Independent evaluation of nuclear power plant project safety

Looking at examples in Hungary and Finland

This report was prepared for Greenpeace

June 2018

Nikolaus Arnold

Klaus Gufler

Michael Kraxberger

Nikolaus Müllner

I S R

Institut für Sicherheits- und Risikowissenschaften

Universität für Bodenkultur Wien

Table of Contents

List of Figures

List of Tables

Summary

The decision of a country to construct nuclear power plants (NPP) is hardly ever a decision based on consensus in the population. While advocates of civil use of nuclear energy see the possibility of electricity production at low carbon emission costs, opponents point to the large quantities of highly radioactive materials that are produced during operation of a nuclear power plant NPP and to the fact that a catastrophic accident, releasing part or the entire radioactive inventory, cannot be fully excluded. So a political decision for or against the use of nuclear power has to be taken on governmental level. While this general decision is taken at a very high level, the decision to permit construction of a specific nuclear power plant is usually managed by an independent governmental expert organization, the regulatory authority. In the past, such decisions on NPP projects were often taken following the DAD-principle – decide, announce, defend. However, nowadays "stakeholders", i.e. persons or organizations that can argue that they might be affected, should be involved in the decision making process.

For the present analysis, a method was developed which enables a stakeholder, but not the regulatory authority, NPP vendor, or utility company, to derive a statement on the safety of the NPP project. The analysis focused on the NPP design, together with its regulatory infrastructure. In total 15 requirements for the regulatory infrastructure and 67 requirements for the NPP design were derived. Each requirement was evaluated according to two categories: transparency, in the sense of "is information on this requirement publicly available" and "is the information presented in a way that the relevant message can be accessed with limited resources", and second, fulfillment of the technical content of the requirement. The method was then applied to two NPP projects, the project Paks II in Hungary, and the project Hanhikivi in Finland, together with their regulatory infrastructures. Both projects are based on the same NPP design a VVER-1200 and are currently in a similar phase of construction. While the Finnish project is in the phase of construction license application, in Hungary it is expected for the second half of 2018. However, in neither case a final design specification is publicly available, since the licensing process is currently ongoing. Therefore, the requirements on the NPP design imposed by the Finnish Radiation and Nuclear Safety Authority (STUK) and by the Hungarian Atomic Energy Authority (HAEA) were evaluated. In theory, an operating license should only be issued if a design corresponds to the requirements of a regulatory authority. However, experience shows that the question "does a specific safety system fulfill the requirements" is subject to debate. Therefore, the design information should be made public, once it is available, and the present analysis may be repeated with the actual design.

The analysis did identify a number of questions. For one, HAEA is required by law to respond to submissions of the licensee within a strict time limit: Act CXL/2004 prescribes time limits for the regulatory body to complete various authorization processes. Such limits on the regulatory authority are rarely found in international context. There are open questions on the consequences of such a time limits - there are examples of projects where unforeseen questions regarding safety might took years to resolve. How such a situation would be handled if there is a fixed time frame remains to be seen. The prescribed time limits may lead to undue pressure on the regulatory body to complete its decision-making process and thus compromise safety. STUK, the regulatory authority of Finland, can evaluate without such constraints. Another question regarding HAEA regards the information provided on staffing. While total staff numbers are provided, information how the staff is divided among divisions and units is missing (an information present at STUK). A definite answer on how many regulators are responsible for licensing of Paks II is therefore uncertain. Regarding the design specifications there is one issue, which regards both projects. The fact that the final design specifications are published only after the permit by the regulatory authority (if at all) makes an

independent evaluation of the actual design impossible. The check that was performed in this study, the national design requirements for new plants against international standards, cannot be a full substitute. The comparison of national standards against international showed that almost all IAEA requirements on design that were looked at could be found as well in national legislation in both countries. However, the requirement on aircraft crash in Hungary leaves room for interpretation on the size of the aircraft. Finish regulation (and WENRA common positions on new reactors) specify that the intentional crash of a commercial airplane should be considered in the design.

Introduction

The decision of a country to construct nuclear power plants (NPP) is hardly ever a decision based on consensus in the population. While advocates of civil use of nuclear energy see the possibility of electricity production at low carbon emission costs, opponents point to the large quantities of highly radioactive materials that are produced during operation of a nuclear power plant and to the fact that a catastrophic accident, releasing part or the entire radioactive inventory, cannot be fully excluded.

In the end, the decision to make use of nuclear power or not is a political one. Engineers can reduce the risk of a nuclear power plant by using high quality components, large operational margins, and safety systems. However, as long as radioactive fission and activation products are accumulated during operation, there is a non-zero probability that those fission products cannot be contained at the NPP. They could be released, dispersed, and contaminate large areas of land. Society must decide whether it is willing to take this “residual risk” and embark on a nuclear power project, or not. Scientists can support the decision by providing as much information as possible as well as providing their judgment. Nevertheless, the final decision has to be taken by the sovereign, the people, who will reap the benefits of a nuclear generated electricity and bear the consequences of a nuclear catastrophe.

Now while the principal decision on nuclear energy use and acceptable risk is taken on high level of government, the decision whether a specific nuclear power plant project adheres to the general principles laid out in the atomic law is taken by the regulatory authority of a country, an independent governmental body with the task to ensure that the risk from a nuclear power plant stays within the permitted limits over its whole lifetime. In the past decisions of said authority on permits for new builds followed the DAD principle – Decide, Announce, Defend. The authority, backed by its experts, takes the decision, which is then merely communicated to the public. But following decades of strong and even violent protests against nuclear power plant projects, transport of radioactive materials, projects for interim storage and final storage of radioactive waste, there is a change in approach (OECD/NEA 2015b, 2015a). Nowadays there is a push on international as well as national level to involve “stakeholders” in the decision making process. There are different definitions of stakeholder in various contents, but the broad meaning is that people, who want to engage in the decision making process and who can argue that they might be affected by the project, should be allowed to get involved. They might even be citizens of another country. EU legislation, international conventions (Arhus, Espoo) and also IAEA safety standards (e.g. (IAEA 2016c)) even legally entitle citizens to be involved. However, as past projects and consultations showed, such involvement does not happen on a level playing field. Once regulatory authority and the utility company reached a consensus, other stakeholders simply lack resources in every field to compete: in depths technical knowledge, access to the design information of the project, financial resources to dedicate time to go deeply into the project, or to commission independent expert organizations to give their judgment.

The present project aims to support stakeholders other than regulatory authority and utility in the early phase of a new NPP project, by developing a method that allows making a statement on the residual risk that will likely stem from the NPP, once it is built and operated. The method for such analysis aims to satisfy a number of conditions:

- The analysis shall provide a statement on the residual risk of a NPP project, independent from regulatory authority and utility
- The analysis shall be done by stakeholders other than regulatory authority and utility
- The analyst will not have in-depths access to all design information of the NPP project as regulatory authority and utility or design organization have, the analysis shall rely only on information openly available
- The analysis shall be based on factual information provided by experts organizations (like NPP designer and regulatory authority), but shall not rely on judgments and conclusions drawn by said organizations
- The method for the analysis shall take into account that only limited resources are available.

Stakeholder involvement, taken seriously, shall provide the opportunity for persons possibly affected by the project to discuss about the safety level of the project, and to reach independently from the experts' organization the conviction that the project is safe enough, and that the benefits outweigh the residual risk. Alternatively, to provide a different opinion, backed by information, which allows adapting the technology at an early stage to make it acceptable. However, this means that stakeholders should be placed in a position where it is possible to reach an independent conclusion on the safety of the project. The expert organizations, regulatory authority and designer, should not sell the project as a black box, with the statement that experts checked and came to the conclusion that the project is safe. The stakeholder should be given access to the technical background, why such a verdict was reached. This alone is not enough. Technical information on projects as complex as nuclear power plants easily fill thousands of pages. It is not uncommon for a final safety analysis report to fill up to 5000 pages, without referenced reports. A team of experts is needed to draw conclusions the contained information, since no single person is knowledgeable in all the technical fields involved. It is clearly beyond the capabilities of a single stakeholder to repeat the job of a regulatory authority and to come to conclusions interdependently based on presented technical materials (which often is even hold back). This means, the materials have to be presented in a way that they are not only available, but also accessible to a stakeholder. The thousands of pages have to be condensed reporting key information only, but without depriving the stakeholder of the possibility to check on what grounds the conclusions are drawn.

The method for the analysis (as will be explained in more detail in a later section of the report) aims to give draw conclusions on the safety level of an NPP project, considering not only the technical design of the project, but also the regulatory infrastructure of the country where the project is situated. Since detailed design information is not available on an early stage of an NPP project, the requirements from the regulatory body on the project are considered instead. The method takes a normative point of view: stakeholders should be able to come to conclusions on the safety of the project independently. Therefore, part of the analysis is to check whether the needed information is publicly available, and if so, if it is accessible (in the sense explained above). For the present report, this part of the analysis is termed “transparency”. If the information is available and accessible, it is compared to IAEA safety standards and a very coarse qualitative judgment is given to what level the standards are fulfilled. This part of the analysis is termed “requirements”. The analysis focuses on two main fields of an NPP project: the regulatory infrastructure in which it is build, and the technical design that is envisaged. In both fields, regulatory infrastructure and technical plant design, the "transparency" and "fulfillment of requirements" are analyzed. In this sense, the analysis is "multidimensional", since two fields very important for the safety level of the NPP, once it is operating, are investigated, and within both fields, two set of criteria are looked at, completely different of each other. The result of the analysis can be seen as a comprehensive checklist. Critical or questionable issues stand out and a more detailed analysis can be made afterwards.

This method was then applied to two NPP projects: The Finish project of Hanhikivi, a VVER-1200 reactor together with its regulatory infrastructure (regulatory authority STUK), and the Hungarian project of Paks II, again a VVER-1200 reactor, together with its regulatory infrastructure and its authority HAEA. Those two projects offer ideal conditions as "test subjects" for our method, since both projects are from the same vendor, and are based on the same NPP design. For both projects the final design, as it will be build, is not yet available. So instead of the design, the regulatory requirements on the design was analyzed. Comparison of regulatory bodies is a difficult task due to the complex nature of regulation and nuclear law, different responsibilities for safety, security or radiation protection and the historic development of nuclear oversight in the country. That this is a highly delicate mater can also be seen by a quote that can be found in all IRRS[1] reports:

> *"The number of recommendations, suggestions and good practices is in no way a measure of the status of the regulatory body. Comparisons of such numbers between IRRS reports from different countries should not be attempted."*

It has to be noted that the Hungarian Atomic Energy Authority (HAEA) as well as the Finnish Nuclear Regulatory Body (STUK) made (unofficial) translations of law relevant to nuclear energy and regulations available on their website. The focus of the analysis is only NPP design within its regulatory infrastructure, which means the study excluded Waste, Decommissioning, Security questions, LTO. The analysis of the technical plant design was restricted to the Nuclear Island of the plant.

After a short summary on the generic VVER-1200 design, the report provides first the analysis for Paks II, then the analysis for Hanhikivi project. Both analysis are then compared and differences are reported, which are appraised in the conclusions section of the report.

VVER-1200 / AES2006 (Version 491)

The VVER-1200 was designed by Russian AtomENERGOPROEKT and OKB Gidropress. The reactors build in Finland and Hungary are both are based on the Version 491 of the Reactor, with some adoptions for the local conditions and are called VVER-1200/522 (Finland) and VVER-1200/527 (Hungary) (Nucleopedia 2018). The following is a description of the base model VVER-1200/491. Changes to this model are described in the respective country-sections of this report, as far as they are known.

The VVER-1200, also known as NPP-2006 and AES-2006, is an evolutionary design based on previous VVER-1000. It is a 4-loop pressurized water cooled and water moderated reactor with horizontal steam generators. It has a gross electrical capacity of 1199 MWe with house loads of 90 MWe, for a net capacity of 1109 MWe. The thermal power (3212 MWt) and net electrical power give a net efficiency of 34.5%. The plant can operate in baseload and load following modes[2]. It has a design life of 60 years (Nucleopedia 2018).

[1] IRRS: Integrated Regulatory Review Service - A service of the IAEA that offers a review of common aspects of State's national, legal and governmental framework.

[2] *"The reactor is designed to operate in the daily load-following mode in the power interval of 100-50% of the rated power, and also to participate in the frequency control. Also, AES-2006 is capable of fast power modulations with ramps of up to 5% Pr per second*

The primary pressure at the reactor inlet is 16.2 MPa, reactor coolant inlet temperature is 298.2 ºC and the outlet temperature is 328.9 ºC. The secondary pressure is 7 MPa. The primary system design relies on the leak-before-break (LBB) concept for reactor coolant piping (Rusatom Overseas 2013).

The double containment has a pre-stressed concrete primary containment, which has a 6 mm thick carbon steel liner. The outer containment is a 0.8 meter thick, reinforced concrete structure to provide physical protection for the primary containment (Atomenergoprom 2014).

External Hazard Design

The safe shutdown earthquake seismic design is 0.25g PGA.

Aircraft crash design basis is for a 5.7 tonne aircraft (same as VVER-1000). An aircraft crash protection against "large" aircraft (i.e., Boeing 747) is listed as "optional". The design shall take into account both the collision force of the aircraft itself and the eventual fire caused by its fuel. The snow load design is for 4.3 kPa. The external explosion design is for 30 kPa with a compression time of 1 second. Tornado protection is for a whirlwind of class 3.60 of the Fujita scale (Rusatom Overseas 2013).

Safety Systems

The VVER-1200 provides active and passive safety systems, which are mostly evolutionary developments from the preceding VVER designs. The active safety system design is a four train concept including systems such as: high pressure / low pressure emergency core cooling systems, residual heat removal system (RHR), boron injection, primary / secondary overpressure protection, main steamline isolation system, gas removal system, emergency feedwater and containment spray systems (Rusatom Overseas 2013; IAEA 2011; Nucleopedia 2018).

The passive systems include a passive steam generator heat removal system, SG PHRS, and containment passive heat removal system, CPHRS. Both the PHRS and CPHRS use the steam emergency heat removal tanks (EHRT) outside containment. Operation of 3 out of 4 EHRTs provides cooling for 24 hours. Operation of all four provides cooling for 72 hours. The passive part of the ECCS, the hydro accumulators, discharges at a pressure below 5.9 MPa. Passive autocatalytic recombiners (PARs) are included for hydrogen control (Laaksonen 2013).

A core catcher is provided as a cone-shaped metal structure weighing about 800 tonnes, double-walled, with the gap filled with FAOG (ferric and aluminum oxide granules), and with the core catcher filled with sacrificial material (a ceramic mixture of iron oxide and aluminum oxide) (Kolchinsky et al. 2013).

The core melt frequency for the V-491 design was calculated to 5.94E-07 per year (IAEA 2011).

Protection, isolation, safety and safety control systems	No. trains/capacity
High pressure safety injection system	4 x 100 %
Low pressure safety injection system	4 x 100 %
Emergency boration system	4 x 50 %

(in the interval of ±10%Pr), or power drops of 20% Pr per minute in the interval of 50-100% of the rated power. However, the number of such very fast power variations is limited, and they are mainly reserved for emergency situations." (OECD/NEA 2011b)

Emergency feedwater system	4 x 100 %
Containment emergency spray systems	4 x 50 %
Residual heat removal system and reactor cooling	4 x 100 %
Containment isolation valve system	2 x 100 %
Emergency gas removal system	2 x 100 %
Primary circuit overpressure protection	3 x 50 %
Secondary circuit overpressure protection	2 x 100 %
Emergency diesel generator power system	4 x 100 %
Passive safety systems for design basis accidents	
Emergency reactor core cooling hydro-accumulator system	4 x 33 %
Containment hydrogen removal system	1 x 100 %
Auxiliary means for beyond design basis accident management	
Passive heat removal system through steam generators	4 x 33 %
Passive heat removal system from containment	4 x 33 %

Table 1: VVER-1200 (AES-2006) safety systems (Rusatom Overseas 2013)

Project status Finland

The whole timeline of the project can be found on the Fennovoima project homepage (Fennovoima 2018).

In October 2008, Fennovoima submitted an Environmental Impact Assessment Report. In January 2009, Fennovoima submitted their application for a Decision-in-Principle to the Ministry of Economic Affairs and Employment. STUK gave the Ministry its Preliminary Safety Assessment on the project in October 2009. The Decision-in-Principle is granted in summer 2010. In October 2011, the plant site, Hanhikivi peninsula in Pyhäjoki, is selected.

In February 2014, Fennovoima submitted a new Environmental Impact Assessment Report, as plant supplier and type had changed, and a supplemented Decision-In-Principle soon afterwards. STUK provided a Preliminary Safety Assessment concerning the supplemented Decision-In-Principle in May 2014. The Ministry of Economic Affairs and Employment issues a statement on the EIA report in June 2014. In the same month, the site electrification begins. The parliament approves the supplemented Decision-In-Principle in December 2014. Fennovoima submitted a Construction License Application to the Finnish Government in June2015. Planning materials are submitted to STUK beginning with October 2016. These are not publically available.

Site excavation and infrastructure work is carried out between 2015 and 2017.

Construction License is expected in 2019.

Fennovoima and Rusatom Overseas signed an engineering, equipment supply, and turnkey construction contract on 21 December 2013. Atomprojekt was hired by Rusatom Overseas in October 2014 to develop the design and licensing documentation for the project. TVEL signed a 10-year contract on 26 December 2013 fuel supply with Fennovoima worth €450 million. The contract covers the first core and ten years of operation using TVS-2006 fuel, and includes fuel management and design, as well as licensing and personnel training services. Siemens was selected on 25 June 2014 for "electrification of the construction site". A consortium of ÅF-Consult Oy and M+W Group as the consulting partner for Fennovoima for project management, nuclear safety, licensing, and auditing of subcontracting chains. Suomen Maastorakentajat Oy was constructed in September 2014 to construct the access road, the water supply piping, and domestic wastewater sewer system for the site. Alstom Power Systems was selected to deliver power systems in 2016, Rolls Royce to supply the main automation in 2017.

Specifics of the Finnish reactor - Version 522

The reactor to be constructed at the Hanhikivi site is a VVER-1200/522. Version 522 is an evolutionary development to satisfy European Utility Requirements, WENRA recommendations, the finnish safety requirements (YVL) and specific necessities for the selected site .

Following adoptions / requirements could be found in the open literature (Nucleopedia 2018; Ilinskii 2015; Svetlov 2016; STUK 2014):

- Resist an airplane crash up to 400 tons instead of 5.7 tons
- Seismic load PGA = 0.35g
- Minimizing operational staff
- Extra space in buildings has to be provided to account for subsequent upgrades, as well as increased space for equipment maintenance.
- Adoptions for temperatures, increased snow and wind
- DEC - extended list of accidents and external impacts
- Additional requirements to reflect principles of independence and difference

"According to the Finnish requirements, the design of nuclear power plants shall take ***the crash of a large commercial aircraft*** *into consideration as an external hazard. The protection strategy of the AES-2006 plant against a large aircraft crash is to construct the outer containment to withstand such a crash. [..] In the absence of more extensive structural protection, it is difficult to demonstrate the adequate retention of the safety functions in the event of an aircraft crash. The plant supplier has presented options for the reinforcement of the structural protection of the buildings that are deemed the most important to safety. STUK finds that conformity with the Finnish safety requirements with regard to an aircraft crash has not yet been demonstrated. The solution presented now requires more detailed designs and analyses as well as plant modifications to demonstrate compliance with the safety requirements."* (STUK 2014)

In addition to the four **emergency diesel generators**, which are provided by the standard version, seven diesel generators are available at the Version 522, each with corresponding batteries to guarantee an uninterrupted power supply as the Finnish requirements demand availability diversified for each system. In contrast, the standard version 491 only has two additional diesel generators. One for the emergency power supply and one mobile diesel for DECs and Severe Accidents (Nucleopedia 2018).

Regarding the **depressurization of the primary circuit** in a severe accident there are additional requirements by STUK. In Version 491 the depressurization is planned to be carried out by the safety valves designed for the operational conditions and postulated accidents of the plant. The plant design has to be modified to fit the Finnish regulations, as they require that severe accident systems are independent of the operational systems. The plant has to be equipped with independent valves, intended for pressure reduction for managing severe accidents (STUK 2014).

Furthermore adoptions in the building that houses the four redundant **trains of safety systems** are necessary. The trains are located side by side and connected by service corridors and air-conditioning system channels. Thus, STUK finds resistance to internal or external events, including flooding and fires, questionable due to insufficient physical separation.

> *"According to the Finnish requirements, system de-sign shall apply the separation principle to ensure the implementation of the safety functions even in the event of a failure and during internal and external hazards. The redundant parts of a system implementing safety functions shall be assigned to various safety divisions. Doors, hatches and penetrations between the safety divisions shall be avoided."* (STUK 2014) Plant modifications and further analyses were requested.

Finally,

> *"in accordance with the Finnish requirements, it shall be possible to sufficiently decrease the pressure in the containment after a severe accident so as to ensure that the leak from the containment is minor, even if the containment is not completely leaktight. At several operating nuclear power plants, the function can be implemented by a filtered relief system of the containment. The YVL Guides do not necessarily require that the function be implemented using a filtered relief system of the containment, if another solution is in place which is in compliance with the Finnish requirements. The implementation of the function at the AES-2006 plant shall be specified in connection with the construction licence application."* (STUK 2014)

Project status Hungary

The Hungarian Atomic Energy Authority (HAEA) issued a site assessment and evaluation permit for the new nuclear power plant in November 2014. License application and the related documents on the Paks II. project were presented to the competent authority in December 2014.

> *"The competent authority, the Baranya County Government Office – while considering the experiences of the national and international consultations – issued the first instance environmental license on 29th September 2016, which says: the project fulfills the environmental and conservation requirements of Hungary and the European Union. [...] On 18 April 2017 the competent authority, Pest County Government Office issued the second instance procedure's result, the resolution which approved the Paks II. project's environmental license."* (PAKS II ZRT. 2017a)

In October 2016 the project company submitted its site license application to HAEA. HAEA issued the site license on 30 March 2017.

In December 2017, the application of the construction licenses for the buildings of the construction and erection base was cancelled, to address some remarks by the HAEA. *"After the design documentation is modified in compliance with the observations made by the authority, the construction licence applications will be filed with the authority again."* (PAKS II ZRT. 2017b)

It is a target for 2018 to submit an establishment license application to the HAEA. The authority has 15 months to evaluate the documentation (PAKS II ZRT. 2018).

Specifics of the Hungarian reactor - Version 527

There is almost no information available on the Hungarian design modifications requested.

Methodology

Comparing countries regulatory approaches regarding the construction of new nuclear power plants is no easy task, and there is no out-of-the-box tool to perform such a comparison. The NEA Committee on Nuclear Regulatory Activities Working Group on the Regulation of New Reactors conducted surveys in several countries in order to get information's on the different approaches, but no method for comparison was elaborated – the results of the single countries were stand-alone (OECD/NEA 2010). Other reports by the OECD NEA elaborated generic issues on best practice for regulatory bodies without trying to compare countries approaches (OECD/NEA 2011a, 2016b, 2016a, 2014). The IAEA developed a methodology to evaluate a State's regulatory infrastructure for safety against IAEA safety standards, the IRRS mission methodology. Nevertheless the related reports state that the results of IRRS missions cannot be compared with results from other countries (IAEA 2013). There has been an attempt by researchers to compare different regulatory regimes, but only selected case studies are described and no comparative framework was provided (Bredimas and Nuttall 2008).

In order to compare regulatory issues regarding new nuclear power plant projects in different countries a new methodological approach and tool is needed. The comparison has to adhere to scientific standards of objectiveness and follow clear and transparent criteria to derive conclusions from the comparison. To be able to compare regulatory approaches in different regions and countries a common standard is needed. Because nuclear laws and national nuclear codes vary from country to country the IAEA safety standards (which include IAEA safety fundamentals, IAEA safety requirements and IAEA safety guides) were chosen as basic common standards. The IAEA defines those standards as follow:

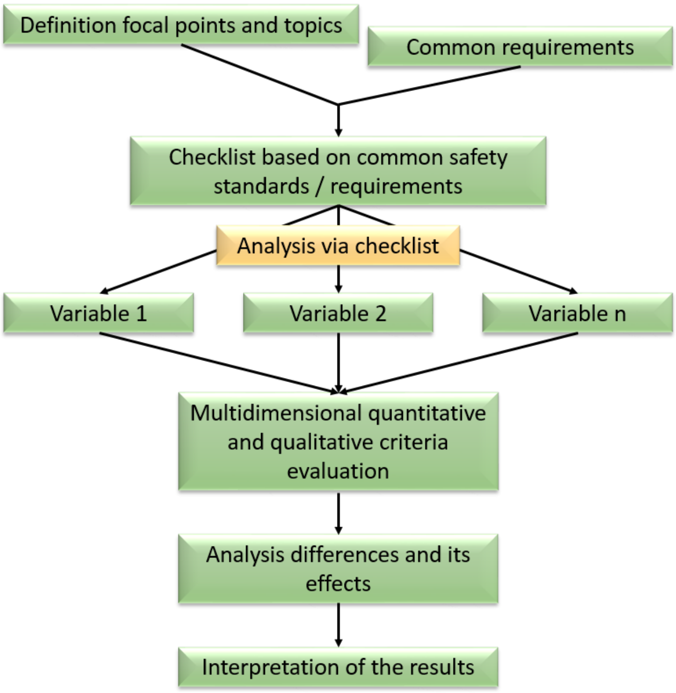

Figure 1: Methodological approach

The Safety Fundamentals establish the fundamental safety objective and principles of protection and safety and provides the basis for the safety requirements (IAEA 2006).

