants. The inspection "Human Resources and Competence" includes assessment of human resource management, competence development and training programs. It also covers the licensee's procedures for managing human resources and competence of suppliers.

3.4 Article 7 – Expertise and skills in nuclear safety

Member States shall ensure that the national framework requires all parties to make arrangements for the education and training for their staff having responsibilities related to the nuclear safety of nuclear installations so as to obtain, maintain and to further develop expertise and skills in nuclear safety and on-site emergency preparedness.

Concerning Licensee's Human Resources, see Article 6.1(f).

According to Section 53 of the Nuclear Energy Act, licensees shall be obliged to participate in financing research aimed at ensuring that, should new factors concerning safe operation of nuclear facilities emerge, the authorities have sufficient and comprehensive nuclear safety analysis capability, tools and faciliteis at their disposal. 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.

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 new NPP projects (Olkiluoto 3, Hanhikivi 1). 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 organization to STUK aim at maintaining and developing the human resources in the nuclear energy sector. Furthermore, the development of the educational resources in technical and other high-level university programs in Finland is also important.

In basic nuclear engineering education, the Ministry of Education and Culture has recognized the MSc in Nuclear Engineering programme in Lappeenranta University of Technology as a "National priority task" and has provided significant additional funding to this program since 2017.

The Nuclear Energy Act was amended in 2003 to ensure funding for a long-term nuclear safety and nuclear waste management research in Finland. Money is collected annually from the licence holders to a special fund. Regarding nuclear safety research the amount of money is proportional to the actual thermal power of the licensed power plants or the thermal power presented in the Decision-in-Principle. For the nuclear waste research, the annual funding payments are proportional to the current fund holdings for the future waste management activities. In 2016 the Nuclear Energy Act was amended and the temporary increase of the money collected to the nuclear safety research fund was introduced. The purpose of temporary increase of the research funding is to renew the ageing infrastructure for the nuclear energy related research. There are two national safety research programmes –SAFIR and KYT – to support and develop the competences in nuclear safety and waste management.

Finland also participates in international research activities, such as OECD/NEA/CSNI working groups, consortium which builds the Jules Horowitz research reactor in France, Scandinavian NKS research programme, EU

programmes, and bilateral co-operation with several countries. The Finnish technical support organisations are active parties of TSO organisations co-operation such as ETSON in Europe and IAEA TSO Forum.

During 2010–2012 a committee set up by Ministry of Economic Affairs and Employment 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, Ministry set up a working group to prepare the research strategy for the nuclear energy. The report was published by the Ministry at the end of April 2014. The recommendations were 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 linked with nuclear energy research and operation as a permanent expert body to support decision-making in national questions related to the nuclear energy.

As the initial report raised concerns about the limitations of national competencies and research infrastructure - a follow-up survey was conducted by the VTT in 2017–2018. The final report indicated that it is to be expected that sufficient number of professionals will be available in Finland in the future. However, in certain competence areas special attention should be paid to the training and introduction of new professionals. The change between two reports can be reasoned 1) by the development actions that were carried after the first initial report (e.g. recruitment programs, development of research infrastructure), 2) by the lowered personnel need estimates for 2030, The most significant difference in the operating environment of the forecasts of 2010 and 2017 is the termination of the Olkiluoto 4 project. The demand of personnel in 2030 was about 5% more than the number of personnel in 2017.

The final report of the follow-up survey can be found: http://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/161464/22_19_Survey_of%20_competence.pdf?sequence=1&isAllowed=y

3.4.1 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 emphasised in STUK's strategy. STUK's strategy highlights the importance of the ability to understand complex entities. This understanding is achieved through systematic development of regulatory competence. Implementation of the strategy is reflected into the STUK's systemic approach to capacity building including competence development, training programmes, on-the-job training and competence-driven workforce planning and recruitment profiles etc.

STUK's staff consist of a mixture of professionals in early, mid and late career stages. Vast majority of STUK's professional staff conducting safety assessments and inspections have a university level degree. On average, a staff member has about 15 years of nuclear related work experience. Many of the senior staff supports the professional growth of the younger generation by providing guidance, advise and training. On an average ~5% of the annual working time is used to competence development and professional growth.

Competence analyses and evaluations are carried out on regular basis in STUK and the results are used as an input for training and competence development programmes etc. The STUK's training programme includes internal courses as well as courses organised by other organisations. The personal development plans include various methods of competence development based on personal needs and targeted targets for personal growth.

An introduction training programme is prepared for all new recruited inspectors at STUK. In addition to administrative issues, the programme includes familiarisation with legislation, regulatory guidance and regulatory oversight practices. Furthermore, the programme includes general technical training. The introduction training programme is tailored to each new inspector and its implementation is followed by the supervisor of the newcomer.

The national nuclear safety and waste management research programmes play an important role in the competence building of the regulator – as well as other nuclear organisations in Finland. The research programmes have two important roles: 1) ensuring the availability of experts and 2) 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. Further information regarding the research programs can be found in chapter 3.3.

The basic professional training course on nuclear safety and safety of nuclear waste management is annually organised under coordination of Lappeenranta University of Technology, in cooperation between the various nuclear energy organisations in Finland. The course is an important part of training provided for STUK's new employees. The first national training course commenced in autumn of 2003. The

following 6-week course will commence in autumn of 2020. So far, about 1300 newcomers and junior experts, of whom about 110 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 – and also by reflecting the development and changes in the nuclear sector. STUK has an active role in development and steering of the course. Furthermore, a significant number of STUK experts act as lecturers of the training course.

3.5 Article 8 – Transparency

1. Member States shall ensure that necessary information in relation to the nuclear safety of nuclear installations and its regulation is made available to workers and the general public, with specific consideration to local authorities, population and stakeholders in the vicinity of a nuclear installation. That obligation includes ensuring that the competent regulatory authority and the licence holders, within their fields of responsibility, provide in the framework of their communication policy:

(a) information on normal operating conditions of nuclear installations to workers and the general public; and

(b) prompt information in case of incidents and accidents to workers and the general public and to the competent regulatory authorities of other Member States in the vicinity of a nuclear installation.

2. Information shall be made available to the public in accordance with relevant legislation and international instruments, provided that this does not jeopardise other overriding interests, such as security, which are recognised in relevant legislation or international instruments.

3. Member States shall, without prejudice to Article 5(2), ensure that the competent regulatory authority engages, as appropriate, in cooperation activities on the nuclear safety of nuclear installations with competent regulatory authorities of other Member States in the vicinity of a nuclear installation, inter alia, via the exchange and/or sharing of information.

4. Member States shall ensure that the general public is given the appropriate opportunities to participate effectively in the decision-making process relating to the licensing of nuclear installations, in accordance with relevant legislation and international instruments.