The Safety Requirements are an integrated set of Safety Requirements. They establish the requirements that should be met to ensure the protection of people and the environment, both now and in the future. The requirements are governed by the objective and principles of the Safety Fundamentals. If the requirements are not met, measures should be taken to reach or restore the required level of safety. The format and style of the requirements facilitate their use for the establishment, in a harmonized manner, of a national regulatory framework. The safety requirements use 'shall' with statements of associated conditions to be met (IAEA 2016a, 2016b).

The Safety Guides provide recommendations and guidance on how to comply with the safety requirements, indicating an international consensus that it is necessary to take the measures recommended (or equivalent alternative measures). The Safety Guides present international good practices, and increasingly reflect best practices, to help users striving to achieve high levels of safety. The recommendations provided in Safety Guides are expressed as 'should' statements (IAEA 2016a).

Because almost all countries operating nuclear power plants agree on the IAEA safety standards, they were identified as a valid and transparent basis for comparison. Depending on the focal points of the analyses, different standards and requirements can be used for the comparison. Figure 1 illustrates the innovative methodological approach used for the analyses.

Definition of focal points and topics

To clarify the aim of the comparison, it is crucial to define focal points and topics which will be compared across countries and regulatory bodies. For this project, the approaches of the regulatory bodies in Hungary in Finland were compared. This comparison is interesting because both countries are members of the EU and both are building the same type of reactor, a VVER-1200. For the project the complex of issues are:

- Responsibilities and functions of the Governments
- Responsibilities and functions of the Regulatory Bodies
- National requirements for NPP design

Development of a checklist based on common Safety Standards

The second step of the approach asks to develop a checklist based on common safety principles and standards. As described above, the IAEA safety standards, including the IAEA safety fundamentals, the IAEA safety requirements and the IAEA safety guides were used. Topics / requirements concerning nuclear security, decommissioning, waste management, transport, emergency preparedness, emergency response, long term operation, and guides regardings other nuclear installations than nuclear power plants were not considered. In order to address the focal points of the projects, the following standards were used for the creation of the checklist:

- IAEA General Safety Requirements Part 1: Governmental, Legal and Regulatory Framework for Safety (IAEA 2016a)
- IAEA Specific Safety Requirements No. SSR-2/1 (Rev. 1): Safety of Nuclear Power Plants: Design (IAEA 2016e)
- IAEA Specific Safety Requirements No. SSR-2/2 Safety of Nuclear Power Plants: Commissioning and Operation (IAEA 2016d)
- IAEA Safety Requirements No. NS-R-3 (Rev. 1): Site Evaluation for Nuclear Installations (IAEA 2016f)

For the complex of issue "**Responsibilities and functions of the Governments**" criteria were derived from General Safety Requirements Part 1 (GSR-1). The criteria to be analyzed and compared are:

- GSR-1 Requirement 1: National policy and strategy for safety
- GSR-1 Requirement 2: Establishment of a framework for safety
- GSR-1 Requirement 3: Establishment of a regulatory body
- GSR-1 Requirement 4: Independence of the regulatory body
- GSR-1 Requirement 11: Competence for safety

The complex of issue "**Responsibilities and functions of the Regulatory Bodies**" are analyzed via criteria derived from GSR-1. The criteria for analyses are:

- GSR-1 Requirement 16: Organizational structure of the regulatory body and allocation of resources
- GSR-1 Requirement 17: Effective independence in the performance of regulatory functions

- GSR-1 Requirement 18: Staffing and competence of the regulatory body
- GSR-1 Requirement 21: Liaison between the regulatory body and authorized parties
- GSR-1 Requirement 22: Stability and consistency of regulatory control
- GSR-1 Requirement 24: Demonstration of safety for the authorization of facilities and activities
- GSR-1 Requirement 32: Regulations and guides
- GSR-1 Requirement 36: Communication and consultation with interested parties

Regarding the complex of issue **"National requirements for NPP Designs**" criteria are derived from SSR-2/1, SSR-2/2 and NS-R-3 (future - SSR-1). Details are provided in Annex 1.

Analyses of the selected countries via the checklist

The next step is the analyses of different variables (countries). For this study, Hungary and Finland were taken as variables. The checklist is used to conduct the analyses of each variable and to elaborate if the criteria from the checklist are met. In order to perform the analyses multiple documents like national legislations, governmental decrees, national nuclear codes and IAEA documents need to be analyzed. In addition to the checklist criteria, transparency is a further point that is evaluated.

This assessment has two possible outcomes. Either the criteria from the checklist are met, or the criteria from the checklist are not (fully) met/ there is room for improvement, which is denoted as shortfall in this document.

For the transparency evaluation, two different segments are analyzed. The availability and the accessibility of documents are evaluated and a common aggregated value is used to indicate the level of transparency.

Concerning the availability, it was checked if all relevant documents are publically available or if some or even all of the relevant documents are not publically available.

Document accessibility includes the accessibility and the clarity of the documents. If the relevant document was available, it was checked, if the fulfilment of the criteria could be clearly identified and confirmed and if this was coherent throughout the set of documents. This also reflects if the information is presented in a way that a small team of persons with technical knowledge can derive conclusions from it in limited time.

Multidimensional quantitative and qualitative criteria evaluation

Based on the analyses of the variables a multidimensional quantitative and qualitative criteria evaluation is performed. Via the multidimensional evaluation, strengths and weakness are made visible. Further, this is used to compare the different variables and to elaborate differences between those regarding the checklist and transparency. Using the multidimensional quantitative and qualitative criteria evaluation, the differences are worked out.

Hungary

Responsibilities and functions of the Governments

GSR-1 Requirement 1: National policy and strategy for safety

"The government shall establish a national policy and strategy for safety, the implementation of which shall be subject to a graded approach in accordance with national circumstances and with the radiation risks associated with facilities and activities, to achieve the fundamental safety objective and to apply the fundamental safety principles established in the Safety Fundamentals."

Hungary's commitment to safety is depicted in the National Security and Safety Strategy statement, approved by Government Resolution in 2012. The Act CXVI of 1996 on Atomic Energy sets the framework from which Hungary's comprehensive regulatory legislation has been developed – and upon which the legislation and authorizations are based. The Act has been regularly amended to take account of developments in nuclear and radiation safety.

Transparency	Availability	The relevant documents are available.
	Accessibility	The relevant documents are accessible.
Requirement		The GSR-1 requirement is met.

Sources: (IAEA 2015b; HAEA 2016, 2018, *Act CXL of 2004 on the General Rules of Administrative Proceedings and Services* 2004, *Govt. Decree 118/2011 (VII. 11.) on the Nuclear Safety Requirements of Nuclear Facilities and on Related Regulatory Activities* 2011, *Act CXVI of 1996 on Atomic Energy*, n.d.)

GSR-1 Requirement 2: Establishment of a framework for safety

"The government shall establish and maintain an appropriate governmental, legal and regulatory framework for safety within which responsibilities are clearly allocated. The government shall promulgate laws and statutes to make provision for an effective governmental, legal and regulatory framework for safety."

The Act on Atomic Energy provides the basis for the legally binding framework of nuclear and radiation safety in Hungary. Subsequent governmental decrees, issued in accordance with the Act, provide allocation of responsibilities to ensure the governmental, legal and regulatory framework for nuclear and radiation safety is effective. All types of nuclear facilities; waste management facilities; and radiation sources facilities and activities; are covered by the Act.

Sources: (IAEA 2015b; HAEA 2016, 2018, *Act CXL of 2004 on the General Rules of Administrative Proceedings and Services* 2004, *Govt. Decree 118/2011 (VII. 11.) on the Nuclear Safety Requirements of Nuclear Facilities and on Related Regulatory Activities* 2011, *Act CXVI of 1996 on Atomic Energy*, n.d.)

Transparency	Availability	The relevant documents are available.
	Accessibility	The relevant documents are accessible.
Requirement		The GSR-1 requirement is met.

GSR-1 Requirement 3: Establishment of a regulatory body

> *"The government, through the legal system, shall establish and maintain a regulatory body, and shall confer on it the legal authority and provide it with the competence and the resources necessary to fulfil its statutory obligation for the regulatory control of facilities and activities."*

The national regulatory body comprises several organisations including the Hungarian Atomic Energy Authority (HAEA), the Baranya County Government Office Department of Environmental Protection and Nature (BCDEPN), the Office of the Chief Medical Officer (OCMO) and the Budapest Radiation Hygiene Decentre (RHD).

The HAEA is a government office with its resources provided by the Government and most of the funding is provided by fees paid by the licensee of nuclear facilities. The independence of the HAEA for its professional and regulatory decision making is provided for in the Act on Atomic Energy. The HAEA is supervised by the Minister for Innovation and Technology (formerly Ministry of National Development).

The HAEA was established and empowered by the Act on Atomic Energy as the nuclear safety authority and was delegated the competence to perform regulatory tasks including: licensing, approving, inspecting, accounting, assessing, identifying and reviewing, and conducting enforcement procedures.

Sources: (IAEA 2015b; HAEA 2016, 2018, *Act CXL of 2004 on the General Rules of Administrative Proceedings and Services* 2004, *Govt. Decree 118/2011 (VII. 11.) on the Nuclear Safety Requirements of Nuclear Facilities and on Related Regulatory Activities* 2011, *Act CXVI of 1996 on Atomic Energy*, n.d., *Annex 1 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 1 – Nuclear Safety Authority Procedures of Nuclear Facilities* 2011)

Transparency	Availability	The relevant documents are available.
	Accessibility	The relevant documents are accessible.
Requirement		The GSR-1 requirement is met.

GSR-1 Requirement 4: Independence of the regulatory body

> *The government shall ensure that the regulatory body is effectively independent in its safety related decision making and that it has functional separation from entities having responsibilities or interests that could unduly influence its decision making.*

Within the Ministry for Innovation and Technology, the State Minister for energy affairs has responsibility for both the Paks NPP and the HAEA. The IRRS mission 2015 noted that although the Minister’s responsibility for the HAEA is solely 'supervisory', the Ministry may face conflicting considerations when progressing the development of legislative provisions submitted by the HAEA. The Ministry may face conflicting considerations when reviewing HAEA resource and organizational change submissions. In 2015 the IRRS Mission noted that the Director General of the HAEA does not currently have prompt and unconstrained access to the highest level of the Ministry for Innovation and Technology formerly named Ministry of National Development, the ministry whose’ minister was in charge for the supervision over HAEA at that time, to address issues of regulatory concern. The Director General of the HAEA needs approval on the HAEA's 'Organisational and Operational Rules'. Additionally, the Director General of the HAEA did not have the authority to spend certain budgeted resources without prior approval from the Ministry of National Development, and the case is the same with the Ministry for Innovation and Technology. Examples include the purchase of information technology equipment; office furnishing; and office space (buildings). (IAEA 2015b)

Hungarian legal provisions, established in Governmental Decree 118/2011. Korm. (and its Annexes) under the Act, prescribe time limits for the regulatory body to complete various authorization processes. Similarly, for the OCMO and the RHDs, the Act CXL/2004 also prescribes time limits which may lead to undue pressure on the regulatory body to complete its decision making process and thus compromise safety. Those are described in detail in the section Effective independence in the performance of regulatory functions.

Sources: (IAEA 2015b; HAEA 2016, 2018, *Act CXL of 2004 on the General Rules of Administrative Proceedings and Services* 2004, *Govt. Decree 118/2011 (VII. 11.) on the Nuclear Safety Requirements of Nuclear Facilities and on Related Regulatory Activities* 2011, *Act CXVI of 1996 on Atomic Energy*, n.d., *Annex 1 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 1 – Nuclear Safety Authority Procedures of Nuclear Facilities* 2011)

Transparency	Availability	The relevant documents are available.
	Accessibility	The relevant documents are accessible.
Requirement		**The GSR-1 requirement is not (fully) met.**

GSR-1 Requirement 11: Competence for safety

The government shall make provision for building and maintaining the competence of all parties having responsibilities in relation to the safety of facilities and activities.

The competencies for all parties with nuclear safety responsibilities is addressed in the Act on Atomic Energy which provides for the requirements on ensuring and acquiring adequate general and professional competences, and designates the members of the Government responsible for the general and personnel training.

Sources: (IAEA 2015b; HAEA 2016, 2018, *Act CXL of 2004 on the General Rules of Administrative Proceedings and Services* 2004, *Govt. Decree 118/2011 (VII. 11.) on the Nuclear Safety Requirements of Nuclear Facilities and on Related Regulatory Activities* 2011, *Act CXVI of 1996 on Atomic Energy*, n.d., *Annex 1 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 1 – Nuclear Safety Authority Procedures of Nuclear Facilities* 2011)

Transparency	Availability	The relevant documents are available.
	Accessibility	The relevant documents are accessible.
Requirement		The GSR-1 requirement is met.

Responsibilities and functions of the Regulatory Bodies

GSR-1 Requirement 16: Organizational structure of the regulatory body and allocation of resources

> *The regulatory body shall structure its organization and manage its resources so as to discharge its responsibilities and perform its functions effectively; this shall be accomplished in a manner commensurate with the radiation risks associated with facilities and activities.*

The regulatory body consists of several authorities, mainly the HAEA, the OCMO, the RHDs, and the BCDEPN. At least four ministries are involved directly, the Minister for Innovation and Technology, the Minister of Human Capacity, the Minister of Agriculture, and the Prime-Minister Office. For specific aspects several other ministers are be involved in addition e.g. in case of a nuclear emergency, in case of the construction of the new nuclear power plant. In 2017 Janos Süli was appointed as minister without portfolio only in charge for the Paks II nuclear power plant project.

The budgets of these regulatory authorities are partly coming from the state budget and partly from levies paid by the licensees (especially in the case of the HAEA). Licensees have to pay an annual amont to the regulatory body as oversight fee, defined in the nuclear energy act. In the Nuclear Act CXVI in section 19 it is defined that:

> *"in the case of an operating nuclear power plant and research reactor the product of the nominal thermal power (MWth) and the calculation base; the calculation base shall be 302 450 HUF/MWth […]*
>
> *in the case of a nuclear power plant and research reactor with a valid construction license the product of designed nominal thermal power (MWth) and the calculation base; the calculation base shall be 82 100 HUF/MWth […]"*

The HAEA is responsible for the regulation of nuclear installations. Since 1 July 2014, the HAEA is also responsible for the regulation of radioactive waste management facilities and activities. As of 1 January 2016, HAEA also regulates the safety of radioactive sources, associated facilities and activities.

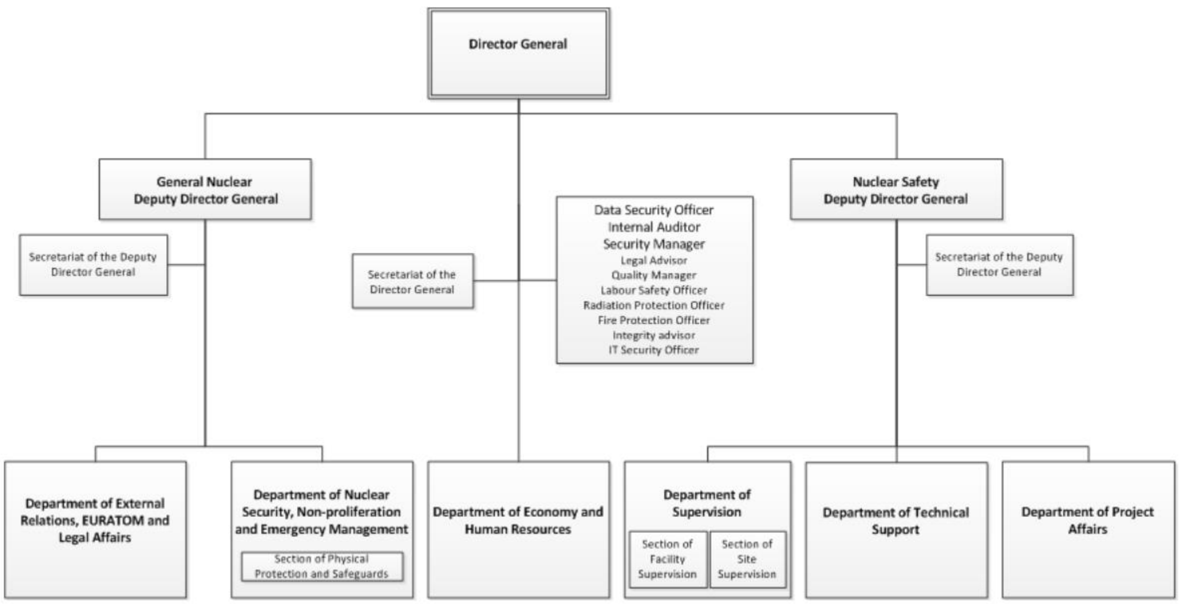

Figure 2: HAEA Organigram

Until end of 2015, the OCMO and the RHDs are responsible for regulating radiation source facilities and activities. The OCMO has approximately 4 full time staff. The seven RHDs use approximately 45 full time staff, about 30 of them with regulatory duties.

Since April 2015, the RHDs are administratively directed by County Government Offices under the Prime-Minister but also receive technical and professional instructions by the OCMO (under Ministry of Human Capacity) through the official channels.

Since April 2015, the Baranya Country Government Office Department of Environmental Protection and Nature Conservation (BCDEPN) has replaced the South Transdanubian Environmental and Nature Conservation Inspectorate for regulating environmental protection. The new formed authority has 2 full time staff involved in regulatory functions. The BCDEPN has 4 full time staff for all environmental radiological issues (2 experts for licensing, 2 employees for laboratory works) for nuclear facilities. The BCDEPN is within the County Government Office under the Prime-Minister's office. The BCDEPN intends to cover the impact of the foreseen workload associated to the planned Paks II units by relieving the 2 full staff involved in regulatory nuclear functions from all other duties. The number of staff that will finally be available is still uncertain.

The regulatory body's obligations are defined by law. The overall organizational structure of the regulatory body is in transition and the IRRS mission noted that all organizations may face significant challenges associated to these organizational changes.

Sources: (IAEA 2015b; HAEA 2016, 2018, *Act CXL of 2004 on the General Rules of Administrative Proceedings and Services* 2004, *Govt. Decree 118/2011 (VII. 11.) on the Nuclear Safety Requirements of Nuclear Facilities and on Related Regulatory Activities* 2011, *Act CXVI of 1996 on Atomic Energy*, n.d., *Annex 1 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 1 – Nuclear Safety Authority Procedures of Nuclear Facilities* 2011, *Annex 9 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 9 – Requirements for the Construction of a New Nuclear Installation* 2011)

Transparency	Availability	The relevant documents are available.
	Accessibility	The relevant documents are accessible.
Requirement		The GSR-1 requirement is met.

GSR-1 Requirement 17: Effective independence in the performance of regulatory functions

> *The regulatory body shall perform its functions in a manner that does not compromise its effective independence.*

The legal provisions for the independence of the regulatory body are partially described in section "Independence of the regulatory body". The "Safety policy and the regulatory Code of Conduct" of the HAEA gives detailed behavioural rules for HAEA staff in case of a conflict of interest. In addition, an integrity adviser has been designated to the director general of the HAEA to assess integrity and corruption risks. The regulatory body is independent in making decisions on nuclear and radiation safety.

The fact that there are very restrictive time schedules for the HAEA to reply to submission of licencees puts pressure on HAEA and might influence safety related decisions due to time constraints. In the Governmental Decree 118/2011 Korm. it is stated:

Section 21

The nuclear safety authority may proceed regulatory procedures with regard to activities subject to licensing with urgency, if it is necessary in order to eliminate an unfavourable safety condition. Such extraordinary proceeding cannot justify any omission of compliance with the requirements for the substantiating documentation, and shall not result in giving priority to aspects different from those of nuclear safety, or shall not decrease safety.

Section 21/A

The nuclear safety authority, in the procedures launched on application, except for the client that submitted the application to launch the case, the client shall be notified of the commencement of the procedure
a) 30 days within the receipt of the application
aa) in the procedures specified in Paragraphs 17 (1) a)-e) and g)-h),
ab) in the procedure specified in Paragraph 17 (1) f), if the modification entails the modification of the operation license,
ac) in the procedures specified in Subsection 18 (1), and
b) 15 days within the receipt of the application in the procedures specified in Paragraphs 17 (1) i) and j), in Subsections 17 (1a) and (3), and in Subsections 18 (2) and (3).

Section 21/B

(1) The administration deadline of the nuclear safety authority is
a) sixty days
aa) in the procedures specified in Paragraphs 17 (1) a), b), i) and j),
ab) with the exceptions specified in Paragraph b) and Subparagraph bb) in the procedures specified in Paragraph 17 (1) f),
ac) in the procedures specified in Subsection 17 (1a),
ad) in the procedures specified in Subsection 17 (3) and
ae) in the procedures specified in Subsections 18 (2) and (3),
b) six months
ba) in the procedures specified in Paragraphs 17 (1) d), c)-e), g) and h),
bb) in the cases specified in Paragraph 17 (1) f), if the modification entails the modification of the operation license and
bc) in the procedures specified in Subsection 18 (1).
(2) If it is justified, the manager of the nuclear safety authority is authorized to extend the administration deadline once
a) at most by 30 days in the cases specified in Paragraph (1) a),
b) at most 90 days in the cases specified in Paragraph (1) b)
The atomic energy oversight organization shall notify the client of the extension of the administration deadline and of all those who have been notified of the commencement of the procedure.

Section 21/C

If the client submitted the a deficient application, the nuclear safety authority shall call it to supplement the deficiency in
*a**)** 4 months within the receipt of the application in the procedures specified in Paragraphs 17 (1) c)–h) and Subsection 18 (1),*

b) 30 days within the receipt of the application in the procedures specified in Paragraphs 17 (1) a), b), i) and j), in Subsection 17 (1a) and (3), in Subsections 18 (2) and (3).

Governmental Decree 118/2011 Korm. Chapter III Reguatory Supervision 11. Licensing and approval Subsection 17 and 18 the relevant applications are specified.

Section 17

(1) According to the requirements set out in Annexes 1 and 4-6, a nuclear safety authority licence is required for

a) survey and assessment of a site (site survey and assessment licence),
b) site characterization and suitability determination (site licence),
c) construction, extension (construction licence),
d) commissioning (commissioning licence),
e) operation, operation beyond the design lifetime (operation licence),
f) modification (modification licence),
g) final decommissioning (final shutdown licence),
h) termination (dismantling licence),
i) in the case of a nuclear power plant unit for restart following outage (start-up license) and
j) construction, demolition and utilization of buildings, building structures and elevators of buildings of a nuclear facility.

(1a) During the construction phase of a nuclear facility, a nuclear safety authority license according to Sections 1.3.1.0200, 1.3.2, 1.3.3, 1.3.4 and 1.3.5 of Annex 1, or in the cases outlined in Section 1.3.1.0300 of Annex 1 a type licence is required for

a) manufacturing (manufacturing licence),
b) procurement (procurement licence),
c) assembly (assembly licence) and
d) operation (operation licence)
of a nuclear system, structure or component. […]

(3) A nuclear safety authority license is required for the modification of the nuclear facility, its safety important systems, structures and components, buildings, building structures, organisational structure, control system or documents according to the details specified in Annexes 1 and 4-6. [...]

Section 18

(1) The nuclear safety authority reviews the Periodic Safety Review Report of the nuclear facility, and then issues its resolution according to Section 34.

(2) Those assembly and execution technologies, measurement, calculation, technical inspection and assessment methods which have influence on nuclear safety but not included in the documents submitted to substantiate authority licensing procedures, and are associated with system components in Safety Classes 1 and 2, may only be used after the preliminary approval of the nuclear safety authority. After examination of the conditions of use, the nuclear safety authority shall approve the document which specifies the method by specifying provisions on the conditions of use.

(3) Job positions important to nuclear safety shall be filled with the approval of the nuclear safety authority.

Sources: (IAEA 2015b; HAEA 2016, 2018, *Act CXL of 2004 on the General Rules of Administrative Proceedings and Services* 2004, *Govt. Decree 118/2011 (VII. 11.) on the Nuclear Safety Requirements of Nuclear Facilities and on Related Regulatory Activities* 2011, *Act CXVI of 1996 on Atomic Energy*, n.d., *Annex 1 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 1 – Nuclear Safety Authority Procedures of Nuclear Facilities* 2011, *Annex 9 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 9 – Requirements for the Construction of a New Nuclear Installation* 2011)

Transparency	Availability	The relevant documents are available.
	Accessibility	The relevant documents are accessible.
Requirement		**The GSR-1 requirement is not (fully) met.**

GSR-1 Requirement 18: Staffing and competence of the regulatory body

The regulatory body shall employ a sufficient number of qualified and competent staff, commensurate with the nature and the number of facilities and activities to be regulated, to perform its functions and to discharge its responsibilities.

The HAEA had developed a database profiling the available organisational expertise and in the light of the Government's plans to build the Paks-2 new units, it has used this to determine the shortfall in staffing. The HAEA made a calculation of the necessary capacity and expertise related to the new tasks up to the year 2038. Due to the on-going recruitment of new staff and loss of senior staff to retirement, training and knowledge sharing is of high importance for the HAEA. The current staff of the HAEA is about 170, the target is to reach 200. The lack of financial resources mainly because of the fact that the HAEA only gets oversight fees after issuing the constuction licence could cause problems for the regulatory body regarding the human resources in order to regulate the process pre-construction of the new nuclear power plants. There is massive financial support needed which needs to be covered by the Government.