3.5.1 Article 8.1 (a) – Information on normal operation

The licence holders are obliged by the Nuclear Energy Act, Section 10 a, to keep a general description of the facility and the safety principles complied with available to the public.

All the facilities have comprehensive websites giving basic information about their facilities. The utilities also publish different reports on their websites, e.g. annual reports or environmental reports. They also regularly publish newsletters that are directed especially to people living in the area. Olkiluoto NPP has a visitor centre. Most of the information is available at least in Finnish, Swedish and English. Some reports may be available only in Finnish and Swedish.

The Decree on the Finnish Centre for Radiation and Nuclear Safety (618/1997) defines STUK’s tasks. One of the tasks is to inform about radiation and nuclear safety matters and participate on training activities in the area. STUK utilises many means to communicate with the public and interested stakeholders, such as meetings, seminars, and training courses. All these are tailored and targeted to different stakeholders and stakeholder groups. STUK’s website is also used to share

information. STUK has special interest 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. STUK publishes on its website oversight reports every four months, describing the performed oversight actions and the results. STUK also arranges meetings with local population and local media in the vicinity of the facilities.

STUK actively reports in its website on significant events that are either significant from the safety point of view or are seen of specific interest for the public and media. For the operating reactors the events are reported as soon as the information is available, and for larger ongoing plant projects and regular oversight every four months. The annual report on the oversight collects all this information, and also gives a wider view on regulatory oversight during the fiscal year with the STUK's views on the performance of the licensees. The information on the website is given in Finnish, but the main part of the annual report is translated in English, as well.

3.5.2 Article 8.1 (b) – Information in case of accidents

According to the Rescue Act (379/2011) licensee and regulator are obligated to co-operate with local rescue authority in preparing for and responding to any nuclear incidents and accident. Rescue authority shall prepare rescue plan with relevant counterparts and sharing of information to public shall be part of this plan. Main responsibility to share information on public protective actions rests with rescue authority, however authorities at governmental, provincial, and municipal level provide information on their own activities and give instructions regarding their own sphere of responsibility. National arrangements are coordinated according to normal responsibilities in different ministries. Ministerial permanent secretaries establish coordination group meetings where national level support will be organized.

In an accident situation the principal information route of warnings to the public is internet, TV and FM radio. 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. Additional mobile phone applications can also be used to share information.

Sharing information with neighboring countries is done according to IAEA Convention on Early Notification directly via USIE and IAEA IEC. In addition to this there is also EC requirements that are organized via ECURIE system. However, best practice among Nordic countries is to share information on any issues which might raise interest in other country in addition to more detailed list of events which are commonly agreed in a shared, joint agreement between Nordic Competent Authorities. This agreement is referred as "Nordic Manual" which is implementation agreement to our shared and commonly agreed protection strategy aka "Nordic Flagbook". There are also bi-lateral state agreements with neighboring countries on sharing information during emergencies. Countries involved in these agreements include all our neighboring countries and some others as well (Sweden, Norway, Denmark, Iceland, Russia, Estonia, Germany and Ukraine)

3.5.3 Article 8.2 – Overriding interests

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 it. The provisions on the secrecy of documents and information on the use of nuclear energy are set out in the Sections 24 and 30 of 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.

According to the Section 10 of the Nuclear Energy Act the license holder also has an obligation to keep certain general documents related to the safety of the plant available to the public, while taking into consideration above mentioned provisions on the secrecy of certain documents.

3.5.4 Article 8.3 – Information exchange with Member States

According to the STUK Decree (618/1997), one of the STUK's tasks is to participate international cooperation in the field of nuclear and radiation safety, security and safeguards, and to take care of any international oversight, contact point and reporting duties that has been authorized to STUK.

STUK is having regular meetings with the Swedish and Russian radiation and nuclear safety authorities SSM and Rostechnadzor (RTN). Cooperation with SSM is focused on topical issues related to the safety of nuclear power plants, oversight findings, and development of the regulations and regulatory functions. Cooperation with RTN has traditionally included topics related to safety of operating nuclear power plants and regulatory issues. During the recent years the cooperation has been expanded to also cover safety assessments of AES-2006 type VVER plants since four AES-2006 plant units are being built in Sosnovyi Bor in Russia (close to Finnish border) and one in Finland. STUK has also other bilateral cooperation especially with countries having similar nuclear power plant projects, i.e. French regulatory body ASN (EPR type NPP under construction) and Hungarian regulatory body HAEA (AES-2006 design).

Finland has bilateral agreements with Sweden, Norway, Russia, Ukraine, Denmark and Germany on early notification of nuclear or radiological emergencies and exchange of information on nuclear facilities. In addition, STUK has done bilateral arrangements with several foreign regulatory bodies, which cover generally the exchange of information on safety regulations, operational experiences, waste management etc.

Also, Multinational Design Evaluation Programme (MDEP) under OECD/NEA enables discussions with countries having similar types of NPPs under construction. STUK is participating the EPR and VVER design specific working groups and working group on supply chain inspections. In addition, STUK is actively participating in other international forums and working groups related to nuclear safety which enable also networking and cooperation with other regulatory authorities.

3.5.5 Article 8.4 – Participation of general public

As part of the licensing process, public hearings are organised and the public is asked for opinions on the license application. MEAE is responsible for the arrangements. The public hearings are arranged only at the Decision-in-Principle phase, but opinions from the public are asked for all licence applications. The applicant is reserved an opportunity to submit an explanation on the opinions expressed on the application. The obligation to provide the public the opportunity to give their opinion is included in the Nuclear Energy Act.

Public hearings, including international hearings are also arranged as part of the EIA process. Finland is a party to the Convention on Environmental Impact Assessment in a Transboundary Context, done in Espoo in 1991. The Convention is applied for Finnish nuclear facility projects by providing a full participation to all countries which announce the willingness to participate in the environmental impact assessment procedure in question. The Ministry of the Environment arranges the international hearing according to the Espoo Convention.

The public is also provided an opportunity to comment the regulations and regulatory guides prepared by STUK. The public participation is made possible through the website of STUK where the drafts for commenting are available.

3.5.6 Article 8a - Nuclear safety objective for nuclear installations

1. Member States shall ensure that the national nuclear safety framework requires that nuclear installations are designed, sited, constructed, commissioned, operated and decommissioned with the objective of preventing accidents and, should an accident occur, mitigating its consequences and avoiding:

(a) early radioactive releases that would require off-site emergency measures but with insufficient time to implement them;

(b) large radioactive releases that would require protective measures that could not be limited in area or time.

2. Member States shall ensure that the national framework requires that the objective set out in paragraph 1:

(a) applies to nuclear installations for which a construction licence is granted for the first time after 14 August 2014;

(b) is used as a reference for the timely implementation of reasonably practicable safety improvements to existing nuclear installations, including in the framework of the periodic safety reviews as defined in Article 8c(b).

3.5.7 Article 8a (1a & b) – Prevention of accidents and mitigating the consequences

According to the Nuclear Energy Act, the primary objective shall be the prevention of accidents. Any practical measures required shall be taken to manage accidents and mitigate the consequences thereof. The probability of an accident must be lower, the

more severe the consequences of such an accident would prove for people, the environment or property.

According to the Regulation STUK 1/Y/2018 the impact of local conditions on safety and on the implementation of the security and emergency arrangements shall be considered when selecting the site of a nuclear facility. The site shall be such that the impediments and threats posed by the plant to its surroundings remain extremely small and heat removal from the plant to the environment can be reliably implemented.

Nuclear Energy Decree sets the criteria for limiting the consequences of normal operation and accidents. The annual dose constraint for an individual member of the population public as a result of an anticipated operational occurrence shall be 0.1 mSv. The annual dose constraint for an individual the member of the population public shall be 1 mSv in the event of Class 1 postulated accidents, 5 mSv in the event of Class 2 postulated accidents and 20 mSv in the event of a design extension accident. The criteria for integrity of the containment, primary circuit and the nuclear fuel in normal operation and accidents are detailed in the YVL Guides B.4, B.5 and B.3. There are also probabilistic criteria defined in Guide YVL A.7 “Probabilistic risk assessment and risk management of a nuclear power plant”. The mean value of the frequency of reactor core damage is less than 10^{-5}/year and the criterion for a large release is described below.

With respect to the large or early releases, it is stated in the Nuclear Energy Decree that the release of radioactive substances as a result of a severe accident at a nuclear power plant shall not necessitate implementation of large-scale protective measures for members of the public or any long-term restrictions on the use of extensive areas of land and water. In order to limit the long-term restrictions, the limit for atmospheric release of caesium-137 shall be 100 terabecquerels. The possibility of exceeding the limit shall be extremely small. The possibility of a release occurring at an early phase of an accident and requiring population protection measures shall be extremely small.

In addition to this, there are further targets set in the YVL Guides, for example in YVL A.7 requirement 306: *A nuclear power plant unit shall be designed in compliance with the principles set forth in Section 22 b of the Nuclear Energy Decree (161/1988) in a way that a) the mean value of the frequency of a release of radioactive substances from the plant during an accident involving a cesium-137 release (Cs-137) into the atmosphere in excess of 100 TBq is less than 5·10 -7/year; b) the accident sequences, in which the containment function fails or is lost in the early phase of a severe accident, have only a small contribution to the reactor core damage frequency*. Guide YVL C.3 explains in more detail what is meant by the wording “large scale protective measures” in Nuclear Energy Decree. Analyses must be provided to demonstrate that any release of radioactive substances in a severe accident shall not warrant the evacuation of the population beyond the protective zone (appr. 5 km) or the need for people beyond the emergency planning zone (appr. 20 km) to seek shelter indoors.

Prevention and mitigation of accidents is implemented by following the Defense-in-Depth principle; this is described under the section concerning Article 8b(1).

3.5.8 Article 8a (2b) – New nuclear installations

2. Member States shall ensure that the national framework requires that the objective set out in paragraph 1:

(a) applies to nuclear installations for which a construction licence is granted for the first time after 14 August 2014;

The objectives set out in Article 8a are similar to WENRA's safety objectives for new reactors. The safety objectives were taken into account in the update of the regulatory guides in 2013.

No construction licenses for nuclear installations within the scope to this report have been granted after 14 August 2014. One application is under review. Fennovoima submitted its construction license application for a new NPP in June 2015. The updated requirements are valid for new plant projects as such as soon as they are published, so the new requirements apply to Fennovoima's project. The safety assessment of the construction license application is still ongoing because STUK has not yet received all the required licensing documentation. In the safety assessment, STUK will ensure compliance with the requirements.

3.5.9 Article 8a (2b) – Existing nuclear installations

Nuclear Energy Act requires maintaining safety of nuclear energy use as high as practically possible, and grading safety requirements and measures according to the risks in the use of nuclear energy. These principles are strongly considered as guiding the regulatory approach on the continuous improvement of nuclear safety. It has been noted that it is not possible to formulate comprehensive and unambiguous criteria for these guiding principles, and the reasonably practicable improvements and their timeliness have to be evaluated case by case. Thus, the regulation does not give further details on the subject. STUK follows closely the events and the international operational experience feedback, as well as the scientific and technological development through international contacts and national research program to be able to evaluate the aspects of reasonably practicability and timeliness of the improvements.

As stated in "WENRA Guidance Article 8a of the EU Nuclear Safety Directive: Timely Implementation of Reasonably Practicable Safety Improvements to Existing Nuclear Power Plants", there are many aspects that have to be taken into account when considering the implementation of a safety improvement in an operating reactor. These all are relevant in regulatory decisions by STUK. STUK also has followed the risk informed decision making in safety improvements, and many of the safety related plant modifications have been due to findings is the PRA in order to select the improvements that would improve the safety most.

The chapter 3.6.1 discussing Article 8a (1a &b) explained the requirements for mitigating consequences of severe accidents. Although the requirements described in the chapter are to be followed as such for the new NPPs in Finland, they are considered as goals for operating reactors, as well. The possible deviations from the new requirements are treated separately, and the licensees have to evaluate and

analyze reasonably practicable improvements with which the new requirements could be met.

As an example of reasonably practicable improvements, implementation of the severe accident management measures was carried out in the operating NPPs in 1980's and 1990's. Another example is implementation of safety improvements due to TEPCO Fukushima Daiichi accident that further enhance the plants' capabilities against extreme natural hazards. See more details about these safety improvements in the Finnish 8th national report for the Convention on Nuclear Safety. Report can be found here: https://www.iaea.org/sites/default/files/finland_nr-8th-rm.pdf.

3.5.10 Article 8b: Implementation of the nuclear safety objective for nuclear installations

1. In order to achieve the nuclear safety objective set out in Article 8a, Member States shall ensure that the national framework requires that where defence-in-depth applies, it shall be applied to ensure that:

(a) the impact of extreme external natural and unintended man-made hazards is minimised;

(b) abnormal operation and failures are prevented;

(c) abnormal operation is controlled and failures are detected;

(d) accidents within the design basis are controlled;

(e) severe conditions are controlled, including prevention of accidents progression and mitigation of the consequences of severe accidents;

(f) organisational structures according to Article 8d(1) are in place.