Based on the comments of the IRRS mission it can be noted that regarding the future additional responsibility for radiation safety, the HAEA will have to recruit and retain sufficient staff with adequate competences such as radiochemistry, dosimetry, medical physics, radiation physics, and in-depth knowledge of applied technologies. In addition, the IRRS mission noted that also support from Technical and Scientific Support Organizations (TSOs) is likely to be needed. Additionally the IRRS noted that during interviews it became clear that in the current oversight of radiation source facilities and activities, the lack of qualified staff is of concern.

The HAEA has had difficulty attracting and retaining qualified staff due to salary levels that are not competitive with industry, suppliers and some TSOs. Through the Project Act, the Government authorized the increase of HAEA salaries to enable the HAEA to counteract the exodus to the TSO's and the industry. These issues were identified by the HAEA in its self-assessment for the IRRS Mission and considered in its action plan. The HAEA has started recruiting new staff, and needs to educate and train them, especially those coming directly from university. (IAEA 2015b; HAEA 2016, 2018)

The HAEA has a systematic approach to training. Based on the findings of the IRRS mission, the HAEA identified in its self-assessment that the transfer of the existing institutional and personal knowledge and information to the new staff is not effective and identified actions to improve the situation. The IRRS team noted that this is especially valid for waste management. Regarding other regulatory authorities (the OCMO, the RHDs and the BCDEPN), the IRRS team noted that none have developed appropriate human resources plans with the number of staff needed and the competences necessary for them to perform their regulatory obligations.

Sources: (IAEA 2015b; HAEA 2016, 2018, *Act CXL of 2004 on the General Rules of Administrative Proceedings and Services* 2004, *Govt. Decree 118/2011 (VII. 11.) on the Nuclear Safety Requirements of Nuclear Facilities and on Related Regulatory Activities* 2011, *Act CXVI of 1996 on Atomic Energy*, n.d., *Annex 1 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 1 – Nuclear Safety Authority Procedures of Nuclear Facilities* 2011) This could become a problem from HAEA too.

Transparency	Availability	**Not all relevant information is available.**
	Accessibility	The available documents are accessible.
Requirement		**The GSR-1 requirement is not (fully) met.**

GSR-1 Requirement 21: Liaison between the regulatory body and authorized parties

The regulatory body shall establish formal and informal mechanisms of communication with authorized parties on all safety related issues, conducting a professional and constructive liaison.

The regulatory body uses various means to inform authorized parties including official communications, publications, website, and official and informal meetings. The HAEA holds meetings with the licensees before application submission and during the licensing process, as appropriate. The management of the HAEA regularly holds meetings with the management of authorized parties. (IAEA 2015b; HAEA 2016)

The regulatory body uses formal and informal communication to build up a constructive relation with licensees.

Regarding resolutions and their justification, the HAEA strives for a formulation as simple and clear as possible, and by referring to legislative prescriptions in support of them.

Sources: (IAEA 2015b; HAEA 2016, 2018, *Act CXL of 2004 on the General Rules of Administrative Proceedings and Services* 2004, *Govt. Decree 118/2011 (VII. 11.) on the Nuclear Safety Requirements of Nuclear Facilities and on Related Regulatory Activities* 2011, *Act CXVI of 1996 on Atomic Energy*, n.d., *Annex 1 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 1 – Nuclear Safety Authority Procedures of Nuclear Facilities* 2011, *Annex 10 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 10 – Nuclear Safety Code Definitions* 2011)

Transparency	Availability	The relevant documents are available.
	Accessibility	The relevant documents are accessible.
Requirement		The GSR-1 requirement is met.

GSR-1 Requirement 22: Stability and consistency of regulatory control

The regulatory body shall ensure that regulatory control is stable and consistent.

The overall legal and regulatory framework is established. Guidelines for its implementation by licensees are established and made publicly available. In addition, the HAEA has a formal process in the management system to ensure stability in regulatory control and prevent subjectivity. Nevertheless, it seem that there is room for improvement. Regulatory decisions are made in accordance with established procedures and must be countersigned by at least two officials including the (deputy) director-general.

Nevertheless, the on-going and anticipated redistribution of regulatory responsibilities will pose challenges in ensuring stability and consistency of regulatory control. The IRRS mission in 2015 noted that, due to the on-going and anticipated redistribution of regulatory responsibilities, the HAEA faces challenges in maintaining the stability and consistency of regulatory control. In some instances, the responsibilities of the individual co-authorities are still uncertain or unclear.

Sources: (IAEA 2015b; HAEA 2016, 2018, *Act CXL of 2004 on the General Rules of Administrative Proceedings and Services* 2004, *Govt. Decree 118/2011 (VII. 11.) on the Nuclear Safety Requirements of Nuclear Facilities and on Related Regulatory Activities* 2011, *Act CXVI of 1996 on Atomic Energy*, n.d., *Annex 1 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 1 – Nuclear Safety Authority Procedures of Nuclear Facilities* 2011)

Transparency	Availability	The relevant documents are available.
	Accessibility	The relevant documents are accessible.
Requirement		The GSR-1 requirement is met.

GSR-1 Requirement 24: Demonstration of safety for the authorization of facilities and activities

The applicant shall be required to submit an adequate demonstration of safety in support of an application for the authorization of a facility or an activity.

The licensing stages for facilities and activities are prescribed in the Act on Atomic Energy and Governmental Decrees. The nuclear safety code prescribes requirements for the contents of licensing applications (document submission requirements) to demonstrate safety arrangements. The Basis for the safety assessment and the need for submission to HAEA is described in the Governmental Decree 118-2011 Chapter 9 Design Section 9. Further specifications and related regulations are specified in Annex 3, 3/A, 5 and 6. The principles regarding construction are lined out in the Governmental Decree 118-2011 Chapter 9/A Construction Section 10A and Section 10. Further specifications are elaborated in Annex 1 and 9.

The very restrictive time schedule for HAEA puts pressure on the regulatory body regarding the analyses of all submitted documents.

As specified in the Governmental Decree 118-2011 Chapter 15 Safety reports, safety assessment Section 31:

"(1) In order to ensure the socially controlled application of atomic energy, the licensee shall prepare a report on its activity with regard to the operation and safety of the nuclear facility and the safety-related events occurring during operation, and the submit this report to the nuclear safety authority. The licensee shall submit the Preliminary Safety Analysis Report of the nuclear facility to the nuclear safety authority with the construction license application and the Final Safety Analysis Report in conjunction with the commissioning license application, according to the rules specified in Annexes 1, 3, 3/A, 5 and 6.

(2) The nuclear safety authority conducts the safety assessment of nuclear facilities on the basis of its licensing experience, inspection results, the reports of the licensee, and other available information.

(3) The reports submitted to the nuclear safety authority shall be prepared in such depth and to such a level of detail that enable the nuclear safety authority to inspect and assess the operational activity and the safety related events independently and substantively."

The very restrictive time schedule for HAEA puts pressure on the regulatory body regarding the analyses of all submitted documents.

The review and assessment process of licensing applications utilizes TSOs. However, since a limited number of TSOs are available in the country, they provide services to both the licensees and the regulatory body.

Sources: (IAEA 2015b; HAEA 2016, 2018, *Act CXL of 2004 on the General Rules of Administrative Proceedings and Services* 2004, *Govt. Decree 118/2011 (VII. 11.) on the Nuclear Safety Requirements of Nuclear Facilities and on Related Regulatory Activities* 2011, *Act CXVI of 1996 on Atomic Energy*, n.d., *Annex 1 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 1 – Nuclear Safety Authority Procedures of Nuclear Facilities* 2011, *Annex 7 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 7 – Site Survey and Assessment of Nuclear Facilities* 2011)

Transparency	Availability	The relevant documents are available.
	Accessibility	The relevant documents are accessible.
Requirement		**The GSR-1 requirement is not (fully) met.**

GSR-1 Requirement 32: Regulations and guides

The regulatory body shall establish or adopt regulations and guides to specify the principles, requirements and associated criteria for safety upon which its regulatory judgements, decisions and actions are based.

The Act CXVI of 1996 on Atomic Energy covers peaceful use of atomic energy, the related rights and obligations and the protection of people and the living and lifeless environment against harmful effects of ionizing radiation of natural and artificial origin. The Government and the concerned ministers issued decrees in the various fields for a detailed regulation of the principles laid down in the act. The Act also determines the HAEA mandate and tasks in the field of law-making. The HAEA has an obligation to initiate the establishment, amendment of laws and to participate in the public administration coordination of them.

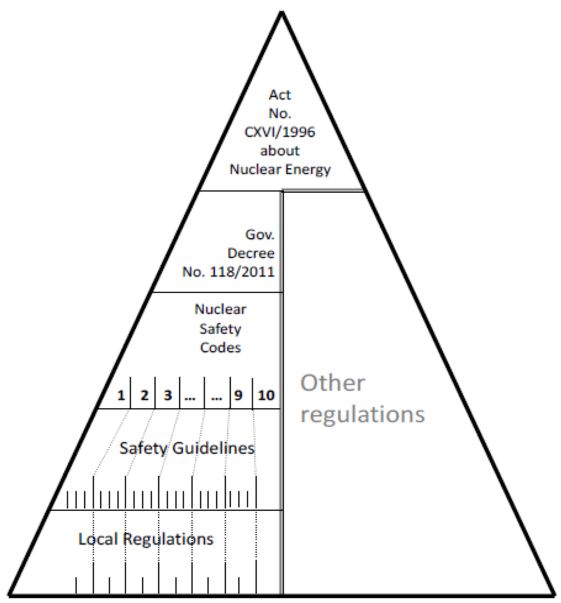

Figure 3: Hierarchy of Hungarian Regulations and Guides
Source: IAEA 2015b

The HAEA, under its mandate, develops a draft proposal of legislation. According to HAEA procedure (ME-0-0-25), it sends draft proposals to the Ministry for Innovation and Technology. According to the Act, the requirements for using atomic energy shall be regularly reviewed and updated, taking into account the results of science and international experiences. According to Governmental Decree 118/2011 Korm.

taking into consideration the scientific results, and national and international experience, the Nuclear Safety Code shall be reviewed at least every five years and updated as required. The guidelines shall be reviewed periodically.

The HAEA is using as a reference IAEA requirements and recommendations, WENRA reference levels and safety objectives, European Utility Requirements (EUR) and OECD NEA MDEP position papers as well as the construction experience of new build NPPs from the OECD NEA ConEx-database.

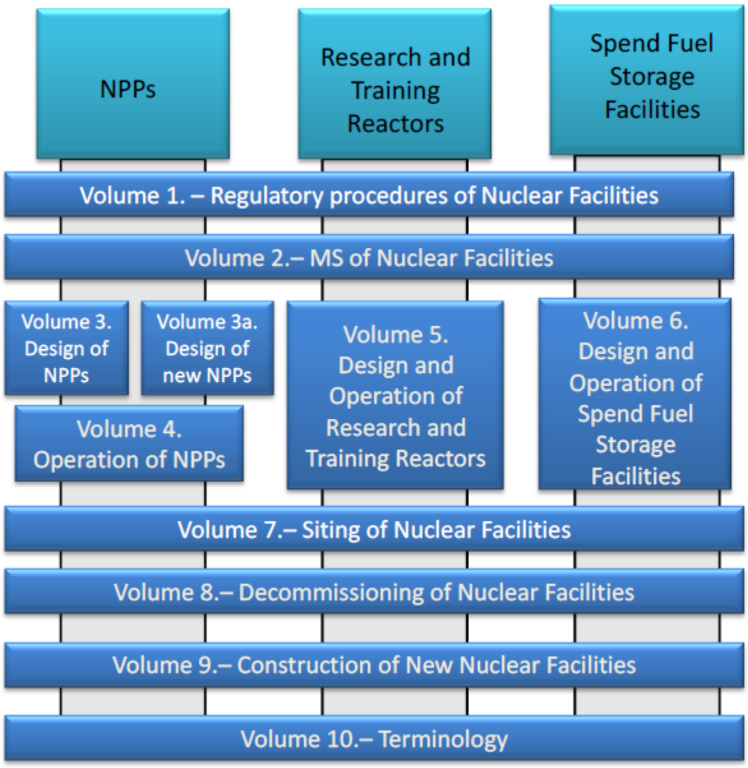

Figure 4: Structure of Nuclear Safety Code (NSC)
Source: IAEA 2015b

The IRRS mission in 2015 observed that, the HAEA has not published the full set of safety guidelines to complement the mandatory safety requirements according to the Nuclear Safety Codes (NSC), Governmental Decree 118/2011 and Governmental Decrees issued from 2005 to 2011. The OCMO, the RHDs and the BCDEPN have not published guidelines with respect to their regulatory requirements.

Further, it was noticed by the IRRS Mission in 2015 that the HAEA consulted with licensees, but not with the public or other interested parties within the process to develop and review the regulatory safety guides (see GSR 1 Requirements 34-36).

The Fundamental safety functions for operating and new nuclear power plants are described in NSC volume 10 and design requirements for safety functions are set in NSC volumes 3 and 3a and fulfil IAEA SSR-2-1 requirement 4.

The principle application of five levels of Defense-in-Depth (DiD) for all nuclear facilities is described in Governmental Decree 118/2011. Korm. Section 7. Supplementary requirements for new NPPs are in NSC volumes 3 and 3a for operating NPPs.

Descriptions of Plant States and Operation Conditions are presented in NSC volume 10 and further requirements are presented in NSC volumes 3 and 3a. Design extension, as “extended design basis”, is also considered in NSC requirements. Requirements for operation of nuclear power plants including operating procedures and operational limits are set in NSC volume 4, which contain also regulatory requirements on operation, in specific. Safety classification requirements for NPPs are presented in design NSC volumes 3 and 3a. NSC volumes 3 and 3a have reliability requirements for computer based systems and safety classified systems have to tolerate a single failure. In addition, requirements to monitor safety performance in all operation conditions are included to design requirements.

One of the design principles for safety in new NPPs, is that systems categorized in nuclear safety classes shall be designed so that the nuclear power plant unit need not shut down due to scheduled preventive maintenance or testing. In the case of all systems, structures and components important to nuclear safety, the program of in-service or regular in-service inspections, reviews and material testing programs, the mode and frequency of the testing of structural integrity, leak tightness and functions, and the designer specifications for planned preventive maintenance and other maintenance strategies shall be determined. Design requirements include the allowance for future modifications of new NPPs as well as authorization, assessment, review and inspection actions are specified to control plant modifications.

Sources: (IAEA 2015b; HAEA 2016, 2018, *Act CXL of 2004 on the General Rules of Administrative Proceedings and Services* 2004, *Govt. Decree 118/2011 (VII. 11.) on the Nuclear Safety Requirements of Nuclear Facilities and on Related Regulatory Activities* 2011, *Act CXVI of 1996 on Atomic Energy*, n.d., *Annex 1 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 1 – Nuclear Safety Authority Procedures of Nuclear Facilities* 2011, *Annex 10 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 10 – Nuclear Safety Code Definitions* 2011, 10, *Annex 2 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 2 – Management Systems of Nuclear Facilities* 2011, *Annex 3 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 3 – Design Requirements for Nuclear Power Plants* 2011, *Annex 4 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 4 – Operation of Nuclear Power Plants* 2011, *Annex 5 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 5 – Design and Operation of Research Reactors* 2011, *Annex 6 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 6 – Interim Storage of Spent Nuclear Fuel* 2011, *Annex 7 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 7 – Site Survey and Assessment of Nuclear Facilities* 2011, *Annex 8 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 8 – Decommissioning of Nuclear Facilities* 2011, *Annex 9 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 9 – Requirements for the Construction of a New Nuclear Installation* 2011, *Annex 10 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 10 – Nuclear Safety Code Definitions* 2011)

Transparency	Availability	**Not all relevant information is available.**
	Accessibility	**Not all relevant information is accessible.**
Requirement		The GSR-1 requirement is met.

GSR-1 Requirement 36: Communication and consultation with interested parties

> *The regulatory body shall promote the establishment of appropriate means of informing and consulting interested parties and the public about the possible radiation risks associated with facilities and activities, and about the processes and decisions of the regulatory body.*

The HAEA has a statutory obligation to inform the public on the safety of the use of atomic energy, its own activities, important decisions, and safety requirements. The HAEA has developed a Public Information Policy and Strategy (ST-2). A mechanism has been established to obtain feedback from selected interested parties. According to the ST-2, the HAEA collects expectations of interested parties through different communications channels, such as, lawmakers, international organizations, independent review organizations, co-authorities, journalists, etc. It is noted that all comments from stakeholders should be discussed at management review meetings.

The HAEA operates a website (http://www.oah.hu/) in Hungarian and English and a Facebook page. The website provides news on all-important events connected to its work, and publishes the main parameters and statements of HAEA resolutions. Interested parties can sign-up to a digital newsletter.

The IRRS mission in 2015 observed that, the HAEA has not published the full set of safety guidelines to complement the mandatory safety requirements according to the Nuclear Safety Codes (NSC), Governmental Decree 118/2011 and Governmental Decrees issued from 2005 to 2011. The OCMO, the RHDs and the BCDEPN have not published guidelines with respect to their regulatory requirements.

It must be noted that the HAEA consulted with licensees, but not with the public or other interested parties within the process to develop and review the regulatory safety guides.

The public hearings in the (transboundary) environmental impact assessment for Paks II did not only take place in Hungary, but also in other neighboring countries. They were organized by BCDEPN. The information regarding the reactor itself is limited. There is no possibility to get additional information on the reactor and its safety systems in detail.

Sources: (IAEA 2015b; HAEA 2016, 2018)

Transparency	Availability	The relevant documents are available.
	Accessibility	The relevant documents are accessible.
Requirement		**The GSR-1 requirement is not (fully) met.**

National requirements for NPP design

This subchapter targets to identify to what extent international technical requirements for nuclear safety are implemented in the national regulatory framework. The comparison is based on three IAEA documents from the Specific Safety Requirements Series. SSR-2/1 - Safety of Nuclear Power Plants: Design (IAEA 2016e), SSR-2/1 Safety of Nuclear Power Plants: Commissioning and Operation (IAEA 2016e) and NS-R-3 - Site Evaluation for Nuclear Installations (IAEA 2016f). The latter is currently undergoing review and shall be established as SSR-1: Site Evaluation for Nuclear Installations afterwards.

The analysis was done on the two levels of transparency and requirement fulfillment, as in the sections before. Due constraints in resources and time budget the topics of the analysis were limited to the nuclear island. Requirements concerning waste, decommissioning, security & transportation, long term, human factors & operation were excluded. Although at some points, interconnections or dependencies with these topics were included.

The IAEA requirements have been compared against the counties' regulatory requirements and not the country-specific VVER design, as there is not much information on the latter (and it was not target of this report). It was also abstained from rating the implementation within the regulation. Solely the taking into account of the IAEA requirement was evaluated.

It also has to be noted that the documents reviewed are mostly unofficial translations. Thus, it is thinkable, that findings are attributable to incorrect translations. On the other hand, a misinterpretation of the translation or a mistranslation could also have led to an assumed fulfillment of a requirement, which actually is not met.

The Hungarian regulation relevant for the safety and design of NPPs is set in (*Govt. Decree 118/2011 (VII. 11.) on the Nuclear Safety Requirements of Nuclear Facilities and on Related Regulatory Activities* 2011). Details are provided in eleven Annexes, which is the so-called Nuclear Safety Code (NSC). The NSC is structure along different topics of which the following were most important for the analysis of requirements for NPP design criteria:

- Volume 2 – Management systems of nuclear facilities
- Volume 3a – Design requirements for new nuclear power plant units
- Volume 7 – Site survey and assessment of nuclear facilities
- Volume 9 – Requirements for the construction of a new nuclear installation

These documents were screened according to the methodology, thus the critria of transparency and fullfilment of requirement were assesed. Overall, working with the safety code proved to be a little tedious, as there is no table of contents or other means for navigation through the documents provided (at least in the English version). A clear structuring would have helped with the analysis of regulatory requirements. This has a general impact on the accessibilitiy aspect of the transparency criteria for all the requirements. This is not reflected in the tables below. On the other hand is has to be positively noted, that all documents were provided in English.

The following tables/chapters provide the assessment of the requirements from the three IAEA documents. Below the tables those requirements found not (fully) meeting the requirements are discussed. In general, only the main requirements and not the paragraphs, describing the requirement in detail, were checked. The tables also mention the main document, where the topic is addressed. In some cases, there might be other NSCs also relevant for part of the issue, but not recorded in table. For each of the IAEA requirement documents an overall evaluation of the fulfilment of the transparency and requirement criteria is provided.

The analysis of requirement-shortfalls is provided in the chapter: Multidimensional quantitative and qualitative criteria evaluation.

SSR-2/1 - Safety of Nuclear Power Plants: Design

Table 2: Fulfillment of selected SSR-2/1 requirements - Hungary

Requirement SSR-2/1	Transparency aspects		Relevant document(s)	Requirement fulfillment
	Information available	Information accessibility		
Requirement 1: Responsibilities in the management of safety in plant design	ok	ok	GD 118/2011	ok
Requirement 4: Fundamental safety functions	ok	ok	NSC3a	ok
Requirement 6: Design for a nuclear power plant	ok	ok	NSC3a	ok
Requirement 7: Application of defence in depth	ok	ok	GD 118/2011 S7, NSC3a	ok
Requirement 9: Proven engineering practices	ok	ok	NSC3a	ok
Requirement 10: Safety assessment	ok	ok	NSC3a	ok
Requirement 11: Provision for construction	ok	ok	NSC3a	ok

Requirement 13: Categories of plant states	ok	ok	NSC3a	ok
Requirement 14: Design basis for items important to safety	ok	ok	NSC10, NSC3a	ok
Requirement 15: Design limits	ok	ok	NSC3a	ok
Requirement 16: Postulated initiating events	ok	ok	GD 118/2011, NSC3a	ok
Requirement 17: Internal and external hazards	ok	ok	NSC3a, NSC7	ok
Requirement 18: Engineering design rules	ok	ok	NSC3a	ok
Requirement 19: Design basis accidents	ok	ok	GD 118/2011 S10, NSC3a	ok
Requirement 20: Design extension conditions	ok	ok	NSC3a	ok
Requirement 21: Physical separation and independence of safety systems	ok	ok	NSC3a	ok
Requirement 22: Safety classification	ok	ok	NSC3a	ok
Requirement 23: Reliability of items important to safety	ok	ok	NSC3a	ok
Requirement 24: Common cause failures	ok	ok	NSC3a	ok
Requirement 25: Single failure criterion	ok	ok	NSC3a	ok
Requirement 26: Fail-safe design	ok	ok	NSC3a	ok
Requirement 27: Support service systems	ok	ok	NSC 3a	ok
Requirement 28: Operational limits and conditions for safe operation	ok	ok	GD 118/2011, NSC4, NSC3a	ok
Requirement 29: Calibration, testing, maintenance, repair, replacement, inspection and monitoring of items important to safety	ok	ok	NSC4, NSC9	ok
Requirement 30: Qualification of items important to safety	ok	ok	NSC1, NSC3a	ok
Requirement 33: Safety systems, and safety features for design extension conditions, of units of a multiple unit nuclear power plant	ok	ok	NSC3a	shortfall
Requirement 34: Systems containing fissile material or radioactive material	ok	ok	NSC3a	ok
Requirement 42: Safety analysis of the plant design	ok	ok	NSC3a	ok
Requirement 43: Performance of fuel elements and assemblies	ok	ok	NSC3a	ok
Requirement 44: Structural capability of the reactor core	ok	ok	NSC3a	ok

Requirement 45: Control of the reactor core	ok	ok	NSC3a	ok
Requirement 46: Reactor shutdown	ok	ok	NSC3a	ok
Requirement 47: Design of reactor coolant systems	ok	ok	NSC3a	ok
Requirement 48: Overpressure protection of the reactor coolant pressure boundary	ok	ok	NSC3a	ok
Requirement 49: Inventory of reactor coolant	ok	ok	NSC3a	ok
Requirement 50: Cleanup of reactor coolant	ok	ok	NSC3a	ok
Requirement 51: Removal of residual heat from the reactor core	ok	ok	NSC3a	ok
Requirement 52: Emergency cooling of the reactor core	ok	ok	NSC3a	ok
Requirement 53: Heat transfer to an ultimate heat sink	ok	ok	NSC3a	ok
Requirement 54: Containment system for the reactor	ok	ok	NSC3a	ok
Requirement 55: Control of radioactive releases from the containment	ok	ok	NSC3a	shortfall
Requirement 56: Isolation of the containment	ok	ok	NSC3a	ok
Requirement 57: Access to the containment	ok	ok	NSC3a	ok
Requirement 58: Control of containment conditions	ok	ok	NSC3a	ok
Requirement 59: Provision of instrumentation	ok	ok	NSC3a	ok
Requirement 60: Control systems	ok	ok	NSC3a	ok
Requirement 61: Protection system	ok	shortfall	NSC3a	shortfall
Requirement 62: Reliability and testability of instrumentation and control systems	ok	ok	NSC3a	ok
Requirement 63: Use of computer based equipment in systems important to safety	ok	ok	NSC3a	ok
Requirement 64: Separation of protection systems and control systems	ok	shortfall	NSC3a	shortfall
Requirement 65: Control room	ok	ok	NSC3a	ok
Requirement 66: Supplementary control room	ok	ok	NSC3a	ok
Requirement 68: Design for withstanding the loss of off-site power	ok	ok	NSC3a	ok

Evaluation of IAEA SSR-2/1

Transparency	Availability	The relevant documents are available.
	Accessibility	**Some documents are not well accessible and/or lack clarity for the requirement evaluation.**
Requirement		**The SSR-2/1 requirements are not (fully) met.**

SSR-2/2 - Safety of Nuclear Power Plants: Commissioning and Operation

Table 3: Fulfillment of selected SSR-2/2 requirements - Hungary

Requirement SSR-2/2	Transparency aspects		Relevant document(s)	Requirement fulfillment
	Information available	Information accessibility		
Requirement 1: Responsibilities of the operating organization	ok	ok	GD 118/2011	ok
Requirement 2: Management system	ok	ok	NSC2, NSC9	ok
Requirement 3: Structure and functions of the operating organization	ok	ok	NSC2, NSC9	ok
Requirement 4: Staffing of the operating organization	ok	ok	GD 118/2011, NSC2	ok
Requirement 5: Safety policy	ok	ok	Act CXVI, NSC3a	ok
Requirement 6: Operational limits and conditions	ok	ok	NSC4	ok
Requirement 8: Performance of safety related activities	ok	ok	NCS3a, NSC4	ok
Requirement 9: Monitoring and review of safety	ok	ok	NSC2, NSC4	ok
Requirement 10: Control of plant configuration	ok	ok	NSC9	ok
Requirement 11: Management of modifications	ok	ok	NSC9	ok
Requirement 12: Periodic safety review	ok	ok	GD 118/2011, NCS1	ok
Requirement 13: Equipment qualification	ok	ok	NSC9, NSC4	ok
Requirement 19: Accident management programme	ok	ok	NSC1, NSC4	ok
Requirement 25: Commissioning programme	ok	ok	GD 118/2011, NSC9	ok

Evaluation of IAEA SSR-2/2

Transparency	Availability	The relevant documents are available.
	Accessibility	The relevant documents are accessible.
Requirement		The SSR-2/2 requirements are met.