2. In order to achieve the nuclear safety objective set out in Article 8a, Member States shall ensure that the national framework requires that the competent regulatory authority and the licence holder take measures to promote and enhance an effective nuclear safety culture. Those measures include in particular:

(a) management systems which give due priority to nuclear safety and promote, at all levels of staff and management, the ability to question the effective delivery of relevant safety principles and practices, and to report in a timely manner on safety issues, in accordance with Article 6(d);

(b) arrangements by the licence holder to register, evaluate and document internal and external safety significant operating experience;

(c) the obligation of the licence holder to report events with a potential impact on nuclear safety to the competent regulatory authority; and,

(d) arrangements for education and training, in accordance with Article 7.

3.5.11 Article 8b (1) – Defence-in depth

The levels of defense in depth to be implemented in nuclear facilities are defined in the STUK Regulations. Regulation on the Safety of a Nuclear Power Plant (STUK Y/1/2018) applies to nuclear power plants and fuel storages. The regulations also set forth the requirements to provide for external hazards, both natural and man-made.

Regulations set requirements for the consecutive physical barriers. For nuclear power plants, in accordance with the functional defense-in-depth safety principle, the design of a nuclear facility must include the following levels of defense:

1. prevention to ensure that the operation of the nuclear facility is reliable and deviations from normal operating conditions are rare;
2. control of deviations from the nuclear facility's normal operating conditions so that the facility is equipped with systems which are able to limit the development of operational occurrences into accidents and if required can bring the facility into a controlled state;
3. control of accident situations so that the nuclear facility is equipped with systems that function automatically and reliably to prevent severe fuel damage in postulated accidents and in design extension conditions; manually actuated systems can be used to manage accident situations if it can be justified from a safety perspective;
4. confinement of a release of radioactive substances in severe reactor accidents by equipping the nuclear power plant with systems which ensure the sufficient leaktightness of the containment in severe reactor accidents so that the limits for releases in severe reactor accidents are not exceeded;
5. mitigation of the consequences by means of emergency arrangements to limit the public's exposure to radiation in situations where radioactive substances are released from the nuclear facility into the environment.

The levels of defense required under the defense-in-depth principle shall be as independent of one another as is reasonably achievable. Further, more detailed requirements on implementation of defence in depth are set in YVL guides, especially YVL B.1 "Safety design of a nuclear power plant". The design requirements for providing for external hazards are defined in YVL B.7, "Provisions for internal and external hazards at a nuclear facility".

Due to the TEPCO Fukushima Dai-ichi accident, the Finnish requirements have been supplemented by requiring that the plants must have equipment and procedures to ensure that decay heat from nuclear fuel in the reactor and in spent fuel pools can be removed for a period of 72 hours independent of external electricity and external water supplies in situations which are caused by rare external events (more severe than design basis conditions) or by a malfunction in the plant's internal electricity distribution system. These events are considered as design extension conditions and shall be coped with without severe fuel damage.

Mitigation of severe accident is required to be implemented as an independent level of defence as is stated above. YVL Guide B.1 and B.6 present more detailed requirements on the severe accident mitigation systems. The main principle is to implement systems independent of systems used for normal operation and

postulated accidents that fulfil the single failure criterion and are safety classified. The systems for severe accidents shall be autonomic for 72 hours.

Article 8a (1) f is described in the section concerning the Article 8d (1).

3.5.12 Article 8b (2) – Safety culture

The Nuclear Energy Act, Section 7j, requires that the management system of a nuclear facility shall take into account in particular the impact of the safety perceptions and attitudes of management and personnel on maintaining and development of safety, as well as systematic practices and their regular assessment and development. Section 25 of Regulation STUK Y/1/2018 sets a binding requirement for the licensees to maintain a good safety culture. It states that when designing, constructing, operating and decommissioning a nuclear power plant, a good safety culture shall be maintained, and it further specifies the following requirements: Safety shall take priority in all operations; The decisions and activities of the management of each organisation participating in the abovementioned activities shall reflect its commitment to operational practices and solutions that promote safety; Personnel shall be encouraged to perform responsible work, and to identify, report, and eliminate factors endangering safety; Personnel shall be given the opportunity to contribute to the continuous improvement of safety. Section 25 of Regulation STUK Y/1/2018 further requires that the licensee shall oblige the suppliers and subcontractors whose involvement affects the safety of the nuclear facility to adhere to the systematic management of safety and quality.

More specific regulatory requirements concerning safety culture, leadership and reporting, investigating and utilizing of operating experiences are given in the YVL Guides, A.3, A.4 and A.10, respectively. For the arrangements for education and training see Chapter 3.4 which covers the Article 7.

Safety is emphasised in STUK's Management System as well as in the framework contract between STUK and its technical support organisation VTT. STUK's Safety and Quality Policy was revised in 2018 to conform STUK's new strategy and to include STUK's data security policy. The policy includes expectation of a good safety culture at the regulatory body. STUK has taken an active role in this area and both developed its own culture and taken the initiative in the assessment of cultures of the licensee organisations. STUK has a safety culture development program which describes the means to monitor, assess and to develop the safety culture of the regulatory body. It includes a specific action plan for the next years. In 2018 a comprehensive independent assessment of STUK's safety culture was performed by external experts. Furthermore, in March 2019 STUK hosted together with the OECD NEA and WANO the Country-Specific Safety Culture Forum in Helsinki where personnel from the Finnish nuclear utilities and STUK discussed the country-specific culture traits and their possible influences on the nuclear safety culture. Report is published by the NEA. STUK arranges regularly training for the inspectors and an introduction programme is set up for all new recruited inspectors.

STUK carries out safety culture oversight by collecting and analysing observations from resident inspectors, documents, events and from other interactions with the licensee. STUK has implemented a tool for recording the observations. STUK also

conducts specific inspections focusing on Leadership and Safety culture. STUK also follows the licensees' safety culture self-assessments (e.g. results, possible changes in the methodology, actions decided based on the results). Furthermore, STUK has utilised VTT to carry out independent safety culture assessments in the licensee organisations.

The licence holders employ several different means for maintaining good safety culture. Priority of safety is emphasised in the safety or company policies. In addition to high level policy, all the Finnish licensees have safety culture programmes, road maps or development plans for implementing the measures for maintaining good safety culture. The licensees monitor the safety culture by regular surveys and in-depth assessments. They also have in their organisations groups or functions independent of the line organisation to oversee and discuss safety and safety culture matters. Corrective action groups or functions exist. Training – including safety culture topics – is given to all newcomers and also to contractors. The senior management participates in the safety culture related workshops and trainings. The safety significant contractors are required to familiarise their workforce with safety culture principles which is one of the topics of licensees' audits on contractors and suppliers.

3.5.13 Article 8b (2a) – Management systems

Please see the text under Article 6(d) for requirements regarding management systems of the licensees.

STUK's management system documents include safety and quality policy, description of the management system, organization and management, roles and responsibilities, personnel policy as well as description of processes and procedures. The management system is built according to IAEA requirements. The results of management reviews, internal audits, self-assessments and international evaluations are used as lessons learned and inputs for the continuous improvement of the management system at STUK.

STUK's departments for regulation of nuclear facilities have recently developed their internal procedure and a supporting tool further to improve regulatory processes and functions based on regulatory experience gathered from various sources. These have been applied since the beginning of 2019 and the experiences seem promising. In the future, the established procedure will be further developed e.g. including practices for sharing the lessons learnt with interested parties.

3.5.14 Article 8b (2b) – Operating experience

The Nuclear Energy Act provides that operating experiences of a nuclear facility shall be systematically monitored and assessed. STUK Regulation (STUK Y/1/2018) requires further that also operating experience from other nuclear facilities, the results of safety research and technical developments shall be regularly monitored and assessed, and safety-significant operational events shall be investigated for the purpose of identifying the root causes as well as defining and implementing the corrective measures. More detailed requirements are laid down in YVL Guide A.10.

The licensees have developed the required procedures for analysing operating experiences and root causes for events. The licensees are using WANO and IRS reports as basic material to be screened for external OEF and they have OEF groups for screening, analysing of OE entry into processing and following the corrective actions. The licensees have also their internal audit programme and OEF is one topic in these programmes.

STUK verifies by means of inspections and by reviewing licensee's event reports that the activities of the licensees as regards incident evaluation are effective. In STUK's periodic inspection programme there is inspection focusing to OEF, namely "Operational experience feedback". When necessary, a special investigation team is appointed by STUK to evaluate a certain incident or group of incidents. The evaluation of foreign operational occurrences and incidents is based on the reports of the IRS Reporting System (IAEA/NEA) and on the reports of other national regulatory bodies.

3.5.15 Article 8b (2c) – Reporting events

Regulatory requirements for notification of events and reporting are given in STUK's Regulatory Guide YVL A.10. The licensee shall promptly notify STUK of any events affecting the nuclear or radiation safety of a nuclear facility by calling STUK's 24h emergency number and include such events in the next daily report. Even events that do not directly affect nuclear or radiation safety but may be anticipated to arouse public interest shall be notified following the same procedure.

In the event review by STUK, the safety significance of the event is first evaluated based on the information given by the operator and STUK´s resident inspectors. Later, the licensee submits an event report to STUK for review.

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.

3.5.16 Article 8b (2d) – Education and training

Please see discussion regarding Article 7.

3.5.17 Article 8c: Initial assessment and periodic safety reviews

Member States shall ensure that the national framework requires that:

(a) any grant of a licence to construct a nuclear installation or operate a nuclear installation, is based upon an appropriate site and installation-specific assessment, comprising a nuclear safety demonstration with respect to the national nuclear safety requirements based on the objective set in Article 8a;

(b) the licence holder under the regulatory control of the competent regulatory authority, re-assesses systematically and regularly, at least every 10 years, the safety of the nuclear installation as laid down in Article 6(c). That safety reassessment aims at ensuring compliance with the current design basis and identifies further safety improvements by taking into account ageing issues, operational experience, most recent research results and developments in international standards, using as a reference the objective set in Article 8a.

3.5.18 Article 8c (a) – Construction and operating licence assessment

The requirements concerning siting, design, construction and operation are laid down in the Nuclear Energy Act, in the STUK Regulations and YVL Guides. The requirements are in line with the safety objective set in Article 8a.

The Regulation STUK Y/1/2018 requires that *the impact of local conditions on safety and on the implementation of the security and emergency arrangements shall be considered when selecting the site of a nuclear facility. The site shall be such that the impediments and threats posed by the plant to its surroundings remain extremely small and heat removal from the plant to the environment can be reliably implemented*. More detailed requirements are laid out in YVL Guide A.2 “Site for a nuclear facility”. Preliminary assessment of the site is made by STUK in the Decision-in Principle Phase. In construction license phase, thorough assessment of compliance with the requirements is performed. The site related issues are also considered in operating and decommissioning license evaluations and in periodic safety reviews and also between the licensing steps if new information affecting the site suitability emerges.

No construction licenses for nuclear installations within the scope to this report have been granted after 14 August 2014. One application is under review. Fennovoima submitted its construction license application for a new NPP in June 2015. The safety assessment of the construction license application is still ongoing because STUK has not yet received all the required licensing documentation.

Additional site investigations were deemed necessary by Fennovoima due obscurities found in the geological site investigations. Fennovoima started the additional investigations based on its own studies on how the site geological investigations were managed and conducted and on correspondence from STUK. The results of the additional investigations have been discussed in meetings between Fennovoima and STUK, site investigations have been finalized and corresponding PSAR chapter has been submitted to STUK for review. STUK is using geologist from University of Turku as external experts in evaluating the results and the conclusions. In its evaluation by now, STUK has raised questions regarding consideration of the fragmented rock zones in the layout of the safety-related buildings and structures and in determining their design bases.

Olkiluoto 3 was granted operating license in March 2019. Based on the safety assessment, STUK concluded that the Olkiluoto 3 nuclear power plant unit has been designed to comply with the requirements on the nuclear safety and radiation safety of plants during operation. The defence-in-depth principle has been observed in the design. The principles of redundancy, diversity and separation have been observed

as a part of the defence-in-depth principle in the design of systems performing safety functions. Various internal and external hazards have also been taken into account in the design. Preparing for severe reactor accidents has been the design basis of the Olkiluoto 3 nuclear power plant unit. The nuclear power plant unit has been designed to have independent systems for bringing it to a safe state after a severe reactor accident and to guarantee the integrity and leak-tightness of the containment. When the containment remains leak-tight, releases are minor and the accident will not necessitate protective measures outside the plant area in the early stages, large-scale protective measures later on nor long-term restrictions on the use of land or water areas. According to probabilistic risk assessment, the probability of failure to accomplish the aims described above is extremely low. The complete safety assessment report by STUK is available in https://www.stuk.fi/documents/88234/0/OL3_Safety_Assessment_2019.pdf/82346e94-7dc1-ca75-c4df-7f638fd14f6d?t=1569913169507.

3.5.19 Article 8c (b) – Periodic safety review every 10 years

Section 7e “Verification and assessment of safety” of the Nuclear Energy Act requires that compliance with the requirements concerning the safety of a nuclear facility shall be reliably proven and that the overall safety of a nuclear facility shall be assessed at least at 10-year intervals (15-year intervals for a facility performing large-scale disposal of nuclear waste).