NS-R-3 Chapter 3: Specific requirements for evaluation of external events

The topics of the NS-R-3 (IAEA 2016f) are mainly covered by the NSC 7 (*Annex 7 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 7 – Site Survey and Assessment of Nuclear Facilities* 2011). All of the relevant hazards mentioned in IAEA NS-R-3 are addressed by this NSC. In addition some requirements for earthquakes can be found in NSC 3a (*Annex 3a to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 3a – Design Requirements for New Nuclear Power Plant Unit* 2011) and NSC 9 (*Annex 9 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 9 – Requirements for the Construction of a New Nuclear Installation* 2011).

Evaluation of IAEA NS-R-3 Chapter 3

Transparency	Availability	The relevant documents are available.
	Accessibility	The relevant documents are accessible.
Requirement		The NS-3-3 requirements are met.

Finland

Responsibilities and functions of the Governments

GSR-1 Requirement 1: National policy and strategy for safety

"The government shall establish a national policy and strategy for safety, the implementation of which shall be subject to a graded approach in accordance with national circumstances and with the radiation risks associated with facilities and activities, to achieve the fundamental safety objective and to apply the fundamental safety principles established in the Safety Fundamentals."

In Finland the policies and strategies for nuclear safety and radiation safety are expressed through legislation. The Finnish Constitution stipulates how and by whom the acts and decrees, as well as delegation of legislative powers, can be issued. The relevant pieces of legislation in these fields are the Nuclear Energy Act and the Radiation Act.

The Nuclear Energy Act states that the use of nuclear energy shall be in line with the overall good of society, and in particular shall ensure that the use of nuclear energy is safe for man and the environment and does not promote the proliferation of nuclear weapons. Basic safety principles are also set out, for example that safety should be as high as reasonably achievable (SAHARA). The Act also lays down general principles for the use of nuclear energy, the implementation of nuclear waste management, the licensing and control of the use of nuclear energy, and those for the competent authorities.

The Radiation Act states that its fundamental legal purpose is to prevent and limit health hazards and other detrimental effects of radiation. The Act covers the use of radiation and other practices that involve or may involve exposure to radiation hazardous to human health. Basic safety principles are also provided, such as justification, optimisation and limitation. The Act lays down the general principles for the use of radiation and other practices, including the licensing processes and regulatory functions.

Sources: (*Nuclear Energy Act (990/1987)* 2008, *Nuclear Energy Decree (161/1988)* 2008, *Radiation Act (592/1991)* 2011, *Radiation Decree (1512/1991)* 2009, IAEA 2012, 2015a, STUK 2016, 2013g)

Transparency	Availability	The relevant documents are available.
	Accessibility	The relevant documents are accessible.
Requirement		The GSR-1 requirement is met.

GSR-1 Requirement 2: Establishment of a framework for safety

"The government shall establish and maintain an appropriate governmental, legal and regulatory framework for safety within which responsibilities are clearly allocated. The government shall promulgate laws and statutes to make provision for an effective governmental, legal and regulatory framework for safety."

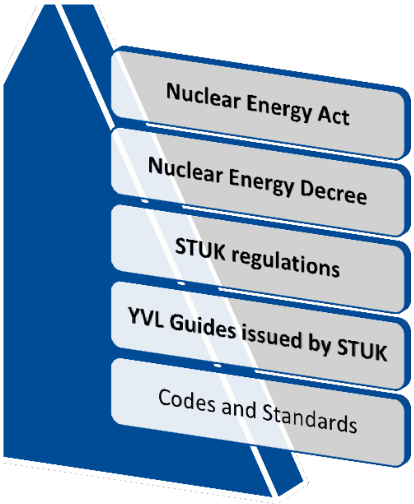

Figure 5: Finland Nuclear regulations and guides. Source: STUK 2017b

The nuclear energy legislation is based on the Nuclear Energy Act and radiation safety is based on the Radiation Act. The Nuclear Energy Act clearly sets out those facilities and activities that are covered. The Radiation Act applies to ionizing and non-ionizing radiation and covers radiation appliances and radioactive materials, radioactive waste, radiation practices and radiation work. These acts are supported by Government decrees that include legally binding regulations. The Acts also clearly identify that the legal responsibility for safety lies with the operator. In 2015 the Finnish Parliament approved changes in Nuclear and Radiation Acts to increase STUK's authorities to set binding regulations and license conditions. In 2016 STUK published binding regulations based on existing Government Decrees. The Nuclear Energy Act and Decree is under revision due to e.g. European directives and BSS by 2018. The STUK regulations and YVL Guides will be updated in spring 2018 taking into account, Lessons from implementation and related clarifications, Changes in Nuclear Energy Act and Decree, the WENRA Reference Levels 2014 and the updated IAEA requirement documents.

STUK is the independent governmental organization for the regulatory control of the use of radiation and nuclear energy. STUK is the body that undertakes review and assessment, inspection, preparation of regulations and guides, and enforcement. It is responsible for regulating both safety and security matters.

The Ministry of Employment and the Economy (MEE) in law has overall authority in the field of nuclear energy. It is responsible for the legislation in the nuclear energy field, and also prepares licensing decisions for the Government.

Sources: (*Nuclear Energy Act (990/1987)* 2008, *Nuclear Energy Decree (161/1988)* 2008, *Radiation Act (592/1991)* 2011, *Radiation Decree (1512/1991)* 2009, IAEA 2012, 2015a, STUK 2016, 2013g, 2017b)

Transparency	Availability	The relevant documents are available.
	Accessibility	The relevant documents are accessible.
Requirement		The GSR-1 requirement is met.

GSR-1 Requirement 3: Establishment of a regulatory body

"The government, through the legal system, shall establish and maintain a regulatory body, and shall confer on it the legal authority and provide it with the competence and the resources necessary to fulfil its statutory obligation for the regulatory control of facilities and activities."

STUK is the independent governmental organization for the regulatory control of the use of radiation and nuclear energy. STUK is administratively under the Ministry of Social Affairs and Health. The Ministry agrees the overall strategic direction of STUK's activities and administers the governmental budget. This Ministry has overall authority in the field of radiation safety.

Sources: (*Nuclear Energy Act (990/1987)* 2008, *Nuclear Energy Decree (161/1988)* 2008, *Radiation Act (592/1991)* 2011, *Radiation Decree (1512/1991)* 2009, IAEA 2012, 2015a, STUK 2016, 2013g, 2017b)

Transparency	Availability	The relevant documents are available.
	Accessibility	The relevant documents are accessible.
Requirement		The GSR-1 requirement is met.

GSR-1 Requirement 4: Independence of the regulatory body

The government shall ensure that the regulatory body is effectively independent in its safety related decision making and that it has functional separation from entities having responsibilities or interests that could unduly influence its decision making.

STUK's overall resources are obtained through three sources: Direct State Funding, Charges on the licensees, and Services. In the nuclear energy field, about 90% of the cost of STUK's resources is recovered directly through charges to the licensees. These resources cover STUK's direct regulatory activities. The other 10% is used for activities such as international cooperation. In the radiation safety field about 60% of the resources is obtained through charges to the licensees, which also cover STUK's direct regulatory activities.

IAEA Requirements allow for authorisations to be granted by the regulatory body or another governmental body. In Finland, the licences are granted by the Government, rather than the Ministry (namely MEE) that has overall authority for the nuclear energy field. The MEE prepares the licence for the governmental decision. The role and authority of STUK in defining conditions relevant to safety in this licensing process. It was noted by the IRRS mission in 2012 that the current practice of the licensing process in Finland is in practice (de facto) in line with IAEA requirements and guidance. Nevertheless, it was mentioned by the IRRS mission team, that in law (de jure) the role of the nuclear safety regulator in the process is not secured completely and unambiguously. Due to the recommendation of the IRRS mission in 2012, the Finnish Government modified the Nuclear Energy Act so that the law clearly and unambiguously stipulates STUKs legal authorities in the authorization process for safety. In particular, the changes ensured that STUK has the legal authority to specify any license conditions necessary for safety and specify all regulations necessary for safety. The Parliament of Finland approved the changes of the Nuclear Energy Act and Radiation Act on March 10, 2015 in such a way that the independence of STUK is increased.

Sources: (*Nuclear Energy Act (990/1987)* 2008, *Nuclear Energy Decree (161/1988)* 2008, *Radiation Act (592/1991)* 2011, *Radiation Decree (1512/1991)* 2009, IAEA 2012, 2015a, STUK 2016, 2013g, 2017b)

Transparency	Availability	The relevant documents are available.
	Accessibility	The relevant documents are accessible.
Requirement		The GSR-1 requirement is met.

GSR-1 Requirement 11: Competence for safety

The government shall make provision for building and maintaining the competence of all parties having responsibilities in relation to the safety of facilities and activities.

MEE set up a wide-ranging committee of all interested parties in Finland, including operators, educational and research institutes, and the regulator, to examine the long-term competence needs of the nuclear energy sector, including those for nuclear safety and to ensure a robust safety culture in Finland. This Committee published a report in May 2012. There are clear responsibilities regarding safety.

Sources: (*Nuclear Energy Act (990/1987)* 2008, *Nuclear Energy Decree (161/1988)* 2008, *Radiation Act (592/1991)* 2011, *Radiation Decree (1512/1991)* 2009, IAEA 2012, 2015a, STUK 2016, 2013g, 2017b)

Transparency	Availability	The relevant documents are available.
	Accessibility	The relevant documents are accessible.
Requirement		The GSR-1 requirement is met.

Responsibilities and functions of the Regulatory Bodies

GSR-1 Requirement 16: Organizational structure of the regulatory body and allocation of resources

The regulatory body shall structure its organization and manage its resources so as to discharge its responsibilities and perform its functions effectively; this shall be accomplished in a manner commensurate with the radiation risks associated with facilities and activities.

The Finnish Radiation and Nuclear Safety Authority (Säteilyturvakeskus – STUK) was established by Act No. 1069/1983. The act sets out the general functions of the authority, while more detailed provisions as to its structure and operations are contained in the Ordinance on the Finnish Radiation and Nuclear Safety Authority (No. 618/1997).

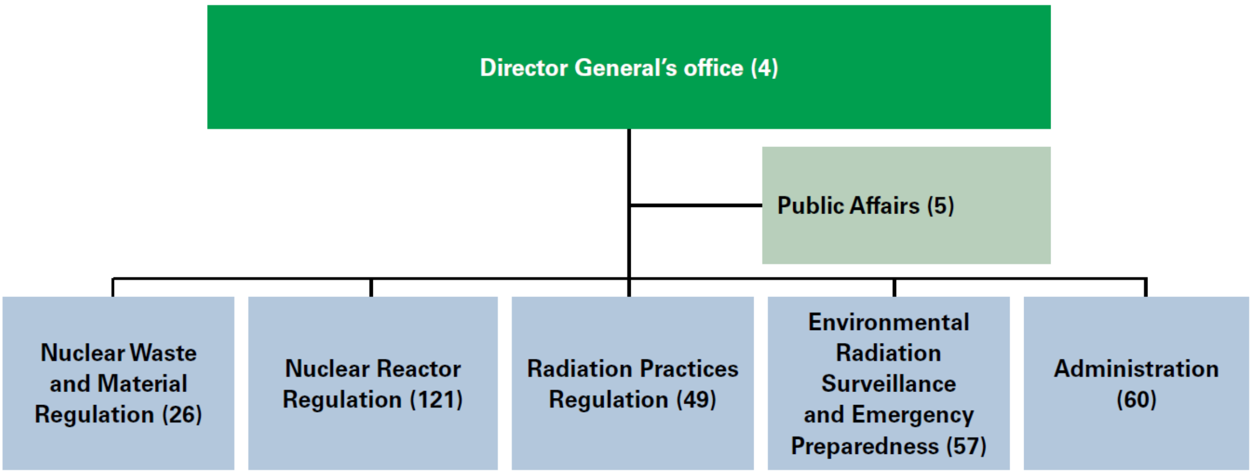

Figure 6: Organization of STUK. Number of staff in brackets (323 in 2015) Source: STUK 2017a

At the end of 2016, STUK had 321 employees. 70% of them were men. A little over 70% of STUK's employees have an M.Sc. or M.A. degree. The average age of the employees is approximately 47 years.

STUK's Director General has the authority to decide STUK's organizational structure and manage STUK's resources without any consent from outside STUK. STUK´s duties are defined in the decree on STUK, and according to the decree STUK has the following duties:

- regulatory control of safety of the use of nuclear energy, emergency preparedness, physical security and nuclear materials;
- regulatory control of the use of radiation and other radiation practices;
- monitoring the radiation situation in Finland, and maintaining of preparedness for abnormal radiation situations;
- maintaining of national metrological standards in the field;
- research and development work for enhancing radiation and nuclear safety;
- informing on radiation and nuclear safety issues, and participating in training activities in the field;
- producing expert services in the field;
- making proposals for developing the legislation in the field, and issuing general guides concerning radiation and nuclear safety; and
- participating in international cooperation in the field, and taking care of international control, contact or reporting activities as enacted or defined. (IRRS 2012)

The costs of regulatory oversight are charged in full to the licensees. The model of financing the regulatory work is called a net-budgeting model and it has been applied since 2000. In this model the licensees pay the regulatory oversight fees directly to STUK. The net-budgeting model makes it possible to increase, for example, personnel resources for regulatory oversight based on changing needs.

The expertise of STUK covers the essential areas needed in the oversight of the use of radiation and nuclear energy. STUK orders independent analyses as needed, such as review and assessment from technical support organizations to complement its own review and assessment work. The main technical support organization of STUK is the Technical Research Centre of Finland (VTT), but Aalto University (former Helsinki University of Technology) and Lappeenranta University of Technology (LUT) are used to some degree. Also international technical support organizations and experts have been used. If this support is needed for decision making related to the regulated activities, the costs of this work is charged to the licensee.

There are also national research programmes for nuclear safety and waste management in Finland. These research programmes are implemented in cooperation with all Finnish stakeholders including the utilities. STUK has the leading role to steer the programmes and ensure that the programmes result in outcomes that support the regulator in anticipating future safety issues by providing information for proactive decision making. SAFIR is the name of the Finnish Research Programme on Nuclear Power Plant Safety and KYT is the name of Finnish Research Programme on Nuclear Waste Management related to the safety of nuclear power plants and waste management. STUK and the Government should be commended for developing a national and international nuclear safety and waste management programmes. STUK demonstrated a systematic and efficient way to identify, prioritize and perform their nuclear safety and waste management research.

The advice and assistance from external organizations does not relieve STUK of its assigned responsibilities. The independence as well as possibilities to conflicting interests are addressed in the course of contracting. The final responsibility with regard to decision making rests with the regulatory body.

Sources: (*Nuclear Energy Act (990/1987)* 2008, *Nuclear Energy Decree (161/1988)* 2008, *Radiation Act (592/1991)* 2011, *Radiation Decree (1512/1991)* 2009, IAEA 2012, 2015a, STUK 2016, 2013g, 2017b)

Transparency	Availability	The relevant documents are available.
	Accessibility	The relevant documents are accessible.
Requirement		The GSR-1 requirement is met.

GSR-1 Requirement 17: Effective independence in the performance of regulatory functions

The regulatory body shall perform its functions in a manner that does not compromise its effective independence.

The foundation for independence of STUK is given in the legislation. Legislation describes STUK's governmental position, regulatory duties as well as regulatory powers and financial arrangements to ensure conduct of regulatory activities. STUK is a governmental organization for the regulatory control of the use of radiation and nuclear energy. The legislation defines no other responsibilities or duties which would be in conflict with regulatory control. (CNS, IRRS, Nuclear Energy Decree 12.2.1988/161, Nuclear Energy Act 11.12.1987/990)

Control of the STUK staff to ensure that it remains independent is accomplished as follow:

- Day to day management activities between the staff and management ensures that there is adequate communication to identify if personal views may have an impact on oversight or decision making. In addition, decision making process is such that STUK's final decisions are always signed with two names and the second has to be a section head or higher depending on the issue.
- Every new employee of STUK has to go through a training programme. This training programme addresses independence by providing training on the role and responsibilities of STUK, principles of good regulation, safety culture, role and responsibilities of a public official working for STUK (including the Civil Service Act).
- In-depth training is described in STUK's management system which provides general guidance for the work. Management system guidance highlights the importance of independence as a one key principle of good regulation at all levels of regulatory activities. It also requires that persons in charge are independent of the issue being handled. The persons must make themselves disqualified when handling an issue which concerns organizations or persons connected with their personal circle of interests.
- There is also specific guidance on STUK's staff on receiving hospitality to avoid conflicting situations with the regulated licensees.

The one area that needs more attention should be the inspectors, particularly the resident inspectors at the nuclear facilities. When the resident inspectors are hired, they spend three to six months at STUK, and then go to the site where they can remain for an indeterminate time. Care should be taken that all resident inspectors have sufficient time at STUK and understand the roles and responsibilities of a public official working for STUK.

Sources: (*Nuclear Energy Act (990/1987)* 2008, *Nuclear Energy Decree (161/1988)* 2008, *Radiation Act (592/1991)* 2011, *Radiation Decree (1512/1991)* 2009, IAEA 2012, 2015a, STUK 2016, 2013g, 2017b)

Transparency	Availability	The relevant documents are available.
	Accessibility	The relevant documents are accessible.
Requirement		The GSR-1 requirement is met.

GSR-1 Requirement 18: Staffing and competence of the regulatory body

The regulatory body shall employ a sufficient number of qualified and competent staff, commensurate with the nature and the number of facilities and activities to be regulated, to perform its functions and to discharge its responsibilities.

The number of staff at STUK at the end of 2016 was 321. The majority of the professional staff of STUK work on regulatory functions related to the nuclear safety and waste management, which to some extent reflect the nature and safety significance of regulated activities. The number of people in this area has been increasing significantly over the past ten years. The increase is due to on-going construction activities and plans for new construction. Also the retirement of experienced staff has required increased recruitment.

To ensure that STUK has the appropriate number of people with relevant competencies, the following general process is applied. STUK establishes a strategy normally for a five year period. The strategy is implemented by core processes where specific operating programmes for the same period are updated annually. These plans reflect as accurately as possible the regulatory duties and work of STUK. STUK's competence and human resource needs are evaluated in each step mentioned above (strategy, operating plans) from organizational level to an individual level. Resource needs identified in the planning are documented in human resource plans and associated competencies influence the training programme.

STUK has an on-going training programme for its personnel. General training programmes are established on organizational as well as on individual level reflecting the tasks and responsibilities of the individual. Individual needs for training are identified in the course of work and annual planning. A specific self-assessment tool, named OSKAR, is used to explore the level of knowledge, skills and abilities available and necessary for regulatory functions. Inspectors working for the control of the use of radiation are required to have a formal qualification as a radiation safety officer.

Until now STUK has not required formal qualifications for inspectors in other regulatory areas. However, the suggestion has been made that STUK should consider development of a formal qualification programme of inspectors for nuclear safety and waste management. One reason for this is the wider use of inspection organization in the future on this particular area. Formal qualification would ensure consistent inspection process between STUK and inspection organizations.

In addition to competence and resources of STUK's own staff, STUK uses technical support organizations as well as other consultants to support regulatory activities. However, also in these areas STUK's expertise has to be wide and deep enough to enable STUK to make good regulatory decisions.

Sources: (*Nuclear Energy Act (990/1987)* 2008, *Nuclear Energy Decree (161/1988)* 2008, *Radiation Act (592/1991)* 2011, *Radiation Decree (1512/1991)* 2009, IAEA 2012, 2015a, STUK 2016, 2013g, 2017b)

Transparency	Availability	The relevant documents are available.
	Accessibility	The relevant documents are accessible.
Requirement		The GSR-1 requirement is met.

GSR-1 Requirement 21: Liaison between the regulatory body and authorized parties

The regulatory body shall establish formal and informal mechanisms of communication with authorized parties on all safety related issues, conducting a professional and constructive liaison.

STUK has established both formal and informal mechanisms for communication between STUK and authorized parties to ensure possibilities for professional and constructive liaison. The IRRS Team in 2012 concluded that, based on the experience and stakeholder feedback, liaison and communication work very well between STUK and the authorized parties.

Formal and most frequently used mechanisms are through correspondence between STUK and authorized parties, and inspections on the authorized activities and organizations. It is also possible for STUK to invite authorized parties to a formal meeting. Formal mechanisms are described in detail in STUK's management system.

The informal mechanisms consist of informal meetings as well as discussions between individuals at different levels of the organizations. The IRRS Mission Team noted, that both mechanisms allow possibilities for frank and open discussions to foster mutual understanding on safety related issues. Authorized parties are also given the possibility to be heard when regulatory decisions are made prior to issuance and to participate in the regulations update process prior they are set in force. Stakeholder feedback is also collected via questionnaires and surveys.

STUK's decisions and requirements have a sound legal basis and the requirements set have to be commensurate with safety. The basis for the decision, evaluation criteria, and scope of the review as well as basis for possible requirements set to the authorized parties is included in the decision or presented in a separate justification memorandum, which is to be attached to the decision and is submitted to the authorized parties.

After his retirement the former head of STUK Jukka Laaksonen (1997-2012) moved to Rosatom Overseas as Vice President. He is in charge to promote Rosatom reactors abroad. This direct movement from the regulatory body to a supplier of reactor technology is not unique, but could raise some questions, having in mind that Rosatom is aiming to build its new VVER at Hanhikivi site.

Sources: (*Nuclear Energy Act (990/1987)* 2008, *Nuclear Energy Decree (161/1988)* 2008, *Radiation Act (592/1991)* 2011, *Radiation Decree (1512/1991)* 2009, IAEA 2012, 2015a, STUK 2016, 2013g, 2017b)

Transparency	Availability	The relevant documents are available.
	Accessibility	The relevant documents are accessible.
Requirement		The GSR-1 requirement is met.

GSR-1 Requirement 22: Stability and consistency of regulatory control

The regulatory body shall ensure that regulatory control is stable and consistent.

STUK's regulatory activities and decisions have to be based on legislation. They are outlined in the Acts and decrees for both Nuclear Safety and Radiation Safety. Regulatory activities and core processes are detailed in the management system and when decisions are made, the legislative justification has to be provided to a decision maker as well as to the authorized party in question.

Changing regulatory requirements presented in the legislation and regulatory guides is possible following a process. The process includes active participation of the involved stakeholders as well as advisory groups. Although the regulatory guides are not legally binding, the licensee has to come with a proposal to meet the intent of the regulations and it must be approved by STUK. There is a four-step process when modifying guidance documents including stakeholder as well as the respective advisory commission comment. This is an additional step to assure transparency when changing regulatory requirements.

Consistency in decision-making process is ensured to some extent with a scope of and procedures for the review and assessment process and decision-making. Regulatory decisions are made with two signatures to decrease the possibility for subjectivity. Nevertheless, the upcoming changes in the regulation need to be addressed, as they are planned to take place in the first half of 2018.

Sources: (*Nuclear Energy Act (990/1987)* 2008, *Nuclear Energy Decree (161/1988)* 2008, *Radiation Act (592/1991)* 2011, *Radiation Decree (1512/1991)* 2009, IAEA 2012, 2015a, STUK 2016, 2013g, 2017b)

Transparency	Availability	The relevant documents are available.
	Accessibility	The relevant documents are accessible.
Requirement		The GSR-1 requirement is met.

GSR-1 Requirement 24: Demonstration of safety for the authorization of facilities and activities

The applicant shall be required to submit an adequate demonstration of safety in support of an application for the authorization of a facility or an activity.

STUK consults interested parties (public, advisory bodies, licensees, ministries, other authorities etc.) in licensing steps (when issuing safety assessments), when drafting new regulations and in the areas related to other authorities (e.g. security, emergency preparedness).

The NPP licenses are prepared by Ministry of Employment and the Economy (MEE) with STUK providing the STUK statement and safety assessment report. The Government through the same Ministry must approve all changes of license conditions. STUK performs also in these cases the safety assessment to support the MEE processes.

STUK has established a comprehensive set of technical and radiological acceptance criteria and associated safety assessment requirements for all plant states including adequate consideration of different design extension conditions and severe accidents.