STUK makes its own safety assessment based on the licensee’s Periodic Safety Review and sets the requirements on safety improvements with the expected schedule, as needed. STUK’s statement on the Periodic Safety Review is needed always when a license renewal application is under evaluation.

The latest PSR of Loviisa NPP was submitted to STUK in 2015, and that of Olkiluoto NPP in 2016 as part of the license renewal application. STUK finalized its assessments on these in 2017 and 2018, respectively.

- STUK's safety assessment on Loviisa PSR in 2017
  - Safety assessment: https://www.stuk.fi/documents/88234/254201/1694438-stuks-assessment-on-loviisa-npp-periodic-safety-review-safety-assessment.pdf/05543da6-3dd2-2a79-f8b8-7ddb9ba4d8bd
  - Decision: https://www.stuk.fi/documents/88234/254201/1694439-stuks-decision-concerning-the-loviisa-npp-periodic-safety-review.pdf/1a1beb6c-9ae8-cd0b-0c6e-c001e7452ac9
- STUK’s safety assessment on Olkiluoto unit 1 and 2 PSR and statement on the application for a renewal of the operating license in 2018
  - Safety assessment: https://www.stuk.fi/documents/88234/254201/1801235-stuks-assessment-on-olkiluoto-1-2-npp-periodic-safety-review-safety-assessment.pdf/e7e0f675-93e5-251a-3d9a-ebe3674955a0
  - Statement: https://www.stuk.fi/documents/88234/254201/1794809-stuks-statement-on-

the-operating-license-of-olkiluoto-1-2-npp.pdf/7d01233f-da39-63f9-fa47-21da81eea444

Ageing management is an integral part of the PSR, as it is needed to ensure the safe operation of the NPPs during the upcoming period until the next PSR at least.

In sections 12.2 and 12.3 of STUK's safety assessment on Loviisa NPP PSR:

Based on the conclusions in its periodic safety review, Fortum states it will pay special attention to the following during the upcoming operating licence period:

[…]

- *the ELSA [I&C renewal] project and managing the service life of I&C and electrical equipment (LARP programme)*
- *completing the on-going projects to improve safety (e.g., ensuring fuel pool cooling, improving the storage and availability of diesel fuel, improving flood protection, securing secondary-circuit safety functions, and updating the steam generator safety valves)*
- *lifting of heavy objects and related changes*

[…]

- *developing Human Performance (HuP) methods*

[…]

STUK will monitor the timely and compliant implementation of Fortum's safety-improving methods.

In section 12.2 of STUK's safety assessment on Olkiluoto PSR:

Based on its periodic safety review, TVO has presented an action plan to improve safety. Safety-related development targets include the following:

[…]

- *completing the on-going projects to improve safety (e.g. updating the emergency diesel generators, updating the main circulation pumps and their frequency converters, feeding of high- and low-pressure water into the reactor, applying the diversity principle to the reactor level measurement trips and decay heat removal, modifying the auxiliary feedwater system's circulation line as well as projects and spare parts changes in accordance with the ELMA programme)*

[…]

- *planning and implementing plant modifications concerning the KPA storage.*

STUK monitors the progress of the development measures and modification as part of its control activities.

Regarding to Olkiluoto PSR, the most significant requirement by STUK concerned the pressure test of the primary circuit. At the Olkiluoto 1 and 2, the primary circuit's periodic pressure test has not been performed after the commissioning, instead a tightness tests (1.02 x operating pressure) have been performed. When the pressure test was originally replaced with a tightness test compliant with ASME XI, it was not known that the service life of the plant units would be longer than 40 years. For this reason, STUK required that a periodic pressure test conducted every eight year at the maximum allowable operating pressure must be performed. The purpose of the pressure test is to demonstrate through tests that the known or any possible latent ageing mechanisms have not weakened the integrity of the primary circuit once the plant units have reached their original design life span.

Regarding to Loviisa PSR, the most significant issue raised by STUK during the review concerned the brittle fracture risk of the reactor pressure vessel. STUK required clarification of the possible technical means and/or changes to operating methods that would achieve a substantial improvement in the level of safety to reduce the brittle fracture risk of the reactor pressure vessel.

3.5.20 Article 8d: On-site emergency preparedness and response

1. Without prejudice to the provisions of the Directive 2013/59/Euratom, Member States shall ensure that the national framework requires that an organisational structure for on-site emergency preparedness and response is established with a clear allocation of responsibilities and coordination between the licence holder, and competent authorities and organisations, taking into account all phases of an emergency.

2. Member States shall ensure that there is consistency and continuity between the on-site emergency preparedness and response arrangements required by the national framework and other emergency preparedness and response arrangements required under Directive 2013/59/Euratom

3.5.21 Article 8d (1) – Emergency preparedness

Regulations concerning emergency preparedness and response arrangements at the NPPs are given in the Nuclear Energy Act, the Nuclear Energy Decree and the STUK Regulation on the Emergency Arrangements of a Nuclear Power Plant (STUK Y/2/2018). Detailed requirements and STUK's oversight procedures are given in the Guide YVL C.5 "Emergency Arrangements of a Nuclear Power Plant". This updated Guide was published on 20 January 2020. The Guide YVL C.5 contains the detailed requirements concerning the tasks and responsibilities of the licence holder's emergency response organisation.

In connection to the renewal of radiation legislation the Council Directive 2013/59/Euratom as well as the Council Directive 2014/87/Euratom has been implemented. The new regulations affecting the Emergency Arrangements are the Radiation Act, Government Decree on Ionizing Radiation and Ministry of Social Welfare and Health's Decree on Ionizing Radiation. Also, the Nuclear Energy Act was updated accordingly.

Regulation STUK Y/2/2018 states that the licence holder's management system and organisation shall ensure maintenance and development of the emergency arrangements. A person responsible for emergency arrangements has been appointed both for the Loviisa and Olkiluoto nuclear power plants. The Regulation also states that the licence holder shall have a management system and organisation in place to ensure a timely response in an emergency situation. The tasks of people assigned to act during an emergency situation are to be defined in advance. The licence holder shall ensure that the personnel needed in emergency situations are promptly available. There shall also be enough personnel to bring a long-term emergency situation under control.

The Section 9 of the Nuclear Energy Act states that the licence holder shall be under an obligation to ensure the safe use of nuclear energy. This obligation may not be delegated to another party. It shall be the licence holder's obligation to carry out such security and emergency arrangements and other arrangements necessary for the limitation of nuclear damage which do not rest with the authorities.

According to the Regulation STUK Y/2/2018 the licence holder is in charge of matters related to nuclear safety and radiation safety at the nuclear power plant. In an emergency situation, the emergency manager of the nuclear power plant, as specified in the emergency plan, shall initiate and direct the work of the emergency response organization at the power plant. The nuclear power plant's emergency manager issues recommendations for protecting the public to the director of rescue operations, until STUK announces responsibility for issuing such recommendations. The nuclear power plant's emergency manager shall ensure that personnel who are familiar with nuclear safety and radiation safety are designated to assist the director of rescue operations.

Chapter 5 of the Rescue Act describes the responsibilities of director of rescue operations. According to Section 48 of the Rescue Act the regional rescue service shall, in co-operation with the licence holder, prepare an external rescue plan for nuclear facilities.

The Ministry of the Interior's Decree 1286/2019 contains detailed requirements for the external rescue plan. According to the decree, the regional rescue service shall arrange full scale emergency exercises every three years in co-operation with the licence holder and authorities. In addition to this, the licence holder shall arrange exercises on a yearly base as stated in the Regulation STUK Y/2/2018. The emergency 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 exercises also included conditions classified as alert. These exercises have contained also multi-unit scenarios and scenarios which combine illegal activities and a technical emergency situation at the plant. In the end of the year 2020 a long-lasting full-scale emergency exercise is to be arranged in Olkiluoto.

The Ministry of the Interior's Decree 774/2011 contains the detailed requirements for informing the radiation emergency situations both beforehand and during the emergency.

STUK's Preparedness Guides VAL1 and VAL2 gives the guidance for protective actions during the early and intermediate phases of the radiation emergency situation. The renewal of these guides is now going on.

3.5.22 Article 8d (2) – Consistency of emergency arrangements

Based on the Council Directives 2013/59/Euratom and 2014/87/Euratom a few new requirements are set.

- Qualified Radiation Protection Expert (RPE) shall advise the licence holder in questions regarding the preparedness and response in emergency exposure situations. The RPE role is new in Finland in the use of nuclear energy and the arrangements for the recognition of the RPE are implemented newly. The amount of qualified RPEs in the use of nuclear energy is accounted to be sufficient at the moment.
- Reference levels instead of earlier dose limits are set for emergency occupational exposure in the Government Decree 1034/2018. According to Radiation Act, the exposure of emergency workers and helpers should be kept below the limits of radiation workers (20 mSv/a). In situation where this is not possible, the reference levels specified in the Government Decree 1034/2018 are used. The reference levels in the decree for emergency workers and helpers is 100 mSv/a. In exceptional situations in order to save life, prevent severe radiation-induced health effects, or prevent the development of catastrophic conditions 500 mSv/a.
- Licence holders shall according to the Regulation STUK Y/2/2018 be prepared for receiving external assistance in an emergency situation. The assistance can be either human resources or material. The necessary arrangements shall be defined and e.g. during the Loviisa-19 full scale emergency exercise, the logistical arrangements and just-in-time training to the emergency workers and helpers was exercised.

STUK reviews and accepts the licence holder's emergency plans as stated in the Nuclear Energy Act. STUK also verifies the preparedness of the organisations operating nuclear power plants in yearly on-site inspections belonging to STUK's periodic inspection programme. The content and scope of the emergency training as well as feedback obtained from the training are assessed in these inspections. During the emergency exercises STUK oversees and assess the licence holder's activities.

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.

In the Ministry of the Interior's publication "Guide for radiation situations" (10/2016, issued in Finnish only) the responsibilities and tasks of all actors in a radiological emergency are described. A permanent working group has been established to keep this guide up to date.

3.5.23 Article 8e: Peer reviews

1. Member States shall, at least once every 10 years, arrange for periodic self-assessments of their national framework and competent regulatory authorities and invite an international peer review of relevant segments of their national framework and competent regulatory authorities with the aim of continuously improving nuclear safety. Outcomes of such peer reviews shall be reported to the Member States and the Commission, when available.

2. Member States shall ensure that, on a coordinated basis:

(a) a national assessment is performed, based on a specific topic related to nuclear safety of the relevant nuclear installations on their territory;

(b) all other Member States, and the Commission as observer, are invited to peer review the national assessment referred to in point (a);

(c) appropriate follow-up measures are taken of relevant findings resulting from the peer review process;

(d) relevant reports are published on the above-mentioned process and its main outcome when results are available.

3.5.24 Article 8e (1) – Periodic self-assessment

In 2000, STUK invited IAEA International Regulatory Review Team (IRRT) for peer reviewing its regulatory activities. The follow-up mission was conducted in 2003. IRRT mission has been replaced by IRRS mission (Integrated Regulatory Review Service) which was conducted in Finland in 2012 (follow-up in 2015). In 2009 STUK organized a Peer Review of STUK's waste management related activities and conducted the first self-assessment of a kind. All EU member states were invited and representatives from 11 countries participated in the peer review. Security arrangements were peer reviewed in IPPAS in 2009 (follow-up in 2012). The documents related to the missions can be found through this link: https://www.stuk.fi/web/en/about-us/international-reviews-of-stuk-s-operations. In addition, STUK has conducted regular self-assessments related to relevant topics such as leaning and measuring processes and safety culture.

The next IRRS mission will be carried out in 2022. Also, ARTEMIS mission will take place in 2022. An IPPAS mission will take place in 2021. Emergency preparedness arrangements will be peer reviewed in EPREV mission in 2023. In the preparatory phase STUK will carry out a comprehensive self-assessment and an action plan for improvement will be based on the results of these missions and the related self-assessment. The actions will be included in STUK's strategy and annual plans.

3.5.25 Article 8e (2) – Topical peer reviews

Finland participated in the Topical Peer Review (TPR) "Ageing Management" under the Nuclear Safety Directive 2014/87/EURATOM, carried out in 2017–2019. The overall conclusion was that the ageing management has been satisfactory.

However, some challenges and areas for improvement, as well as good practices, were identified.

The most important areas for improvement are related to ageing management during extended periods when an NPP unit is out of service. This may happen if the construction time or outage is much longer than expected. One component level issue is inspectability of concealed pipework. However, surveillance of their integrity was considered adequate. Other areas of improvement are proactive ageing management, consolidation of ageing management data base and elaboration of Time Limited Ageing Analyses. Furthermore, realising the importance of ageing management aspects in design (e.g. inspectability and maintainability) in the new build projects were identified as challenges.

Further studies and additional information received during preparation of the action plan led to the following additional actions concerning the Ageing Management Programs (AMPs) of the licensees:

- further development of AMPs by itemizing individual SSCs or SSC groups and specifying the actions for them as well as reporting on long-term trends in defects/failures operability etc.;
- preparing separate AMP for cables (if not already existing).

The peer review also noted some good practices, like interdisciplinary ageing management working groups established by the licensees, the concept of maintenance categories and STUK's periodic inspection programme, and Finland's active participation in international peer reviews, such as SALTO and OSART coordinated by IAEA.