In accordance with the Government Decree on the Safety of Nuclear Power Plants Section 3 and STUK guide YVL 2.0 Section 2.3, the licensee shall independently verify the safety assessment delivered by the designer or vendor as essential component of demonstration of the prime responsibility of the licensee for safety. Large number of guides related to safety assessment to be performed by the licensees, as well as well as those for control of internal review processes are available, thus providing adequate framework for review and assessment. For nuclear power plants, this framework includes a comprehensive set of technical and radiological acceptance criteria and assessment conditions for all plant states, including severe accidents.

Sources: (*Nuclear Energy Act (990/1987)* 2008, *Nuclear Energy Decree (161/1988)* 2008, *Radiation Act (592/1991)* 2011, *Radiation Decree (1512/1991)* 2009, IAEA 2012, 2015a, STUK 2016, 2013g, 2017b)

Transparency	Availability	The relevant documents are available.
	Accessibility	The relevant documents are accessible.
Requirement		The GSR-1 requirement is met.

GSR-1 Requirement 32: Regulations and guides

The regulatory body shall establish or adopt regulations and guides to specify the principles, requirements and associated criteria for safety upon which its regulatory judgements, decisions and actions are based.

In Finland, legally binding regulatory principles and requirements are stipulated through relevant acts of Parliament and (mainly) through specific Government or Ministerial decrees. Appropriate authorization in the Law allows Government or individual Ministries to issue decrees in defined areas. STUK makes proposals for the development of legislation related to its competence according to the Decree on STUK. The Ministries (Social Affairs and Health, the Interior, Employment and the Economy) are those who have the legal basis to initiate changes to the legislation. Therefore, STUK needs to cooperate with relevant ministries in the legislative process to maintain an appropriate framework of regulatory principles and requirements relevant to its areas of competence. The Parliament of Finland approved the changes of the Nuclear Energy Act and Radiation Act on the 10th of March 2015 in such a way that the independence of STUK is increased. Based on the changes STUK has the authority to issue mandatory technical safety regulations. Further, based on the changes of the Nuclear Energy Act the Government has to take into account the proposals included in the STUK's statements when considering the conditions of the Decision in Principles and licenses for nuclear facilities. In addition, STUK's authority is widened to environmental surveillance of mining and milling facilities and nuclear facilities.

Based on provisions in Radiation Act and Nuclear Energy Act, STUK issues detailed regulatory guides (YVL, ST, VAL) to provide details relating to the main principles and requirements stipulated in acts and decrees. The legislation together with YVL and ST guides constitute an integral system of regulations for the use of nuclear energy and the use of radiation. Some of the requirements in the YVL and ST regulatory guides are overlapping.

The regulatory guides are not legally binding. The licensees have the right to propose an alternative procedure or solution to that provided in the regulations. If the licensee can convincingly demonstrate that the proposed procedure or solution will implement safety standards in accordance with or greater than the regulatory guides, STUK may approve the procedure or solution by which this safety level is achieved. In addition, STUK can approve exemptions to the YVL and ST guides if this is properly justified.

Sources: (*Nuclear Energy Act (990/1987)* 2008, *Nuclear Energy Decree (161/1988)* 2008, *Radiation Act (592/1991)* 2011, *Radiation Decree (1512/1991)* 2009, IAEA 2012, 2015a, STUK 2016, 2013g, 2017b)

Transparency	Availability	The relevant documents are available.
	Accessibility	The relevant documents are accessible.
Requirement		The GSR-1 requirement is met.

Structure of the new YVL Guides

A Safety management of a nuclear facility

- A.1 Regulatory oversight of safety in the use of nuclear energy
- A.2 Site for a nuclear facility
- A.3 Management system for a nuclear facility
- A.4 Organisation and personnel of a nuclear facility
- A.5 Construction and commissioning of a nuclear facility
- A.6 Conduct of operations at a nuclear power plant
- A.7 Probabilistic risk assessment and risk management of a nuclear power plant
- A.8 Ageing management of a nuclear facility
- A.9 Regular reporting on the operation of a nuclear facility
- A.10 Operating experience feedback of a nuclear facility
- A.11 Security of a nuclear facility
- A.12 Control of information security on a nuclear facility

B Plant and system design

- B.1 Safety design of a nuclear power plant
- B.2 Classification of systems, structures and components of a nuclear facility
- B.3 Deterministic safety analyses for a nuclear power plant
- B.4 Nuclear fuel and reactor
- B.5 Reactor coolant circuit of a nuclear power plant
- B.6 Containment of a nuclear power plant
- B.7 Provisions for internal and external hazards at a nuclear facility
- B.8 Fire protection at a nuclear facility

C Radiation safety of a nuclear facility and environment

- C.1 Structural radiation safety and radiation monitoring of a nuclear facility
- C.2 Radiation protection and dose control of the personnel of a nuclear facility
- C.3 Control and measuring of radioactive releases to the environment of a nuclear facility
- C.4 Radiological control of the environment of a nuclear facility
- C.5 Emergency arrangements of a nuclear power plant
- C.6 Radiation monitoring at a nuclear facility
- C.7 Radiological monitoring of the environment of a nuclear facility

D Nuclear materials and waste

- D.1 Regulatory control of nuclear safeguards
- D.2 Transport of nuclear materials and nuclear waste
- D.3 Handling and storage of nuclear fuel
- D.4 Predisposal management of low and intermediate level nuclear waste and decommissioning of a nuclear facility
- D.5 Disposal of nuclear waste
- D.6 Production of uranium and torium in mining and milling activities
- D.7 Barriers and rock engineering of nuclear waste disposal facility

E Structures and equipment of a nuclear facility

- E.1 Authorised inspection body and the licensee's in-house inspection organisation
- E.2 Procurement and operation of nuclear fuel
- E.3 Pressure vessels and pipings of a nuclear facility
- E.4 Strength analyses of nuclear power plant pressure equipment
- E.5 In-service inspection of nuclear facility pressure equipment with non-destructive testing methods
- E.6 Buildings and structures of a nuclear facility
- E.7 Electrical and I&C equipment of a nuclear facility
- E.8 Valves of a nuclear facility
- E.9 Pumps of a nuclear facility
- E.10 Emergency power supplies of a nuclear facility
- E.11 Hoisting and transfer equipment of a nuclear facility
- E.12 Testing organisations for mechanical components and structures of a nuclear facility

Collected definitions of YVL Guides: same data is shown both as the collection and within the guides.

Figure 7: Structure of the new YVL Guides Source: (STUK 2017a)

GSR-1 Requirement 36: Communication and consultation with interested parties

> *The regulatory body shall promote the establishment of appropriate means of informing and consulting interested parties and the public about the possible radiation risks associated with facilities and activities, and about the processes and decisions of the regulatory body.*

The decree on STUK 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 (Section 1 of the Decree on STUK). STUK's management system (Guide STUK 1.1) describes STUK's values, and one of the values is openness. In addition, Guide STUK 1.1 provides STUK's communication policy highlighting the following principles:

- STUK's communication is open, prompt and starts on STUK's own initiative
- STUK's experts and expertise are made available also outside office hours

- Good cooperation with the media to make STUK available and known to the public
- STUK's website is up to date and easy to use and contains good information on radiation and nuclear safety.

STUK utilizes the website to inform the public and interested stakeholders about nuclear and radiation safety in general, risks related to radiation and use of nuclear energy, safety requirements, roles and responsibilities of STUK, STUK's organization, current activities and operating experience, significant regulatory decisions taken, events and publications and safety research. STUK web pages can be found (www.stuk.fi) in Finnish, Swedish and in English. STUK has also made itself available in social media (Facebook and Twitter).

In addition to the website, STUK utilizes different means to communicate with public and interested stakeholders:

- Communication with the authorized parties is conducted via correspondence, meetings and seminars and personal contacts
- STUK organizes and participates in training courses on nuclear and radiation safety for interested parties (e.g. training to media people, training on radiation protection, training on customs officers, training on regulatory requirements for licensees, vendors and subcontractors etc.)
- Press releases are published on safety significant events at nuclear facilities or in the use of radiation.
- Regular reports on radiation and nuclear safety are published quarterly and annually.
- STUK has also organized meetings and seminars with the public of the municipalities living near the nuclear power plants. The purpose of these meetings has mainly been to interact with the public and present the results of annual oversight results and safety assessments of the nuclear power plants.

For communication during emergencies, STUK has established lists of contact points to relevant licensees, authorities and ministries in Finland and abroad. Communication is practiced in the annual emergency exercises.

STUK consults interested parties (public, advisory bodies, licensees, ministries, other authorities etc.) in licensing steps (when issuing safety assessments), when drafting new regulations and in the areas related to other authorities (e.g. security, emergency preparedness).

Sources: (*Nuclear Energy Act (990/1987)* 2008, *Nuclear Energy Decree (161/1988)* 2008, *Radiation Act (592/1991)* 2011, *Radiation Decree (1512/1991)* 2009, IAEA 2012, 2015a, STUK 2016, 2013g, 2017b)

Transparency	Availability	The relevant documents are available.
	Accessibility	The relevant documents are accessible.
Requirement		The GSR-1 requirement is met.

National requirements for NPP design

This subchapter targets to identify to what extent international technical requirements for nuclear safety are implemented in the national regulatory framework. The comparison is based on three IAEA documents from the Specific Safety Requirements Series. SSR-2/1 - Safety of Nuclear Power Plants: Design (IAEA 2016e), SSR-2/1 Safety of Nuclear Power Plants: Commissioning and Operation (IAEA 2016e) and NS-R-3 - Site Evaluation for Nuclear Installations (IAEA 2016f). The latter is currently undergoing review and shall be established as SSR-1: Site Evaluation for Nuclear Installations afterwards.

The analysis was done on the two levels of transparency and requirement fulfillment, as in the sections before. Due constraints in resources and time budget the topics of the analysis were limited to the nuclear island. Requirements concerning waste, decommissioning, security & transportation, long term, human factors & operation were excluded. Although at some points, interconnections or dependencies with these topics were included.

The IAEA requirements have been compared against the counties' regulatory requirements and not the country-specific VVER design, as there is not much information on the latter (and it was not target of this report). It was also abstained from rating the implementation within the regulation. Solely the taking into account of the IAEA requirement was evaluated.

It also has to be noted that the documents reviewed are mostly unofficial translations. Thus, it is thinkable, that findings are attributable to incorrect translations. On the other hand, a misinterpretation of the translation or a mistranslation could also have led to an assumed fulfillment of a requirement, which actually is not met.

The base regulation for safety and design of NPP design is STUK Y/1/2016 (STUK 2016), which has superseded Government Degree on the Safety of Nuclear Power Plants (717/2013) . Together with YVL guides, a system of regulations for the use of nuclear energy is established[3]. All these documents are available in English. A complete list of YVL Guides is provided in the Litereature section of this document.

The following tables/chapters provide the assessment of the requirements from the three IAEA documents. Below the tables those requirements found not (fully) meeting the requirements are discussed. In general, only the main requirements and not the paragraphs, describing the requirement in detail, were checked. The tables also mention the main document, where the topic is addressed. In some cases, there might be other YVLs also relevant for part of the issue, but not recorded in table. For each of the IAEA requirement documents an overall evaluation of the fulfilment of the transparency and requirement criteria is provided.

The analysis of requirement-shortfalls is provided in the chapter: Multidimensional quantitative and qualitative criteria evaluation.

[3] At the moment these YVLs relate to the previous government decree. This should be corrected with the next update of YVLs.

SSR-2/1 - Safety of Nuclear Power Plants: Design

Table 4: Fulfillment of selected SSR-2/1 requirements - Finland

Requirement	Transparency aspects		Relevant document(s)	Requirement fulfillment
	Information available	Information accessibility		
Requirement 1: Responsibilities in the management of safety in plant design	ok	ok	NEA Section 7	ok
Requirement 4: Fundamental safety functions	ok	ok	NED, YVL B.1, YVL B.4	ok
Requirement 6: Design for a nuclear power plant	ok	ok	Various guides within A, B, and E Series	ok
Requirement 7: Application of defence in depth	ok	ok	NED, STUK Y/1/2016, YVL B.1/4.3	ok
Requirement 9: Proven engineering practices	ok	ok	STUK Y/1/2016, YVL B.1, 3.7	ok
Requirement 10: Safety assessment	ok	ok	STUK Y/1/2016, YVL_B.1, YVL A.7, YVL B.3	ok
Requirement 11: Provision for construction	ok	ok	YVL B.1	ok
Requirement 13: Categories of plant states	ok	shortfall	STUK Y/1/2016, various YVL	ok
Requirement 14: Design basis for items important to safety	ok	ok	YVL B.1/3.7, YVL B.2	ok
Requirement 15: Design limits	ok	ok	YVL C.3	ok
Requirement 16: Postulated initiating events	ok	ok	YVL B.1, B.3, A.7	ok
Requirement 17: Internal and external hazards	ok	ok	STUK Y/1/2016, YVL B.7	ok
Requirement 18: Engineering design rules	ok	ok	E: Structures and equipment of a nuclear facility	ok
Requirement 19: Design basis accidents	ok	shortfall	IRRS, STUK Y/1/2016, YVL B.3	ok
Requirement 20: Design extension conditions	ok	ok	IRRS, STUK Y/1/2016, YVL B.3, YVL B.4	ok
Requirement 21: Physical separation and independence of safety systems	ok	ok	STUK Y/1/2016	ok
Requirement 22: Safety classification	ok	ok	STUK Y/1/2016, YVL B.2	ok

Requirement 23: Reliability of items important to safety	ok	ok	Requested by several YVL	ok
Requirement 24: Common cause failures	ok	ok	STUK Y/1/2016	ok
Requirement 25: Single failure criterion	ok	ok	YVL_B.1	ok
Requirement 26: Fail-safe design	ok	shortfall	YVL_B.1	ok
Requirement 27: Support service systems	ok	ok	YVL_B.1	ok
Requirement 28: Operational limits and conditions for safe operation	ok	ok	STUK Y/1/2016 S22, YVL_C.3	ok
Requirement 29: Calibration, testing, maintenance, repair, replacement, inspection and monitoring of items important to safety	ok	ok	Various YVLs	ok
Requirement 30: Qualification of items important to safety	ok	ok	YVL B.1, 3.9	ok
Requirement 33: Safety systems, and safety features for design extension conditions, of units of a multiple unit nuclear power plant	Not relevant for a single unit site.			
Requirement 34: Systems containing fissile material or radioactive material	ok	ok	YVL B.4	ok
Requirement 42: Safety analysis of the plant design	ok	ok	YVL A.7, YVL B.3	ok
Requirement 43: Performance of fuel elements and assemblies	ok	ok	YVL B.4	ok
Requirement 44: Structural capability of the reactor core	ok	ok	YVL B.4	ok
Requirement 45: Control of the reactor core	ok	ok	YVL B.4	ok
Requirement 46: Reactor shutdown	ok	ok	YVL B.4	ok
Requirement 47: Design of reactor coolant systems	ok	ok	STUK Y/1/2016 S10, YVL B.5	ok
Requirement 48: Overpressure protection of the reactor coolant pressure boundary	ok	ok	YVL B.5, 4.3	ok
Requirement 49: Inventory of reactor coolant	ok	ok	YVL B.5, 5	ok
Requirement 50: Cleanup of reactor coolant	ok	ok	YVL B.5, 5	ok
Requirement 51: Removal of residual heat from the reactor core	ok		STUK Y/1/2016 11/7, YVL B.1	ok
Requirement 52: Emergency cooling of the reactor core	ok	ok	YVL B.1, 5.1	ok
Requirement 53: Heat transfer to an ultimate heat sink	ok	ok	YVL B.1, 5.1	ok

Requirement 54: Containment system for the reactor	ok	ok	YVL B.6, 3	ok
Requirement 55: Control of radioactive releases from the containment	ok	ok	YVL B.6	ok
Requirement 56: Isolation of the containment	ok	ok	YVL B.6, 3.6	ok
Requirement 57: Access to the containment	ok	ok	YVL B.6, 3.5	ok
Requirement 58: Control of containment conditions	ok	ok	STUK Y/1/2016 S10/3, YVL B.6, 3.8	ok
Requirement 59: Provision of instrumentation	ok	ok	YVL B.1, 5.2	ok
Requirement 60: Control systems	ok	ok	YVL B.1, 5.2	ok
Requirement 61: Protection system	ok	ok	YVL B.1, 5.2	ok
Requirement 62: Reliability and testability of instrumentation and control systems	ok	ok	YVL E.7	ok
Requirement 63: Use of computer based equipment in systems important to safety	ok	ok	YVL E.7	ok
Requirement 64: Separation of protection systems and control systems	ok	ok	YVL B.1, 5.2	ok
Requirement 65: Control room	ok	ok	STUK Y/1/2016 S16, YVL B.1, 5.3	ok
Requirement 66: Supplementary control room	ok	ok	STUK Y/1/2016 S16, YVL B.1, 5.3	ok
Requirement 68: Design for withstanding the loss of off-site power	ok	ok	STUK Y/1/2016 S11, YVL B.1, 5.4, YVL E.10	ok

Evaluation of IAEA SSR-2/1

Transparency	Availability	The relevant documents are available.
	Accessibility	**Some documents are not well accessible and/or lack clarity for the requirement evaluation.**
Requirement		The SSR-2/1 requirements are met.

SSR-2/2 - Safety of Nuclear Power Plants: Commissioning and Operation

Table 5: Fulfillment of selected SSR-2/2 requirements- Finland

Requirement	Transparency aspects		Relevant document(s)	Requirement fulfillment
	Information available	Information accessibility		
Requirement 1: Responsibilities of the operating organization	ok	ok	NEA Section 7f, NED	ok
Requirement 2: Management system	ok	ok	NEA Section 7j-k, STUK Y/1/2016, YVL A.3	ok
Requirement 3: Structure and functions of the operating organization	ok	ok	STUK Y/1/2016, YVL A.3, YVL A.4	ok
Requirement 4: Staffing of the operating organization	ok	ok	STUK Y/1/2016, YVL A.4	ok
Requirement 5: Safety policy	ok	ok	STUK Y/1/2016, YVL A.4	ok
Requirement 6: Operational limits and conditions	ok	ok	STUK Y/1/2016 S22, YVL A.6	ok
Requirement 8: Performance of safety related activities	ok	ok	STUK Y/1/2016, YVL Guides, Group C, YVL A.4	ok
Requirement 9: Monitoring and review of safety	ok	ok	STUK Y/1/2016, YVL A.4	ok
Requirement 10: Control of plant configuration	ok	ok	YVL B.1	ok
Requirement 11: Management of modifications	ok	ok	YVL B.1	ok
Requirement 12: Periodic safety review	ok	ok	STUK Y/1/2016, YVL A.1, YVL B.1	ok
Requirement 13: Equipment qualification	ok	ok	YVL B.1	ok
Requirement 19: Accident management programme	ok	ok	YVL A.4	ok
Requirement 25: Commissioning programme	ok	ok	STUK Y/1/2016, NED, YVL A.5	ok

Evaluation of IAEA SSR-2/2

Transparency	Availability	The relevant documents are available.
	Accessibility	The relevant documents are accessible.
Requirement		The SSR-2/1 requirements are met.

NS-R-3 Chapter 3: Specific requirements for evaluation of external events

The topics of the NS-R-3 are addressed at several parts of the Finnish framework. The baseline is set in STUK Y/1/2016, Section 14 (STUK 2016):

> ***"Section 14 Protection against external hazards affecting safety***
> *1. The design of a nuclear power plant shall take account of external hazards that may endanger safety functions. Systems, structures, components and access shall be designed, located and protected so that the impacts of external hazards deemed possible on plant safety remain minor. The operability of systems, structures and components shall be demonstrated in their design basis external environmental conditions.*
> *2. External hazards shall include exceptional weather conditions, seismic events, the effects of accidents that take place in the environment of the facility, and other factors resulting from the environment or human activity. The design shall also consider unlawful actions with the aim of damaging the plant and a large commercial aircraft crash."*

The basic guide for site requirements is YVL A.2 - Site for nuclear facility (STUK 2013a). This guide does not provide many specifics, instead it refers to other guides, such as guides YVL B.1 - Safety design of a nuclear power plant (STUK 2013c) and YVL B.7 Provisions for internal and external hazards at a nuclear facility (STUK 2013e), as well as guides relating to radiation protection.

The most details considering external events are provided in chapters 4 and 5 of YVL B.7, called "Earthquakes" and "Other hazards external to the nuclear facility". Further requirements are set in YVL B.2 Classification of systems, structures and components of a nuclear facility (STUK 2013d) and YVL E.6 Buildings and structures of a nuclear facility (STUK 2013f). Human induced events are also covered by YVL A.11 Security of a nuclear facility (STUK 2013b).

Concerning external event STUK states (STUK 2017a):

> *"PRA covers as a starting point all conceivable external hazards at the site, except intentional damaging of the plant, including those listed in international guidance. Most of the hazads can be screened out from PRA modelling because they are irrelevant at the site or have low frequency (< 1E-8/year) or no safety impact. The external hazards modelled in the PRAs include high sea water level, frazil ice formation in cooling water system, high sea water temperature, impurities in sea water (algae, oil slick), harsh weather conditions (extreme wind, tornadoes, temperatures, snowfall, lightnings), earthquakes and their relevant combinations. "* and *"Many types of severe external hazards are not relevant at the Finnish sites, e.g., dam breaks, tidal surges, landslides, soil instability. The licensee/applicant shall justify the conditions or events and their frequencies in detail. External events and conditions with an estimated frequency of occurrence less than 10-5/year shall be considered as DEC C."*(STUK 2017a)

Altough it might be true that *"many types of severe external hazards are not relevant at the Finnish sites"* this should be explained at some point. E.g., some geotechnical hazards cannot be found in YVL B.7.

Evaluation of NS-R-3 Chapter 3

Transparency	Availability	The relevant documents are available.
	Accessibility	**Some documents are not well accessible and/or lack clarity for the requirement evaluation.**
Requirement		The NS-R-3 requirements are met.

Multidimensional quantitative and qualitative criteria evaluation

Based on the analyses of the variables a multidimensional quantitative and qualitative criteria evaluation is performed. Via the multidimensional evaluation strengthens and weakness are made visible. Further, this is used to compare the different variables and to elaborate differences between those regarding the checklist and transparency. Areas, where differences between the requirements and the status quo were observed, are discussed in this section.

Hungary

Responsibilities and functions of the Governments

Based on the results from the checklist the multidimensional quantitative and qualitative criteria evaluation indicted that the independence of the regulatory body needs to be elaborated more in detail.

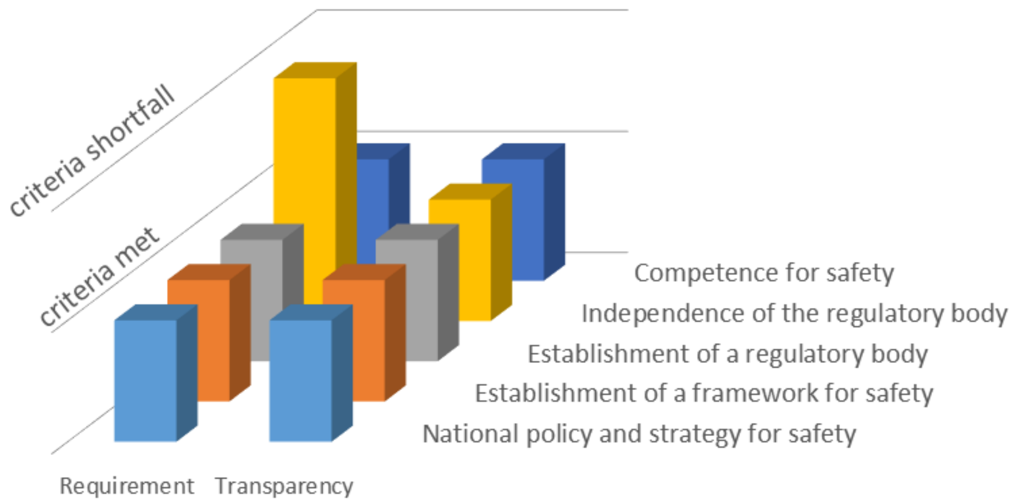

Figure 8: Hungary Criteria Evaluation - Responsibility and Functions of the Governments

Independence of the regulatory body

The checklist indicated that some of the checklist criteria are not fully met. Based on GSR-1 Requirement 4: Independence of the regulatory body the following should be fulfilled (IAEA 2016c, 6–8).

> *"The government shall ensure that the regulatory body is effectively independent in its safety related decision making and that it has functional separation from entities having responsibilities or interests that could unduly influence its decision making.*
>
> *An independent regulatory body will not be entirely separate from other governmental bodies. The government has the ultimate responsibility for involving those with legitimate and recognized interests in its decision making. However, the government shall ensure that the regulatory body is able to make decisions under its statutory obligation for the regulatory control of facilities and activities, and that it is able to perform its functions without undue pressure or constraint.*
>
> *To be effectively independent from undue influences on its decision making, the regulatory body:*
>
> > *(a) Shall have sufficient authority and sufficient competent staff;*

(b) Shall have access to sufficient financial resources for the proper and timely discharge of its assigned responsibilities;

(c) Shall be able to make independent regulatory judgements and regulatory decisions, at all stages in the lifetime of facilities and the duration of activities until release from regulatory control, under operational states and in accidents;

(d) Shall be free from any pressures associated with political circumstances or economic conditions, or pressures from government departments, authorized parties or other organizations;

(e) Shall be able to give independent advice and provide reports to government departments and governmental bodies on matters relating to the safety of facilities and activities. This includes access to the highest levels of government;

(f) Shall be able to liaise directly with regulatory bodies of other States and with international organizations to promote cooperation and the exchange of regulatory related information and experience

No responsibilities shall be assigned to the regulatory body that might compromise or conflict with its discharging of its responsibility for regulating the safety of facilities and activities.

The staff of the regulatory body shall have no direct or indirect interest in facilities and activities or authorized parties beyond the interest necessary for regulatory purposes.

In the event that a department or agency of government is itself an authorized party operating an authorized facility or facilities, or conducting authorized activities, the regulatory body shall be separate from, and effectively independent of, the authorized party.

The regulatory body shall be conferred with the legal authority to require an authorized party or an applicant, whether a person or an organization, to make arrangements to provide:

(a) All necessary safety related information, including information from suppliers, even if this information is proprietary;

(b) Access, solely or together with the authorized party or applicant, for making inspections on the premises of any designer, supplier, manufacturer, constructor, contractor or operating organization associated with the authorized party." (IAEA GSR-1, Requirement 4)

Within the Ministry for Innovation and Technology, the State Minister for energy affairs has responsibility for both the Paks NPP and the HAEA. Although the Minister's responsibility for the HAEA is solely 'supervisory', the Ministry may face conflicting considerations when progressing the development of legislative provisions submitted by the HAEA. Similarly, the Ministry may face conflicting considerations when reviewing HAEA resource and organizational change submissions.

Further the HAEA does currently not have prompt and unconstrained access to the highest level of the Ministry for Innovation and Technology to address issues of regulatory concern. The Director General of the HAEA needs approval on the HAEA's 'Organisational and Operational Rules'. Additionally, the Director General of the HAEA does not have the authority to spend certain budgeted resources without prior approval from the Ministry for Innovation and Technology. Examples include the purchase of information technology equipment; office furnishing; and office space (buildings).

Hungarian legal provisions, established in Governmental Decree 118/2011. Korm. (and its Annexes) under the Act, prescribe time limits for the regulatory body to complete various authorization processes. The Act CXL/2004 also prescribes time limits which may lead to undue pressure on the regulatory body to complete its decision making process and thus compromise safety, which is not in line with the checklist criteria. Those are elaborated in detail in the next section.

Sources: (IAEA 2015b; HAEA 2016, 2018, *Act CXL of 2004 on the General Rules of Administrative Proceedings and Services* 2004, *Govt. Decree 118/2011 (VII. 11.) on the Nuclear Safety Requirements of Nuclear Facilities and on Related Regulatory Activities* 2011, *Act CXVI of 1996 on Atomic Energy*, n.d., *Annex 1 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 1 – Nuclear Safety Authority Procedures of Nuclear Facilities* 2011, *Annex 9 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 9 – Requirements for the Construction of a New Nuclear Installation* 2011; IAEA 2016a; *Annex 10 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 10 – Nuclear Safety Code Definitions* 2011)

Responsibilities and functions of the Regulatory Bodies

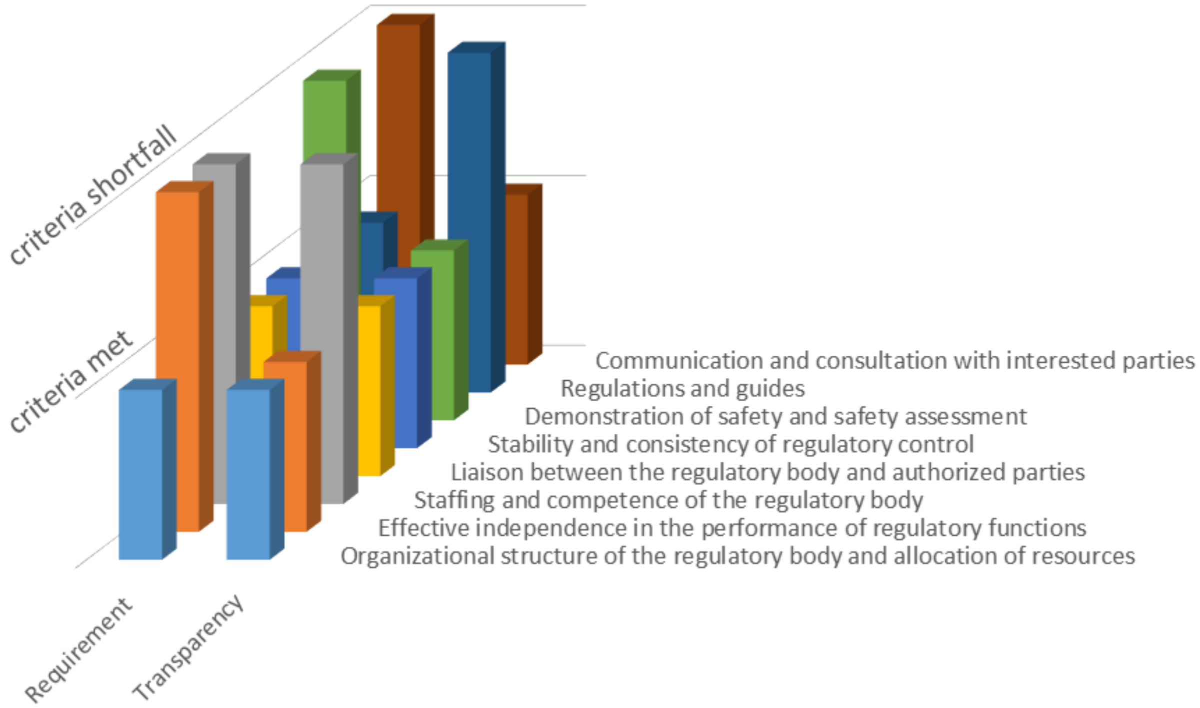

Figure 9: Hungary Criteria Evaluation - Responsibility and Functions of the Regulatory Body

Effective independence in the performance of regulatory functions

The checklist indicated that some of the checklist criteria are not fully met. This holds true for GSR-1 Requirement 17: Effective independence in the performance of regulatory functions, and GSR-1 Requirement 4 Independence of the regulatory body (IAEA 2016c, 20).

> *"The regulatory body shall perform its functions in a manner that does not compromise its effective independence.*
>
> *4.6. Requirements 3 and 4 in Section 2 stipulate that the government establish and maintain a regulatory body that is effectively independent in its decision making and that has functional separation from entities*

having responsibilities or interests that could unduly influence its decision making. This imposes an obligation on the regulatory body to discharge its responsibilities in such a way as to preserve its effective independence. The staff of the regulatory body shall remain focused on performing their functions in relation to safety, irrespective of any personal views. The competence of staff is a necessary element in achieving effective independence in decision making by the regulatory body.

4.7. The regulatory body shall prevent or duly resolve any conflicts of interests or, where this is not possible, shall seek a resolution of conflicts within the governmental and legal framework.

4.8. To maintain the effective independence of the regulatory body, special consideration shall be given when new staff members are recruited from authorized parties, and the independence of the regulatory body, regulatory aspects and safety considerations shall be emphasized in their training. The regulatory body shall ensure that its staff operate professionally and within its remit in relation to safety.

4.9. To maintain its effective independence, the regulatory body shall ensure that, in its liaison with interested parties, it has a clear separation from organizations or bodies that have been assigned responsibilities for facilities or activities or for their promotion.

4.10. The regulatory body, consistent with its effective independence, shall exercise its authority to intervene in connection with any facilities or activities that present significant radiation risks, irrespective of the possible costs to the authorized party"

Based on GSR-1 Requirement 4: Independence of the regulatory body the following should be fulfilled (IAEA 2016c, 6–8).

"The government shall ensure that the regulatory body is effectively independent in its safety related decision making and that it has functional separation from entities having responsibilities or interests that could unduly influence its decision making.

An independent regulatory body will not be entirely separate from other governmental bodies. The government has the ultimate responsibility for involving those with legitimate and recognized interests in its decision making. However, the government shall ensure that the regulatory body is able to make decisions under its statutory obligation for the regulatory control of facilities and activities, and that it is able to perform its functions without undue pressure or constraint."

The fact that there are very restrictive time schedules for HAEA to reply to submission of licencees puts pressure on HAEA and might influence safety related decisions due to time constraints. In the Governmental Decree 118/2011 Korm. Section 21 it is stated (*Govt. Decree 118/2011 (VII. 11.) on the Nuclear Safety Requirements of Nuclear Facilities and on Related Regulatory Activities* 2011, 14):

Section 21

The nuclear safety authority may proceed regulatory procedures with regard to activities subject to licensing with urgency, if it is necessary in order to eliminate an unfavourable safety condition. Such extraordinary proceeding cannot justify any omission of compliance with the requirements for the substantiating documentation, and shall not result in giving priority to aspects different from those of nuclear safety, or shall not decrease safety.

Section 21/A

The nuclear safety authority, in the procedures launched on application, except for the client that submitted the application to launch the case, the client shall be notified of the commencement of the procedure

a) 30 days within the receipt of the application

aa) in the procedures specified in Paragraphs 17 (1) a)-e) and g)-h),

ab) in the procedure specified in Paragraph 17 (1) f), if the modification entails the modification of the operation license,

ac) in the procedures specified in Subsection 18 (1), and

b) 15 days within the receipt of the application in the procedures specified in Paragraphs 17 (1) i) and j), in Subsections 17 (1a) and (3), and in Subsections 18 (2) and (3).

Section 21/B

(1) The administration deadline of the nuclear safety authority is

a) sixty days

aa) in the procedures specified in Paragraphs 17 (1) a), b), i) and j),

ab) with the exceptions specified in Paragraph b) and Subparagraph bb) in the procedures specified in Paragraph 17 (1) f),

ac) in the procedures specified in Subsection 17 (1a),

ad) in the procedures specified in Subsection 17 (3) and

ae) in the procedures specified in Subsections 18 (2) and (3),

b) six months

ba) in the procedures specified in Paragraphs 17 (1) d), c)-e), g) and h),

bb) in the cases specified in Paragraph 17 (1) f), if the modification entails the modification of the operation license and

bc) in the procedures specified in Subsection 18 (1).

(2) If it is justified, the manager of the nuclear safety authority is authorized to extend the administration deadline once

a) at most by 30 days in the cases specified in Paragraph (1) a),

b) at most 90 days in the cases specified in Paragraph (1) b)

The atomic energy oversight organization shall notify the client of the extension of the administration deadline and of all those who have been notified of the commencement of the procedure.

Section 21/C

If the client submitted the a deficient application, the nuclear safety authority shall call it to supplement the deficiency in

*a**)** 4 months within the receipt of the application in the procedures specified in Paragraphs 17 (1) c)–h) and Subsection 18 (1),* *b) 30 days within the receipt of the application in the procedures specified in Paragraphs 17 (1) a), b), i) and j), in Subsection 17 (1a) and (3), in Subsections 18 (2) and (3)."*

In Governmental Decree 118/2011 Korm. Chapter III Reguatory Supervision 11. Licensing and approval Subsection 17 and 18 the relevant applications are specified.

This makes clear, that the timeframes posed to the regulatory body HAEA are very strict. Such a strict timeframe may influence the decisions by the regulatory body and therefore have an impact on safety. HAEA has about 170 employees and two new nuclear power plants are planned to be built. It is questionable if the staff, which is planned to be increased to around 200 people, can put on discussion all the specific points they would like to, when comparing it so other systems where there is no pressure due to legislative time contraints.

Sources: (IAEA 2015b; HAEA 2016, 2018, *Act CXL of 2004 on the General Rules of Administrative Proceedings and Services* 2004, *Govt. Decree 118/2011 (VII. 11.) on the Nuclear Safety Requirements of Nuclear Facilities and on Related Regulatory Activities* 2011, *Act CXVI of 1996 on Atomic Energy*, n.d., *Annex 1 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 1 – Nuclear Safety Authority Procedures of Nuclear Facilities* 2011, *Annex 9 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 9 – Requirements for the Construction of a New Nuclear Installation* 2011; IAEA 2016a; *Annex 10 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 10 – Nuclear Safety Code Definitions* 2011)

Staffing and competence of the regulatory body

"Requirement 18: Staffing and competence of the regulatory body

The regulatory body shall employ a sufficient number of qualified and competent staff, commensurate with the nature and the number of facilities and activities to be regulated, to perform its functions and to discharge its responsibilities.

4.11. The regulatory body has to have appropriately qualified and competent staff. A human resources plan shall be developed that states the number of staff necessary and the essential knowledge, skills and abilities for them to perform all the necessary regulatory functions.

4.12. The human resources plan for the regulatory body shall cover recruitment and, where relevant, rotation of staff in order to obtain staff with appropriate competence and skills, and shall include a strategy to compensate for the departure of qualified staff.

4.13. A process shall be established to develop and maintain the necessary competence and skills of staff of the regulatory body, as an element of knowledge management. This process shall include the development of a specific training programme on the basis of an analysis of the necessary competence and skills. The training programme shall cover principles, concepts and technological aspects, as well as the procedures followed by the regulatory body for assessing applications for authorization, for inspecting facilities and activities, and for enforcing regulatory requirements."(IAEA 2016c, 21)

The HAEA had developed a database profiling the available organisational expertise and in the light of the Government's plans to build the Paks-2 new units, it has used this to determine the shortfall in staffing. The HAEA made a calculation of the necessary capacity and expertise related to the new tasks up to the year 2038. Due to the on-going recruitment of new staff and loss of senior staff to retirement, training and knowledge sharing is of high importance for the HAEA. The current staff of the HAEA is about 170, the target is to reach 200. There is no clear information regarding the professional working fields of HAEA employees, so that it not transparent how many professionals are working on what. Therefore an assessment on how many people are dealing with the new construction or the regulation of the existing plants is not possible. The lack of financial resources mainly because of the fact that the HAEA only gets oversight fees after issuing the constuction licence could cause problems for the regulatory body regarding the human resources in order to regulate the process pre-construction of the new nuclear power plants. There is massive financial support needed which needs to be covered by the Government.

Based on the comments of the IRRS mission in 2015 it can be noted that regarding the future additional responsibility for radiation safety, the HAEA will have to recruit and retain sufficient staff with adequate competences such as radiochemistry, dosimetry, medical physics, radiation physics, and in-depth knowledge of applied technologies. In addition, the IRRS mission noted that also support from TSOs is likely to be needed. Additionally the IRRS noted that during interviews it became clear that in the current oversight of radiation source facilities and activities, the lack of qualified staff is of concern.

The HAEA has had difficulty attracting and retaining qualified staff due to salary levels that are not competitive with industry, suppliers and some TSOs. Through the Project Act, the Government authorized the increase of HAEA salaries to enable the HAEA to counteract the exodus to the TSO's and the industry. These issues were identified by the HAEA in its self-assessment for the IRRS Mission and considered in its action plan. The HAEA has started recruiting new staff, and needs to educate and train them, especially those coming directly from university.

Sources: (IAEA 2015b; HAEA 2016, 2018, *Act CXL of 2004 on the General Rules of Administrative Proceedings and Services* 2004, *Govt. Decree 118/2011 (VII. 11.) on the Nuclear Safety Requirements of Nuclear Facilities and on Related Regulatory Activities* 2011, *Act CXVI of 1996 on Atomic Energy*, n.d., *Annex 1 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 1 – Nuclear Safety Authority Procedures of Nuclear Facilities* 2011, *Annex 9 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 9 – Requirements for the Construction of a New Nuclear Installation* 2011; IAEA 2016a; *Annex 10 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 10 – Nuclear Safety Code Definitions* 2011)

Demonstration of Safety and Safety Assessment

The GSR-1 Requirements 24-26 are taken as benchmark for this section (IAEA 2016c, 25–29).

> *"GSR-1 Requirement 24: Demonstration of safety for the authorization of facilities and activities*
>
> *The applicant shall be required to submit an adequate demonstration of safety in support of an application for the authorization of a facility or an activity.[…]*
>
> *GSR-1 Requirement 25: Review and assessment of information relevant to safety*
>
> *The regulatory body shall review and assess relevant information — whether submitted by the authorized party or the vendor, compiled by the regulatory body, or obtained from elsewhere — to determine whether facilities and activities comply with regulatory requirements and the conditions specified in the authorization. This review and assessment of information shall be performed prior to authorization and again over the lifetime of the facility or the duration of the activity, as specified in regulations promulgated by the regulatory body or in the authorization. […]*
>
> *GSR-1 Requirement 26: Graded approach to review and assessment of a facility or an activity*
>
> *Review and assessment of a facility or an activity shall be commensurate with the radiation risks associated with the facility or activity, in accordance with a graded approach. […]"*

The licensing stages for facilities and activities are prescribed in the Act on Atomic Energy and Governmental Decrees. The nuclear safety code prescribes requirements for the contents of licensing applications (document submission requirements) to demonstrate safety arrangements. The Basis for the safety assessment and the need for submission to HAEA is described in the Governmental Decree 118-2011 Chapter 9 Design Section 9. Further specifications and related regulations are specified in Annex 3, 3/A, 5 and 6. The principles regarding construction are lined out in the Governmental Decree 118-2011 Chapter 9/A Construction Section 10A and Section 10. Further specifications are elaborated in Annex 1 and 9.

The very restrictive time schedule for HAEA puts pressure on the regulatory body regarding the analyses of all submitted documents.

As specified in the Governmental Decree 118-2011 Chapter 15 Safety reports, safety assessment Section 31:

> *(1)In order to ensure the socially controlled application of atomic energy, the licensee shall prepare a report on its activity with regard to the operation and safety of the nuclear facility and the safety-related events occurring during operation, and the submit this report to the nuclear safety authority. The licensee shall submit the Preliminary Safety Analysis Report of the nuclear facility to the nuclear safety authority with the construction license application and the Final Safety Analysis Report in conjunction with the commissioning license application, according to the rules specified in Annexes 1, 3, 3/A, 5 and 6.*
>
> *(2) The nuclear safety authority conducts the safety assessment of nuclear facilities on the basis of its licensing experience, inspection results, the reports of the licensee, and other available information.*
>
> *(3) The reports submitted to the nuclear safety authority shall be prepared in such depth and to such a level of detail that enable the nuclear safety authority to inspect and assess the operational activity and the safety related events independently and substantively.*

The very restrictive time schedule for HAEA puts pressure on the regulatory body regarding the analyses of all submitted documents. Additionally the submission of the Preliminary Safety Analysis Report in conjunction with the short response period for the HAEA might influence the amount of potential requested changes in the design.

The review and assessment process of licensing applications utilizes TSOs. However, since a limited number of TSOs are available in the country, they provide services to both the licensees and the regulatory body.

Sources: (IAEA 2015b; HAEA 2016, 2018, *Act CXL of 2004 on the General Rules of Administrative Proceedings and Services* 2004, *Govt. Decree 118/2011 (VII. 11.) on the Nuclear Safety Requirements of Nuclear Facilities and on Related Regulatory Activities* 2011, *Act CXVI of 1996 on Atomic Energy*, n.d., *Annex 1 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 1 – Nuclear Safety Authority Procedures of Nuclear Facilities* 2011, *Annex 9 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 9 – Requirements for the Construction of a New Nuclear Installation* 2011; IAEA 2016a; *Annex 10 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 10 – Nuclear Safety Code Definitions* 2011)

Regulations and Guides

The requirements analyzed in this section are based on the GSR-1 Requirements 32-34 (IAEA 2016c, 32–33).

> *Requirement 32: Regulations and guides*
>
> *The regulatory body shall establish or adopt regulations and guides to specify the principles, requirements and associated criteria for safety upon which its regulatory judgements, decisions and actions are based.*
>
> *Requirement 33: Review of regulations and guides*

Regulations and guides shall be reviewed and revised as necessary to keep them up to date, with due consideration of relevant international safety standards and technical standards and of relevant experience gained.

Requirement 34: Promotion of regulations and guides to interested parties

The regulatory body shall notify interested parties and the public of the principles and associated criteria for safety established in its regulations and guides, and shall make its regulations and guides available.

The HAEA has an obligation to initiate the establishment, amendment of laws and to participate in the public administration coordination of them. The HAEA, under its mandate, develops a draft proposal of legislation. According to HAEA procedure, it sends draft proposals to the Ministry for Innovation and Technology.

According to the Act, the requirements for using atomic energy shall be regularly reviewed and updated, taking into account the results of science and international experiences. According to Governmental Decree 118/2011 Korm. taking into consideration the scientific results, and national and international experience, the Nuclear Safety Code shall be reviewed at least every five years and updated as required. The guidelines shall be reviewed periodically.

HAEA has not published the full set of safety guidelines to complement the mandatory safety requirements according to the Nuclear Safety Codes (NSC), Governmental Decree 118/2011 and Governmental Decrees issued from 2005 to 2011. Further, there is the need to notice that the HAEA consulted with licensees, but not with the public or other interested parties within the process to develop and review the regulatory safety guides.

Sources: (IAEA 2015b; HAEA 2016, 2018, *Act CXL of 2004 on the General Rules of Administrative Proceedings and Services* 2004, *Govt. Decree 118/2011 (VII. 11.) on the Nuclear Safety Requirements of Nuclear Facilities and on Related Regulatory Activities* 2011, *Act CXVI of 1996 on Atomic Energy*, n.d., *Annex 1 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 1 – Nuclear Safety Authority Procedures of Nuclear Facilities* 2011, *Annex 9 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 9 – Requirements for the Construction of a New Nuclear Installation* 2011; IAEA 2016a; *Annex 10 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 10 – Nuclear Safety Code Definitions* 2011)

Communication and consultation with interested parties

The requirements analyzed in this section are based on the GSR-1 Requirement 36 (IAEA 2016c, 34).

GSR-1 Requirement 36: Communication and consultation with interested parties

The regulatory body shall promote the establishment of appropriate means of informing and consulting interested parties and the public about the possible radiation risks associated with facilities and activities, and about the processes and decisions of the regulatory body.

The HAEA has a statutory obligation to inform the public on the safety of the use of atomic energy, its own activities, important decisions, and safety requirements. The HAEA has developed a Public Information Policy and Strategy. A mechanism has been established to obtain feedback from selected interested parties. According to the ST-2, the HAEA collects expectations of interested parties through different communications channels, such as, lawmakers, international organizations, independent review organizations, co-authorities, journalists, etc. It is noted that all comments from stakeholders should be discussed at management review meetings.

The HAEA operates a website Hungarian and English and a Facebook page. The website provides news on all-important events connected to its work, and publishes the main parameters and statements of HAEA resolutions. Interested parties can sign-up to a digital newsletter.

The IRRS mission in 2015 observed that, the HAEA has not published the full set of safety guidelines to complement the mandatory safety requirements according to the Nuclear Safety Codes (NSC), Governmental Decree 118/2011 and Governmental Decrees issued from 2005 to 2011.

It must be noted that the HAEA consulted with licensees, but not with the public or other interested parties within the process to develop and review the regulatory safety guides.

The HAEA has established a good practice regarding the information exchange with national and international partners. The BCDEPN chaired the transboundary environmental impact assessment regarding Paks II, which did not only take place in Hungary but also in other neighboring countries. Nevertheless, information regarding the reactor itself is limited. There is no possibility to get additional information on the reactor and its safety systems in detail. (IAEA 2015b; HAEA 2016, 2018, *Act CXL of 2004 on the General Rules of Administrative Proceedings and Services* 2004, *Govt. Decree 118/2011 (VII. 11.) on the Nuclear Safety Requirements of Nuclear Facilities and on Related Regulatory Activities* 2011, *Act CXVI of 1996 on Atomic Energy*, n.d., *Annex 1 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 1 – Nuclear Safety Authority Procedures of Nuclear Facilities* 2011, *Annex 9 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 9 – Requirements for the Construction of a New Nuclear Installation* 2011; IAEA 2016a; *Annex 10 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 10 – Nuclear Safety Code Definitions* 2011)

National requirements for NPP Design

The figure provides the results of the overall evaluation of the requirements for NPP design - criteria. Before discussing those topics where shortfalls to the IAEA requirements were identified, the following general findings shall be stated (again).

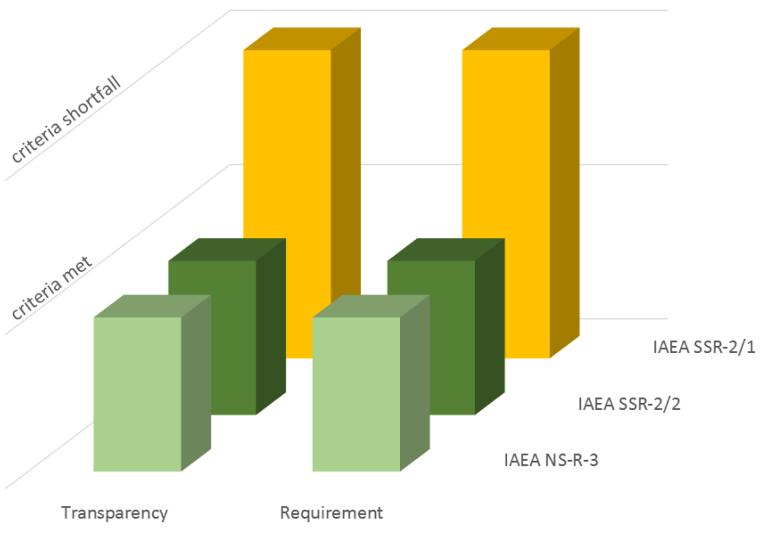

Figure 10: Hungary Criteria Evaluation - NPP Design requirements

The regulatory requirements would benefit from a clear structuring and formatting. At the moment this negatively influences the accessibilitiy aspect of the transparency criteria for all the requirements. This general finding was not reflected in the transparency criteria. Furthermore, some requirements were covered by some rather general regulation, providing few details for the specifics of the IAEA requirements. During the IRRS mission it was requested, that

> *"The regulatory body should consider establishing a formalized procedure to undertake a gap analysis between new IAEA requirements and the Hungarian legislative framework in order to ensure that the framework is up to date."* (IAEA 2015b, 84)

Concerning IAEA SSR-2/1 some discrepancies to the requirements were identified, as presented in the table below (IAEA 2016e).