Relating to the recognized areas for improvement STUK prepared a national action plan together with the utilities and delivered it to ENSREG in September 2019. In future, topical peer review will be organized every 6years and planning of the next review has already been started by collecting feedback from the first peer review experiences.

A description of the TPR process is found here (link):
http://www.ensreg.eu/eu-topical-peer-review

The result material including the final reports is found here (link):
http://www.ensreg.eu/eu-level-reports

The national assessment report of Finland is found here (link):
http://www.ensreg.eu/country-specific-reports/EU-Member-States/Finland

The national action plan of Finland is found here (link):
http://www.ensreg.eu/tpr-national-action-plans/EU-Member-States/Finland

List of acronyms and abbreviations

AIO	Authorised Inspection Organisation
BSS	Basic Safety Standards Directive, 2013/59/ Euratom
BWR	Boiling water reactor
CSNI	Committee on the Safety of Nuclear Installations
DiP	Decision-in-Principle
EIA	Environmental Impact Assessment
ENSREG	European Nuclear Safety Regulators Group
EPR	European Pressurized water Reactor
ETSON	European Technical Support Organisation Network
Fennovoima	Finnish nuclear power company Fennovoima Oy
Fortum	Finnish nuclear power company Fortum Power and Heat Oy
FSAR	Final Safety Analysis Report
IAEA	International Atomic Energy Agency
IEC	Incident and Emergency Centre (IAEA)
IPPAS	IAEA's International Physical Protection Advisory Service
IRRS	IAEA's Integrated Regulatory Review Service
MDEP	Multinational Design Evaluation Programme
MEAE	Ministry of Economic Affairs and Employment
NPP	Nuclear power plant
NRR	Department of Nuclear Reactor Regulation
OECD/NEA	Organisation for Economic Co-operation and Development / Nuclear Energy Agency
OSART	Operational Safety Review Team
PRA	Probabilistic risk assessment
PSAR	Preliminary Safety Analysis Report
PSR	Periodic safety review
PWR	Pressurised water reactor
RDS	Radio Data System
RPE	Radiation Protection Expert
SAFIR	Finnish nuclear safety research programme
SALTO	Safety Aspects of Long-Term Operation
STUK	Finnish Radiation and Nuclear Safety Authority
TPR	Topical Peer Review
TSO	Technical Support Organisation
TVO	Finnish nuclear power company Teollisuuden Voima Oyj
USIE	Unified System for Information Exchange in Incidents and Emergencies
WENRA	Western European Nuclear Regulators' Association
VTT	Technical Research Centre of Finland
VVER	Water-Water Power Reactor, Russian PWR
YVL Guide	Finnish regulatory guide for nuclear safety

List of references

Decision by the Radiation and Nuclear Safety Authority on the periodic safety review of Loviisa NPP (2017): https://www.stuk.fi/documents/88234/254201/1694439-stuks-decision-concerning-the-loviisa-npp-periodic-safety-review.pdf/1a1beb6c-9ae8-cd0b-0c6e-c001e7452ac9

Finlex: STUK Regulations in Finnish and Swedish, https://www.finlex.fi/fi/viranomaiset/normi/555001/

Finnish report on nuclear safety, Finnish 8th national report as referred to in Article 5 of the Convention on Nuclear Safety, July 2019, https://www.iaea.org/sites/default/files/finland_nr-8th-rm.pdf

International Evaluation of the Research Activities of the Finnish Radiation and Nuclear Safety Authority (Wolfgang Weiss, 2012), Reports and memorandums of the Ministry of Social Affairs and Health, https://www.stuk.fi/web/en/about-us/international-reviews-of-stuk-s-operations.

Report of the Committee for Nuclear Energy Competence in Finland, Publications of the Ministry of Employment and the Economy 14/2012, https://tem.fi/documents/1410877/3437250/Report+of+the+Committee+for+Nuclear+Energy+Competence+in+Finland+23052012.pdf

Safety assessment by the Radiation and Nuclear Safety Authority of the Olkiluoto 1 and 2 nuclear power plant units and the KPA, KAJ, MAJ and component storages (2018): https://www.stuk.fi/documents/88234/254201/1801235-stuks-assessment-on-olkiluoto-1-2-npp-periodic-safety-review-safety-assessment.pdf/e7e0f675-93e5-251a-3d9a-ebe3674955a0Safety assessment by the Radiation and Nuclear Safety Authority of the operating licence application for the Olkiluoto 3 nuclear power plant unit (2019): https://www.stuk.fi/documents/12547/8995921/Sateilyturvakeskuksen_turvallisuusarvio_Olkiluoto_3_kayttolupa_englanti.pdf/eb3b95c4-9a60-ff5e-9d0b-0521e1bf8605

Safety assessment by the Radiation and Nuclear Safety Authority on the periodic safety review of Loviisa NPP (2017): https://www.stuk.fi/documents/88234/254201/1694438-stuks-assessment-on-loviisa-npp-periodic-safety-review-safety-assessment.pdf/05543da6-3dd2-2a79-f8b8-7ddb9ba4d8bd

Safety assessment by the Radiation and Nuclear Safety Authority of Posiva's construction licence application (2015): https://www.stuk.fi/documents/88234/963503/stuk_safety_assessment_of_posiva_construction_application.pdf/b01e5c91-2944-4d8a-a5dd-0d9b48a2b509?t=1444844110542

Statement by the Radiation and Nuclear Safety Authority on the operating licence of the Olkiluoto 1 and 2 nuclear power plant units (2018): https://www.stuk.fi/documents/88234/254201/1794809-stuks-statement-on-the-operating-license-of-olkiluoto-1-2-npp.pdf/7d01233f-da39-63f9-fa47-21da81eea444

Statement by the Radiation and Nuclear Safety Authority on the operating licence of the Olkiluoto 3 nuclear power plant unit (2019): https://www.stuk.fi/documents/12547/8995921/OL3_lausunto_TEMille_englanti.pdf/4f0a519e-b414-0925-9b3f-a454aeda55c7

Stuklex: STUK Regulations in English: https://www.stuklex.fi/en/maarays

Survey of Competence in the NUCLEAR Energy Sector 2017–2018 in Finland, Publications of the Ministry of Economic Affairs and Employment, 2019:22, http://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/161464/22_19_Survey_of%20_competence.pdf?sequence=1&isAllowed=y

Topical Peer Review: Report (October 2018), Country Findings (October 2018) and Action plan (November 2019), http://www.ensreg.eu/eu-level-reports

Topical Peer Review: The national assessment report of Finland (December 2017), http://www.ensreg.eu/country-specific-reports/EU-Member-States/Finland

Topical Peer Review: The national action plan of Finland (September 2019) http://www.ensreg.eu/tpr-national-action-plans/EU-Member-States/Finland