Table 6: Shortfalls in selected SSR-2/1 requirements - Hungary

Requirement in SSR-2/1	Transparency Availability	Transparency Accessibility	Requirement
Requirement 33: Safety systems, and safety features for design extension conditions, of units of a multiple unit nuclear power plant	ok	ok	shortfall
Requirement 55: Control of radioactive releases from the containment	ok	ok	shortfall
Requirement 61: Protection system	ok	shortfall	shortfall
Requirement 64: Separation of protection systems and control systems	ok	shortfall	shortfall

Requirement 33 states (IAEA 2016e, 33):

> *"Safety systems, and safety features for design extension conditions, of units of a multiple unit nuclear power plant*
>
> *Each unit of a multiple unit nuclear power plant shall have its own safety systems and shall have its own safety features for design extension conditions."*

The Hungarian NSC 3a states, that the "*safety systems may be shared between the units only if warranted from a safety point of view."* According to the IAEA requirement, the safety systems shall not be shared in any case.

Requirement 55 states (IAEA 2016e, 43):

> *"Control of radioactive releases from the containment. The design of the containment shall be such as to ensure that any radioactive release from the nuclear power plant to the environment is as low as reasonably achievable, is below the authorized limits on discharges in operational states and is below acceptable limits in accident conditions.*
>
> *6.21. The number of penetrations through the containment shall be kept to a practical minimum and all penetrations shall meet the same design requirements as the containment structure itself. The penetrations shall be protected against reaction forces caused by pipe movement or accidental loads such as those due to missiles caused by external or internal events, jet forces and pipe whip."*

There is no mentioning of minimizing containment penetrations in the NSC. Also for the specification of the isolation valve, it is only stated that they shall be "taking into account all operating conditions belonging to the design basis of the nuclear power plant". This statement does not define requirements for the isolation valves for accident conditions.

Requirements 61 & 64 are related to the Protection System (IAEA 2016e, 46–48):

"Requirement 61: Protection system. A protection system shall be provided at the nuclear power plant that has the capability to detect unsafe plant conditions and to initiate safety actions automatically to actuate the safety systems necessary for achieving and maintaining safe plant conditions.

Requirement 64: Separation of protection systems and control systems Interference between protection systems and control systems at the nuclear power plant shall be prevented by means of separation, by avoiding interconnections or by suitable functional independence."

Only a single requirement for the protection system is mentioned in the document (see below). No requirements for the design e.g. separation is provided. The requirement for a protection system can only indirectly be derived by the following paragraph.

"The reactor protection system generating the protection signal giving an instruction for a quick shutdown of the reactor shall also perform its task even if one of the branches of the system fails and, simultaneously, another branch is also inoperable due to maintenance or testing." (*Annex 3a to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 3a – Design Requirements for New Nuclear Power Plant Unit* 2011)

There is no requirement explicitly stating that there has to be a system in place "that has the capability to detect unsafe plant conditions and to initiate safety actions automatically to actuate the safety systems necessary for achieving and maintaining safe plant conditions."

Finland

Responsibilities and functions of the Governments

Based on the results from the checklist the multidimensional quantitative and qualitative criteria evaluation indicted that the government in mostly in compliance with the requirements.

Figure 11: Finland Criteria Evaluation - - Responsibility and Functions of the Governments

There have been several efforts by the Government to enhance the independence of the regulatory body. With the approved changes in Nuclear and Radiation Acts in 2015 the Governments increased STUK's authorities to set binding regulations and license conditions.

It was noted by the IRRS mission in 2012 that the current practice of the licensing process in Finland is in practice (de facto) in line with IAEA requirements and guidance. Nevertheless, it was mentioned by the IRRS mission team, that in law (de jure) the role of the nuclear safety regulator in the process is not secured completely and unambiguously. Due to the recommendation of the IRRS mission in 2012, the Finnish Government modified the Nuclear Energy Act so that the law clearly and unambiguously stipulates STUKs legal authorities in the authorization process for safety.

Sources: (*Nuclear Energy Act (990/1987)* 2008, *Nuclear Energy Decree (161/1988)* 2008, *Radiation Act (592/1991)* 2011, *Radiation Decree (1512/1991)* 2009, IAEA 2012, 2015a, STUK 2016, 2013g, 2017b; IAEA 2016a)

Responsibilities and functions of the Regulatory Bodies

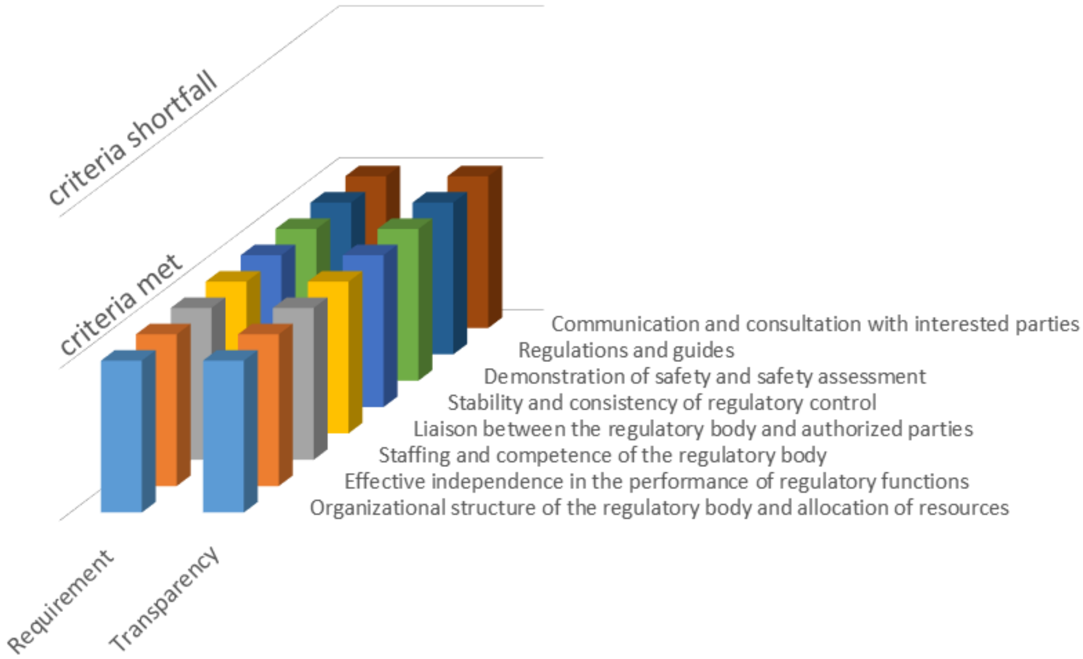

Figure 12: Finland Criteria Evaluation - - Responsibility and Functions of the Regulatory Body

Staffing and competence of the regulatory body

The number of staff at STUK at the end of 2016 was 321. The majority of the professional staff of STUK work on regulatory functions related to the nuclear safety and waste management, which to some extent reflect the nature and safety significance of regulated activities. The number of people in this area has been increasing significantly over the past ten years. The increase is due to on-going construction activities and plans for new construction. Also the retirement of experienced staff has required increased recruitment.

Until now STUK has not required formal qualifications for inspectors in other regulatory areas. However, the suggestion has been made that STUK should consider development of a formal qualification programme of inspectors for nuclear safety and waste management. One reason for this is the wider use of inspection organization in the future on this particular area. Formal qualification would ensure consistent inspection process between STUK and inspection organizations.

In addition to competence and resources of STUK's own staff, STUK uses technical support organizations as well as other consultants to support regulatory activities. However, also in these areas STUK's expertise has to be wide and deep enough to enable STUK to make good regulatory decisions.

Sources: (*Nuclear Energy Act (990/1987)* 2008, *Nuclear Energy Decree (161/1988)* 2008, *Radiation Act (592/1991)* 2011, *Radiation Decree (1512/1991)* 2009, IAEA 2012, 2015a, STUK 2016, 2013g, 2017b; IAEA 2016a)

Liaison between the regulatory body and authorized parties

STUK has established both formal and informal mechanisms for communication between STUK and authorized parties to ensure possibilities for professional and constructive liaison. The informal mechanisms consist of informal meetings as well as discussions between individuals at different levels of the organizations.

STUK's decisions and requirements have a sound legal basis and the requirements set have to be commensurate with safety. The basis for the decision, evaluation criteria, and scope of the review as well as basis for possible requirements set to the authorized parties is included in the decision or presented in a separate justification memorandum, which is to be attached to the decision and is submitted to the authorized parties.

After his retirement the former head of STUK Jukka Laaksonen (1997-2012) moved to Rosatom Overseas as Vice President. He is in charge to promote Rosatom reactors abroad. This direct movement from the regulatory body to a supplier of reactor technology is not unique, but could raise some questions, having in mind that Rosatom is aiming to build its new VVER at Hanhikivi site.

Sources: (*Nuclear Energy Act (990/1987)* 2008, *Nuclear Energy Decree (161/1988)* 2008, *Radiation Act (592/1991)* 2011, *Radiation Decree (1512/1991)* 2009, IAEA 2012, 2015a, STUK 2016, 2013g, 2017b; IAEA 2016a)

Stability and consistency of regulatory control

In 2016 STUK published binding regulations based on existing Government Decrees. The Nuclear Energy Act and Decree is under revision due to e.g. European directives and BSS by 2018. The STUK regulations and YVL Guides will be updated in spring 2018 taking into account, Lessons from implementation and related clarifications, Changes in Nuclear Energy Act and Decree, the WENRA Reference Levels 2014 and the updated IAEA requirement documents. It should be noted, that such changes might influence the stability and consistency of regulatory control, which sould be monitored. (*Nuclear Energy Act (990/1987)* 2008, *Nuclear Energy Decree (161/1988)* 2008, *Radiation Act (592/1991)* 2011, *Radiation Decree (1512/1991)* 2009, IAEA 2012, 2015a, STUK 2016, 2013g, 2017b; IAEA 2016a)

National requirements for NPP Design

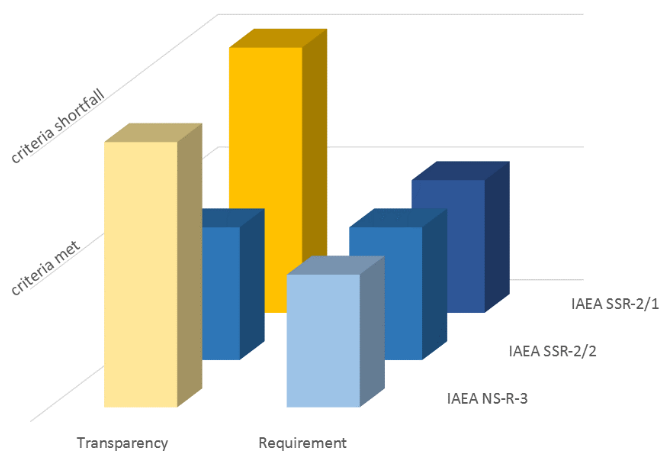

Figure 13: Finland Criteria Evaluation - NPP design requirements

The figure provides the results of the overall evaluation of the National requirements for NPP Design - criteria for Finland.

The findings for SSR-2/1, provided in the table below, are caused by different nomenclature, which influences the accessibility. Requirements 13 and 19 are related to Design Base Accidents. STUK prefers to call DBAs "postulated accidents" which is not internationally common and makes it difficult finding those regulations within the regulatory framework.

Otherwise, the requirements on plant states and Design Basis Accidents (DBA) are fulfilled. The IRRS-report states (IAEA 2012):

> *"STUK has well elaborated system of acceptance criteria and associated assessment conditions for deterministic and probabilistic safety analysis, which is considered as a good practice. The system covers all plant states from normal operation up to severe accidents"*

Similarly, Requirement 26: Fail-safe design is included in a descriptive way within the Finnish requirements, while avoiding the word "Fail-safe design".

Table 7: Shortfalls in selected SSR-2/1 requirements - Finland

Requirement in SSR-2/1	Transparency Availability	Transparency Accessibility	Requirement
Requirement 13: Categories of plant states	ok	shortfall	ok
Requirement 19: Design basis accidents	ok	shortfall	ok
Requirement 26: Fail-safe design	ok	shortfall	ok

Concerning IAEA NS-R-3, some geotechnical hazards mentionend there cannot be found in Finnish regulation and guides. While initially concidering seeing this requirement as not fullfilled, the following statement was found in the Finnish Answers to CNS:

> *"Many types of severe external hazards are not relevant at the Finnish sites, e.g., dam breaks, tidal surges, landslides, soil instability. The licensee/applicant shall justify the conditions or events and their frequencies in detail. External events and conditions with an estimated frequency of occurrence less than 10-5/year shall be considered as DEC C. A large commercial airplane crash is to be considered as DEC C as well. The assessment of DEC C may be based on realistic analyses and no further conservatisms are required."* (STUK 2017a)

Altough it might be true that *"many types of severe external hazards are not relevant at the Finnish sites"* this should be explained at some point and some reasoning should be provided.

Analyses of differences

The multidimensional quantitative and qualitative analyses is used to compare the responsibilities and functions of the governments in Finland and Hungary.

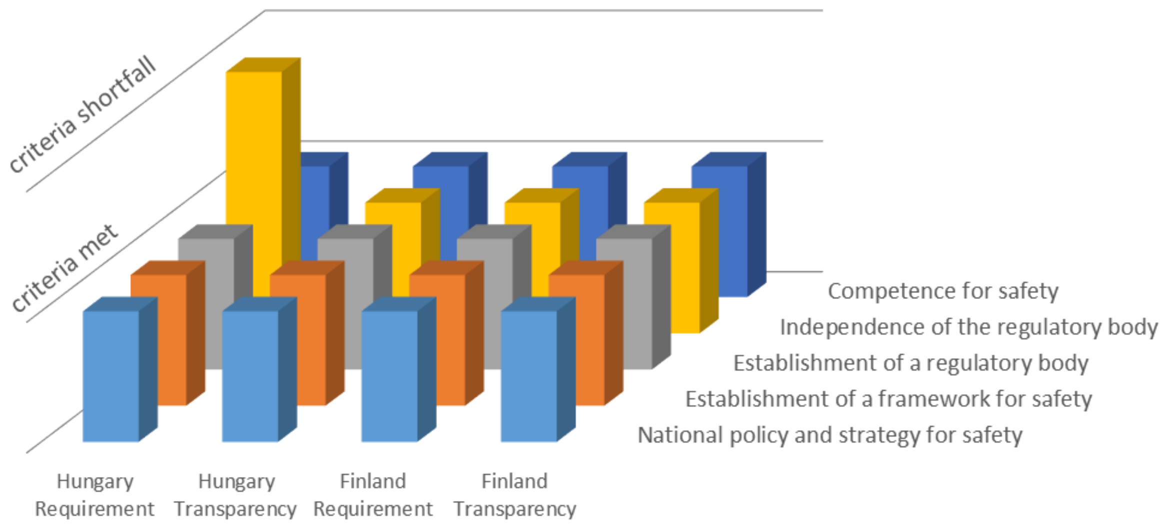

Figure 14: Analysis of differences - Responsibility and Functions of the Governments

Both countries fulfill almost all criteria for this complex of issue. The only deviation can be noted regarding the Independency of the Regulatory Body, where Finland uses a different approach in order to guarantee a higher level of independency via its legislation (i.e. no time constraints) and the competences of the Finnish regulatory body (STUK regulations).

This is caused by the fact, that Hungary within the Ministry for Innovation and Technology, the State Minister for energy affairs has responsibility for both the Paks NPP and the HAEA. It is noted that the minister is responsible to only 'supervise', the Ministry may face conflicting considerations when progressing the development of legislative provisions submitted by the HAEA. The Ministry may face conflicting considerations when reviewing HAEA resource and organizational change submissions.

The Director General of the HAEA does not currently have prompt and unconstrained access to the highest level of the Ministry for Innovation and Technology to address issues of regulatory concern. The Director General of the HAEA needs approval on the HAEA's 'Organisational and Operational Rules'. Additionally, the Director General of the HAEA does not have the authority to spend certain budgeted resources without prior approval from the Ministry for Innovation and Technology. Examples include the purchase of information technology equipment and others.

Further the Hungarian legal provisions, established in Governmental Decree 118/2011. Korm. (and its Annexes) under the Act, prescribe time limits for the regulatory body to complete various authorization processes. These provisions put pressure on the regulatory body, which is not the case in Finland.

The multidimensional quantitative and qualitative analyses is used to compare the responsibilities and functions of the regulatory bodies in Finland and Hungary.

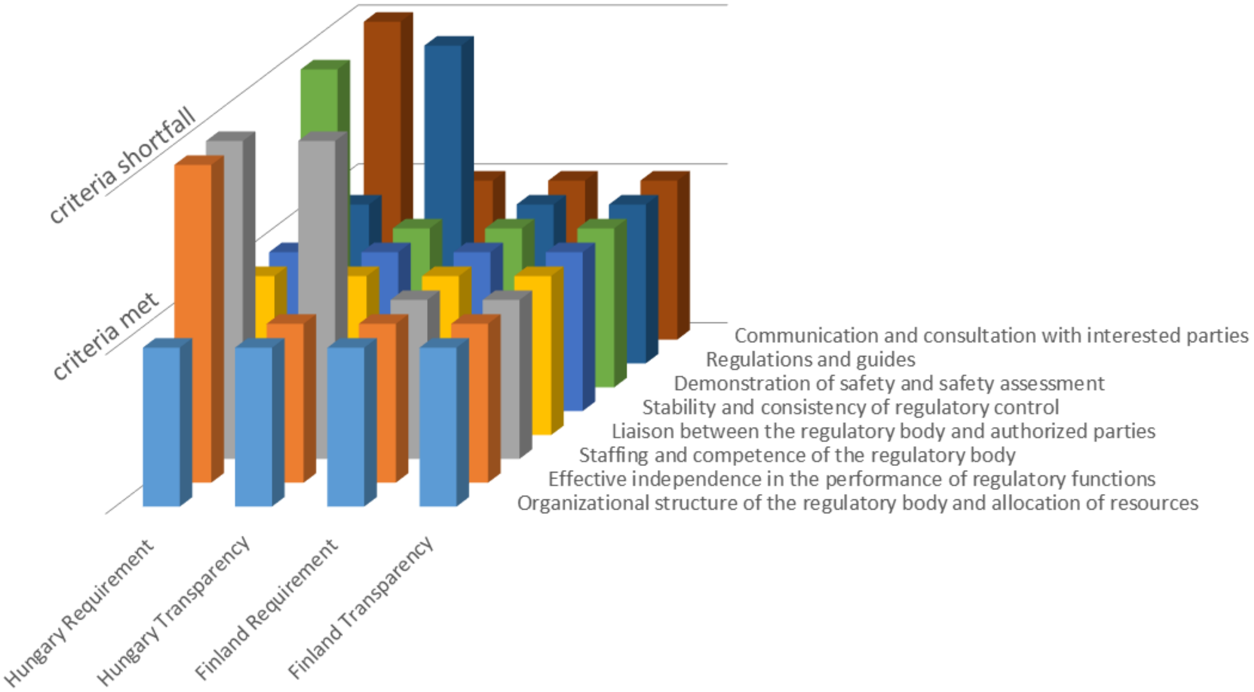

Figure 15: Analysis of differences - Responsibility and Functions of the Regulatory Body

Both countries fulfill most criteria of this complex of issue. Nevertheless there are several topics were there are deviations from the requirements.

In Hungary, the effective independence in the performance of regulatory functions is not fully met, because the timeframes posed to the regulatory body HAEA are very strict. The Act CXL/2004, prescribes time limits for the regulatory body to complete various authorization processes. The prescribed time limits may lead to undue pressure on the regulatory body to complete its decision-making process and thus compromise safety. This is not the case for Finland. The regulatory body has no time pressure.

In Hungary there is no clear information regarding the professional working fields of HAEA employees, so that it not transparent how many professionals are working on what. Therefore, an assessment on how many people are dealing with the new construction or the regulation of the existing plants is not possible, which is not the case for Finland. Further, both regulatory bodies are facing challenges due to retirement and recruiting of new professionals. STUK elaborated a well-structured approach in order to tackle this challenge, while HAEA has had difficulty attracting and retaining qualified staff because salary levels are not competitive with industry, suppliers and some TSOs. Through the Project Act, the Government authorized the increase of HAEA salaries to enable the HAEA to counteract the exodus to the TSO's and the industry. These issues were identified by the HAEA in its self-assessment for the IRRS Mission and considered in its action plan. At the moment there is no clear indication if this plan was successful or not.

Regarding the topic Demonstration of Safety and Safety Assessment, the very restrictive time schedule for HAEA puts pressure on the regulatory body regarding the analyses of all submitted documents. Additionally the submission of the Preliminary Safety Analysis Report in conjunction with the short response period for the HAEA might influence the amount of potential requested changes in the design. Further, the review and assessment process of licensing applications utilizes TSOs. However, since a limited number of TSOs are available in the Hungary, they provide services to both the licensees and the regulatory body. STUK has more time to reply to safety assessment. The problem with the limited number of TSO´s is similar in Finland, but STUK has a larger in house working force and a bigger budget for the external TSO´s (mainly VTT).

STUK has translated all relevant documents from Finnish to Swedish and English, including all relevant guides and requirements. HAEA translated most of the relevant documents from Hungarian to English, but some are missing. HAEA consulted with licensees, but not with the public or other interested parties within the process to develop and review the regulatory safety guides, whereas Finland consulted also with the public and other interested parties.

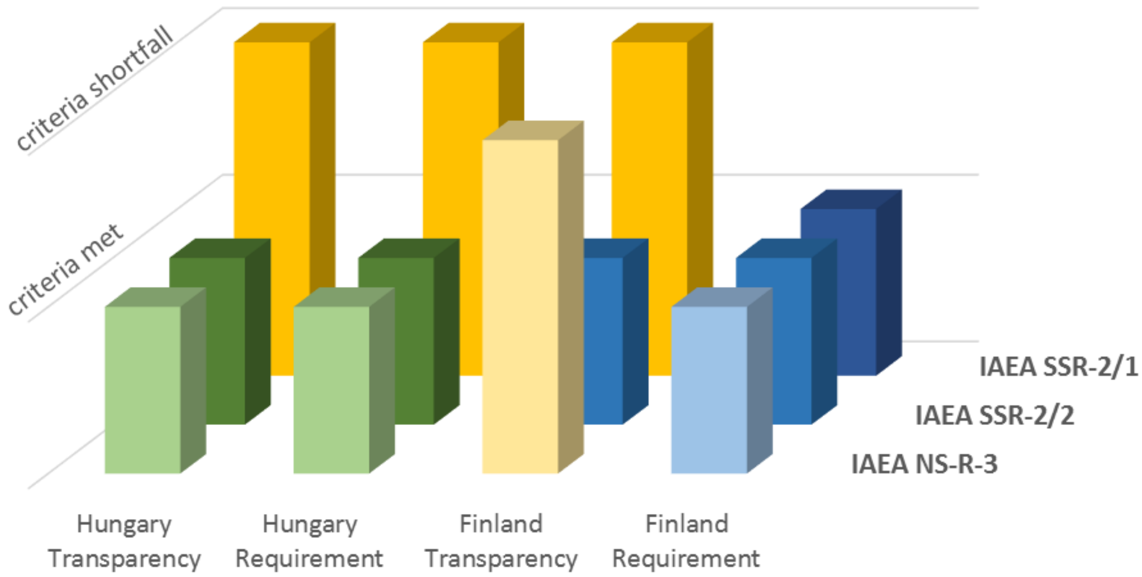

Figure 16: Analysis of differences - NPP design requirements

In the complex of issues, concerning the national requirements for NPP Design Hungarian framework shows room for improvement in both, the transparency and requirement fulfilment. In the Finnish framework, only accessibility issues in the transparency area were identified.

Transparency: The Hungarian regulations provided little information on requirements on reactor protection systems. The Finnish regulation, at a few points, is inconsistent with international practice in nomenclature. Further, there was no reasoning for the selection of geotechnical hazards within the Finnish guides found. Overall, the Finnish framework is more comprehensive, detailed and provides a better structuring.

Requirements: There is an inconsistency with the IAEA requirements in the Hungarian regulations concerning multi-unit sites. In addition, the missing information on reactor protection systems leads to a shortfall in the related requirements. Establishing a formalized procedure to undertake a gap analysis between new IAEA requirements and the Hungarian legislative framework was already recommended by the IRRS mission in 2015. No major shortcomings in the Finnish guides related to the requirement criteria were identified at this point.

Conclusions

A multidimensional method to derive statements on the safety level of a NPP project was developed. The method aims to cover comprehensively the fields of regulatory infrastructure and technical design requirements of the project, without descending deep into technical details. In both areas, “regulatory infrastructure” and “technical design requirements”, the existing regulations of the country are compared to requirements that are derived from IAEA safety standards. Only open published literature, available to every stakeholder, was used for the analysis. So before checking whether the actual technical requirement is addressed, it was analyzed if the needed information is publicly available. Once this was ensured, it was analyzed if the information was presented in a way that a small team of persons with technical knowledge can derive conclusions from it in limited time. This second analysis was termed “accessibility”. It was checked in each field if the criteria / requirements were met or if some shortfalls were identified.

The table below summarizes the analysis.

		Transparency		Requirement fulfilled
		Availability	Accessibility	
Regulatory Infrastructure	Governmental Duties	met / shortfalls	met / shortfalls	met / shortfalls
	Duties Regulatory Authority	met / shortfalls	met / shortfalls	met / shortfalls
Technical NPP Design		met / shortfalls	met / shortfalls	met / shortfalls

It can be objected that the method is too simple to derive conclusions on a topic as complex as a nuclear power plant, and that for such a goal dozens of highly specialized experts of different fields have to deploy considerable time. Nevertheless, a normative approach is taken: if stakeholder involvement were to be taken seriously, such a method should be suitable to come to sound conclusions. It can neither be expected from a stakeholder to fully trust expert organizations in their judgment, nor can it be expected from a stakeholder to repeat the work of the regulatory authority. A stakeholder can be involved in the process on equal level as regulatory authority, designer, utility, if those organizations provide the information such that the relevant conclusions can easily be found, and, in doubt, can be checked at a deeper technical level. This means, the method assumes that stakeholder involvement on equal level is a commonly accepted value, and therefore reports as deficiency if prerequisites for such involvement are not met. The method was then applied to the Finish project Hanhikivi and the Hungarian project Paks II.

Both projects currently are applying for a construction license. Reliable technical information is not available, therefore, to make a statement on the technical NPP design, the regulatory requirements on the design was investigated. The vendor of a NPP must fulfill all regulatory requirements, so in principle a check of the requirements should be sufficient to judge the safety of the design. However, experience shows that the question whether a specific system corresponds to a specific technical requirement can be subject to debate. A stakeholder should have the possibility to check if he or she agrees with the decision of the regulatory authority. Therefore, once the final design of the NPP is drawn up and approved, for transparency, stakeholders should have access to the NPP design specifications. Once this happened, the analysis could be repeated, using the design documentation instead of the regulatory requirements on the NPP design.

Fifteen requirements for the regulatory infrastructure and 67 requirements for the NPP project design were evaluated in each country. For all requirements that were derived, documentation that addressed the requirement could be found. In two cases shortfalls in the criteria transparency-availability were identified, meaning that some information was missing, and in seven cases the criteria "transparency-accessibility" the needed information was not presented in a way that it could be easily evaluated. This means that overall a good fraction of the relevant information could be accessed.

On the level of fulfillment of requirements a total of eleven (out of 134) did not (fully) meet the criteria.

Table 8: Fulfillment of transparency and technical requirements - overall

Total		**Transparency**				**Requirement**	
		Availability		Accessibility			
		Criteria met	Criteria shortfalls	Criteria met	Criteria shortfalls	Criteria met	Criteria shortfalls
Regulatory Infrastructure	Government	10	0	10	0	9	1
	Regulator	18	2	19	1	16	4
Technical NPP Design		134	0	128	6	129	5

Hungary

For the Paks II NPP Project, regarding regulatory infrastructure, from the in total 15 criteria all 15 were evaluated, even if in two cases information transparency was not meeting our criteria. The following evaluation of requirement fulfillment brought up five shortfalls. The underlying issues can be summarized as follows.

HAEA is required by law to respond to submissions of the licensee within a strict time limit, Act CXL/2004, prescribes time limits for the regulatory body to complete various authorization processes. Such limits on the regulatory authority are rarely found in international context. While the rationale, to speed up the licensing process and help the utility in planning, is clear, there are open questions on the consequences of such a time limit on the evaluation. There are examples of other projects show that unforeseen questions regarding safety might take years to resolve. How such a situation would be handled if there were a fixed time frame remains to be seen. The prescribed time limits may lead to undue pressure on the regulatory body to complete its decision-making process and thus compromise safety. STUK, for example, the regulatory authority of Finland, can evaluate without such time constraints.

The situation should be seen with the issue that there is no clear information regarding the professional working fields of HAEA employees, so that it not transparent how many professionals are working on what. Therefore, an assessment on how many people are dealing with the new construction or the regulation of the existing plants is not possible.

Another issue that came up showed that HAEA has not published the full set of safety guidelines to complement the mandatory safety requirements according to the Nuclear Safety Codes (NSC), Governmental Decree 118/2011 and Governmental Decrees issued from 2005 to 2011. It must be noted that the HAEA consulted with licensees, but not with the public or other interested parties within the process to develop and review the regulatory safety guides.

Regarding fulfillment of requirements on the technical NPP design (which was evaluated by looking at the national requirements on NPP design, since the design itself is not yet available) in total 67 criteria were evaluated. In two cases, the information was presented in a way that the important issues were difficult to access. When looking on the fulfillment of requirements shortfalls were identified in five cases. The underlying issues are summarized below:

Overall, working with the safety code proved to be a little tedious, as there is no table of contents or other means for navigation through the documents provided (at least in the English version). A clear structuring would have helped with the analysis of regulatory requirements. This has a general impact on the accessibility aspect of the transparency criteria for all the requirements. This is not reflected in the evaluation below. On the other hand is has to be positively noted, that all documents were provided in English.

One topic that stood out regards shared safety systems between units. The Hungarian NSC 3a states, that the "*safety systems may be shared between the units only if warranted from a safety point of view.*" According to the IAEA requirement, the safety systems shall not be shared in any case. They might be interconnected, to enable support between units, but each unit of a plant should be able to rely just on its own safety systems. Another issue relates to the requirements for the reactor protection system, were little information on the required functionalities and system design is given.

Table 9: Fulfillment of transparency and technical requirements - Hungary

Paks II		**Transparency**				**Requirement**	
		Availability		Accessibility			
		Criteria met	Criteria shortfalls	Criteria met	Criteria shortfalls	Criteria met	Criteria shortfalls
Regulatory Infrastructure	Government	5	0	5	0	4	1
	Regulator	8	2	9	1	6	4
Technical NPP Design		67	0	65	2	62	5

Finland

There were no issues with the 15 requirements in the field of regulatory infrastructure regarding the category "transparency". Answers to all requirements could be found in the literature, and the information was presented in a way that the relevant points could be readily retrieved. In addition, the selected requirements of GSR-1 are met.

Regarding fulfillment of requirements on the technical NPP design (which, again, was evaluated by looking at the national requirements on NPP design, since the design itself is not yet available) four cases showed up, not fully meeting the criteria in the category transparency-accessibility. Otherwise, the requirements were met.

The underlying issues are that Finnish regulation uses different nomenclature to current practice in most countries, which influences the accessibility. For example, Design Base Accidents are called "postulated accidents" which is not internationally common and makes it difficult to compare those regulations within the regulatory frameworks. Another topic that came up is that some geotechnical hazards mentioned in IAEA NS-R-3 cannot be found in Finnish regulation and guides. When asked, "which external Events will be considered for DEC-C Deterministic analysis" during the last meeting of convention on nuclear safety. STUK answered to CNS that "*Many types of severe external hazards are not relevant at the Finnish sites*" (STUK 2017a), but this should be explained at some point and some reasoning should be provided, such that an outside stakeholder has the possibility to understand the reasoning behind the exclusion.

Table 10: Fulfillment of transparency and technical requirements - Finland

Hanhikivi		**Transparency**				**Requirement**	
		Availability		Accessibility			
		Criteria met	Criteria shortfalls	Criteria met	Criteria shortfalls	Criteria met	Criteria shortfalls
Regulatory Infrastructure	Government	5	0	5	0	5	0
	Regulator	10	0	10	0	10	0
Technical NPP Design		67	0	63	4	67	0

Main points

Independent verification of the design requirements

The study aimed at comparing international requirements, common positions, and best practices on the design of new nuclear power plants against the design specification of two specific NPP projects. However, this proofed to be impossible, since neither in Finland nor in Hungary specific design specifications are public (yet). It is questionable if those specifications will be public at a later point. Instead of the specifications of the power plant, national requirements on the design of new reactors are public. A stakeholder has then to trust the regulatory authority in checking and enforcing those requirements. While there are good reasons for not publishing the full licensing documentation of the licensee (e.g. security issues, commercial secrets), it will be impossible for a stakeholder to independently assess and verify claims on the safety of the plant. In view of achieving full transparency and enabling public involvement it would be beneficial to follow e.g. practice of US NRC, where licensee documents are generally published when received by the authority (with exception of single pages or single paragraphs for security reasons or to protect commercial secrets).

Regulatory Independence

Hungary requires by law that its regulatory authority, HAEA, reacts within fixed time limits, once the utility submitted the required documentation for a license. Such limits are not found in other countries (especially Finland does not restrict its authority, STUK, in this way). The regulatory authority is the only body to verify the licensee's claim that the plant will operate within the requirements. While there are targets in other countries, how long such a verification may take; strict deadlines in law cannot be found elsewhere. The main question here is what if the assessment could not be finished in time. Will the assessment be rushed to meet the deadline? Will the deadline, imposed by law, be missed? If so, will the utility be entitled to financial compensation for the delays? In either case, undue pressure is placed on the regulatory authority, which may influence the review of the safety case. In addition, while STUK publishes detailed numbers on its staff, including staff per unit and technical division, HAEA publishes a total number of its staff only. This makes it difficult to assess if the persons working on the licensing of the new NPP project are comparable by number.

Technical requirements – aircraft crash

Internationally it is required to consider aircraft crash in the design of a new NPP. The document of the International Atomic Energy Agency (IAEA) "Site Evaluation for Nuclear Installations", safety requirements, stipulates that aircraft crash should be considered. The Western European Nuclear Regulators Association

(WENRA) goes on step ahead and requires in its RHWG Report “Safety of new NPP designs” that the design of a new NPP should consider the intentional crash of a commercial airplane into the plant, and this despite measures taken to prevent such an event. Finish regulation is in full compliance with the statements of both organization and requires its new reactor builds to withstand the crash of large commercial aircraft. Hungarian regulation is vague in this point – protection against aircraft crash is required, but no statements on the size and type of the aircraft are made. Aircraft therefore could range from small military fighter jet up to a large commercial airliner.

Literature

Act CXL of 2004 on the General Rules of Administrative Proceedings and Services. 2004.

Act CXVI of 1996 on Atomic Energy. n.d.

Annex 1 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 1 – Nuclear Safety Authority Procedures of Nuclear Facilities. 2011.

Annex 2 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 2 – Management Systems of Nuclear Facilities. 2011.

Annex 3 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 3 – Design Requirements for Nuclear Power Plants. 2011.

Annex 3a to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 3a – Design Requirements for New Nuclear Power Plant Unit. 2011.

Annex 4 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 4 – Operation of Nuclear Power Plants. 2011.

Annex 5 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 5 – Design and Operation of Research Reactors. 2011.

Annex 6 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 6 – Interim Storage of Spent Nuclear Fuel. 2011.

Annex 7 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 7 – Site Survey and Assessment of Nuclear Facilities. 2011.

Annex 8 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 8 – Decommissioning of Nuclear Facilities. 2011.

Annex 9 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 9 – Requirements for the Construction of a New Nuclear Installation. 2011.

Annex 10 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 10 – Nuclear Safety Code Definitions. 2011.

Atomenergoprom. 2014. "Project AES-2006."

Bredimas, Alexandre, and William J. Nuttall. 2008. "An International Comparison of Regulatory Organizations and Licensing Procedures for New Nuclear Power Plants." Energy Policy 36 (4): 1344–54. https://doi.org/10.1016/j.enpol.2007.10.035.

Fennovoima. 2018. "Timeline | Hanhikivi 1." 2018. https://www.fennovoima.fi/en/hanhikivi-1-project/timeline.

Govt. Decree 118/2011 (VII. 11.) on the Nuclear Safety Requirements of Nuclear Facilities and on Related Regulatory Activities. 2011.

HAEA. 2016. "Seventh National Report - Prepared in the Framework of the Convention on Nuclear Safety." National report on the Convention on Nuclear Safety. Budapest, Hungary.

———. 2018. "HAEA Website." HAEA Website. 2018. http://www.oah.hu/web/v3/HAEAportal.nsf/web?OpenAgent.

IAEA. 2006. Fundamental Safety Principles. Vol. SF-1. IAEA Safety Standards Series: Safety Fundamentals. Wien.

———. 2011. "Status Report 108 - VVER-1200 (V-491)."

———. 2012. "Integrated Regulatory Review Service (IRRS) Mission to Finland." Integrated Regulatory Review Service (IRRS) Mission. Helsinki, Finland: International Atomic Energy Agency.

———. 2013. "Integrated Regulatory Review Service (IRRS) Guidelines for the Preparation and Conduct of IRRS Missions." Services Series 23. Vienna, Austria: IAEA.

———. 2015a. "Integrated Regulatory Review Service (IRRS) Follow-up Mission to Finland." Integrated Regulatory Review Service (IRRS) Follow-up Mission. Helsinki, Finland: International Atomic Energy Agency.

———. 2015b. "Report of the Integrated Regulatory Review Service (IRRS) Mission to Hungary." IRRS Mission Report. Budapest, Hungary: International Atomic Energy Agency.

———. 2016a. “General Safety Requirements - Governmental, Legal and Regulatory Framework for Safety.” IAEA safety standards series. Series No. GSR Part 1 (Rev. 1). Vienna, Austria: IAEA.
———. 2016b. “General Safety Requirements - Leadership and Management for Safety.” Series No. GSR Part 2. Vienna, Austria: IAEA.
———. 2016c. “Governmental, Legal and Regulatory Framework for Safety General Safety Requirements No. GSR Part 1 (Rev. 1).” IAEA safety standards series. Vienna, Austria: International Atomic Energy Agency.
———. 2016d. “Safety of Nuclear Power Plants: Commissioning and Operation Special Safety Requirements NO. SSR-2/2 (Rev. 1).” IAEA safety standards series. Vienna: International Atomic Energy Agency.
———. 2016e. “Safety of Nuclear Power Plants: Design, Specific Safety Requirements No. SSR-2/1 (Rev. 1).” IAEA safety standards series. Vienna: International Atomic Energy Agency.
———. 2016f. “Site Evaluation for Nuclear Installations Safety Requirements No. NS-R-3 (Rev. 1).” IAEA safety standards series. Vienna: International Atomic Energy Agency.
Kolchinsky, D.E., A.V. Molchanov, V.V. Bezlepkin, M.A. Altshuller, and J. Laaksonen. 2013. “A World-Class PWR from St Petersburg.” Nuclear Engineering International 58: 32–39.
Laaksonen, J. 2013. “International Standards of Safety and the Modern Projects of Nuclear Power Stations.” In . Vilnius, Lithuania.
llinskii, KM. 2015. “The Evolution of the NPP-2006 Project in Naccordance with European Standards and Special Requirements of the Customer.” Moscow, Russia.
Nuclear Energy Act (990/1987). 2008.
Nuclear Energy Decree (161/1988). 2008.
Nucleopedia. 2018. “WWER-1200.” March 24, 2018. https://de.nucleopedia.org/wiki/WWER-1200.
OECD/NEA. 2010. “CNRA Working Group on the Regulation of New Reactors- Report on the Survey on Regulation of Site Selection and Preparation -.” Paris, France: OECD/NEA.
———. 2011a. “Improving Nuclear Regulation - NEA Regulatory Guidance Booklets - Volumes 1-14.” Paris, France: OECD/NEA.
———. 2011b. “Technical and Economic Aspects of Load Following with Nuclear Power Plants.”
———. 2014. “The Characteristics of an Effective Nuclear Regulator.” NEA No. 7185. Paris, France: OECD/NEA.
———. 2015a. “Fostering a Durable Relationship between a Waste Management Facility and Its Host Community.”
———. 2015b. “Stakeholder Involvement in Decision Making: A Short Guide to Issues, Approaches and Resources.”
———. 2016a. “Five Years after the Fukushima Daiichi Accident - Nuclear Safety Improvements and Lessons Learnt.” NEA No. 7284. Paris, France: OECD/NEA.
———. 2016b. “The Safety Culture of an Effective Nuclear Regulatory Body.” NEA No. 7247. Paris, France: OECD/NEA.
PAKS II ZRT. 2017a. “Paks II.’s Environmental License Became Legally Binding.” April 19, 2017. http://www.paks2.hu/en/news/SitePages/newsDetails.aspx?NewsID=227.
———. 2017b. “Licensing Procedures of Certain Buildings of the Construction and Erection Base.” December 21, 2017. http://www.paks2.hu/en/news/SitePages/newsDetails.aspx?NewsID=227.
———. 2018. “János Süli: One of the Milestones of 2018 Will Be the Submission of the Establishment License Application.” March 9, 2018. http://www.paks2.hu/en/news/SitePages/newsDetails.aspx?NewsID=227.
Radiation Act (592/1991). 2011.
Radiation Decree (1512/1991). 2009.
Rusatom Overseas. 2013. “The VVER Today - Evolution | Design | Safety.”
STUK. 2013a. Guide YVL A.2 Site for a Nuclear Facility. Guide YVL A.2.
———. 2013b. Guide YVL A.11 Security of a Nuclear Facility. Guide YVL A.11.
———. 2013c. Guide YVL B.1 Safety Design of a Nuclear Power Plant. Guide YVL B.1.

———. 2013d. Guide YVL B.2 Classification of Systems, Structures and Components of a Nuclear Facility. Guide YVL B.2.
———. 2013e. Guide YVL B.7 Provisions for Internal and External Hazards at a Nuclear Facility. Guide YVL B.7.
———. 2013f. Guide YVL E.6 Buildings and Structures of a Nuclear Facility. Guide YVL E.6.
———. 2013g. Guide YVL A.1 Regulatory Oversight of Safety in the Use of Nuclear Energy. Guide YVL A.1.
———. 2014. "PRELIMINARY SAFETY ASSESSMENT OF THE FENNOVOIMA OY NUCLEAR POWER PLANT PROJECT - Unofficial Translation."
———. 2016. Regulation on the Safety of Nuclear Power Plants. STUK Y/1/2016.
———. 2017a. "Convention on Nuclear Safety- Answers to Written Questions of Other Contracting Parties." Helsinki, Finland.
———. 2017b. "Presentation Finland - 7th Review Meeting of the Convention on Nuclear Safety." presented at the 7th Review Meeting of the Convention on Nuclear Safety, Vienna, Austria, March 28.
Svetlov, S. 2016. "Current VVER.1200 Designs of Generation III+ Technical Solutions, Safety Systems. Influence of Locality." Prag.

Relevant Hungarian Law and Regulations

Act CXVI of 1996 on Atomic Energy

Act CXL of 2004 on the General Rules of Administrative Proceedings and Services

Governmental Decree 118/2011. (VII. 11.) Korm.on the nuclear safety requirements of nuclear facilities and on related regulatory activities

Annex 1 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 1 – Nuclear safety authority procedures of nuclear facilities

Annex 2 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 2 – Management systems of nuclear facilities

Annex 3 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 3 – Design requirements for nuclear power plants

Annex 3a to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 3 – Design requirements for new nuclear power plant units

Annex 4 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 4 – Operation of nuclear power plants

Annex 5 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 5 – Design and operation of research reactors

Annex 6 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 6 – Interim storage of spent nuclear fuel

Annex 7 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 7 – Site survey and assessment of nuclear facilities

Annex 8 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 8 – Decommissioning of nuclear facilities

Annex 9 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 9 – Requirements for the construction of a new nuclear installation

Annex 10 to Governmental Decree 118/2011. (VII. 11.) Korm. Nuclear Safety Code, Volume 10 – Nuclear Safety Code definitions

Relevant Finnish Law and Regulations

Nuclear Energy Act (990/1987)

Nuclear Energy Decree (161/1988)

Radiation Act (592/1991)

Radiation Decree (1512/1991)

STUK Regulations

STUK (2016): Regulation on the Safety of Nuclear Power Plants, STUK Y/1/2016.

STUK (2016): Regulation on Emergency Response Arrangements at Nuclear Power Plants, STUK Y/2/2016.

STUK (2016): Regulation on the Security in the Use of Nuclear Energy, STUK Y/3/2016.

STUK (2016): Regulation on the Safety of Disposal of Nuclear Waste, STUK Y/4/2016.

STUK (2016): Regulation on the Safety of Mining and Milling Operations aimed at Producing Uranium or Thorium, STUK Y/5/2016.

Regulatory Guides on nuclear safety (YVL Guides)

Group A: Safety management of a nuclear facility

STUK (2013): Guide YVL A.1 Regulatory oversight of safety in the use of nuclear energy, 22.11.2013.

STUK (2013): Guide YVL A.2 Site for a nuclear facility, 15.11.2013.

STUK (2014): Guide YVL A.3 Management system for a nuclear facility, 2.6.2014.

STUK (2014): Guide YVL A.4 Organisation and personnel of a nuclear facility, 2.6.2014.

STUK (2014): Guide YVL A.5 Construction and commissioning of a nuclear facility, 2.6.2014.

STUK (2014): Guide YVL A.6 Conduct of operations at a nuclear power plant, 5.6.2014.

STUK (2013): Guide YVL A.7 Probabilistic risk assessment and risk management of a nuclear power plant, 15.11.2013.

STUK (2014): Guide YVL A.8 Ageing management of a nuclear facility, 20.5.2014.

STUK (2014): Guide YVL A.9 Regular reporting on the operation of a nuclear facility, 15.8.2014.

STUK (2013): Guide YVL A.10 Operating experience feedback of a nuclear facility, 15.11.2013

STUK (2013): Guide YVL A.11 Security of a nuclear facility, 15.11.2013

STUK (2013): Guide YVL A.12 Information security management of a nuclear facility, 22.11.2013

Group B: Plant and system design

STUK (2013): Guide YVL B.1 Safety design of a nuclear power plant, 15.11.2013

STUK (2013): Guide YVL B.2 Classification of systems, structures and components of a nuclear facility, 15.11.2013

STUK (2013): Guide YVL B.3 Deterministic safety analyses for a nuclear power plant, 15.11.2013

STUK (2013): Guide YVL B.4 Nuclear fuel and reactor, 15.11.2013

STUK (2013): Guide YVL B.5 Reactor coolant circuit of a nuclear power plant, 15.11.2013

STUK (2013): Guide YVL B.6 Containment of a nuclear power plant, 15.11.2013

STUK (2013): Guide YVL B.7 Provisions for internal and external hazards at a nuclear facility, 15.11.2013

STUK (2013): Guide YVL B.8 Fire protection at a nuclear facility, 15.11.2013

Group C: Radiation safety of a nuclear facility and environment

STUK (2013): Guide YVL C.1 Structural radiation safety at a nuclear facility, 15.11.2013

STUK (2014): Guide YVL C.2 Radiation protection and exposure monitoring of nuclear facility workers, 20.5.2014

STUK (2013): Guide YVL C.3 Limitation and monitoring of radioactive releases from a nuclear facility, 15.11.2013

STUK (2015): Guide YVL C.4 Assessment of radiation doses to the public in the vicinity of a nuclear facility, 17.3.2015

STUK (2013): Guide YVL C.5 Emergency arrangements of a nuclear power plant, 15.11.2013

STUK (2013): Guide YVL C.6 Radiation monitoring at a nuclear facility, 15.11.2013

STUK (2016): Guide YVL C.7 Radiological monitoring of the environment of a nuclear facility, 19.12.2016

Group D: Nuclear materials and waste

STUK (2013): Guide YVL D.1 Regulatory control of nuclear safeguards, 15.11.2013

STUK (2013): Guide YVL D.2 Transport of nuclear materials and nuclear waste, 15.11.2013

STUK (2013): Guide YVL D.3 Handling and storage of nuclear fuel, 15.11.2013

STUK (2013): Guide YVL D.4 Predisposal management of low and intermediate level nuclear waste and decommissioning of a nuclear facility, 15.11.2013

STUK (2013): Guide YVL D.5 Disposal of nuclear waste, 15.11.2013

Group E: Structures and equipment of a nuclear facility

STUK (2013): Guide YVL E.1 Authorised inspection body and the licensees in-house inspection organisation, 15.11.2013

STUK (2013): Guide YVL E.2 Procurement and operation of nuclear fuel, 15.11.2013

STUK (2013): Guide YVL E.3 Pressure vessels and piping of a nuclear facility, 15.11.2013

STUK (2013): Guide YVL E.4 Strength analyses of nuclear power plant pressure equipment, 15.11.2013

STUK (2014): Guide YVL E.5 In-service inspection of nuclear facility pressure equipment with non-destructive testing methods, 20.5.2014

STUK (2013): Guide YVL E.6 Buildings and structures of a nuclear facility, 15.11.2013

STUK (2013): Guide YVL E.7 Electrical and I&C equipment of a nuclear facility, 15.11.2013

STUK (2013): Guide YVL E.8 Valves of a nuclear facility, 15.11.2013

STUK (2013): Guide YVL E.9 Pumps of a nuclear facility, 15.11.2013

STUK (2014): Guide YVL E.10 Emergency power supplies of a nuclear facility, 15.8.2014

STUK (2013): Guide YVL E.11 Hoisting and transfer equipment of a nuclear facility, 15.11.2013

STUK (2014): Guide YVL E.12 Testing organisations for mechanical components and structures of a nuclear facility, 20.5.2014

Annex 1: Detailed Criteria for the assessment

Criteria derived from GSR-1 - Responsibilities and functions of the Governments

GSR-1 Requirement 1: National policy and strategy for safety

The government shall establish a national policy and strategy for safety, the implementation of which shall be subject to a graded approach in accordance with national circumstances and with the radiation risks associated with facilities and activities, to achieve the fundamental safety objective and to apply the fundamental safety principles established in the Safety Fundamentals.

National policy and strategy for safety shall express a long term commitment to safety. The national policy shall be promulgated as a statement of the government's intent. The strategy shall set out the mechanisms for implementing the national policy.

The national policy and strategy for safety shall be implemented in accordance with a graded approach, depending on national circumstances, to ensure that the radiation risks associated with facilities and activities, including activities involving the use of radiation sources, receive appropriate attention by the government or by the regulatory body.

GSR-1 Requirement 2: Establishment of a framework for safety

The government shall establish and maintain an appropriate governmental, legal and regulatory framework for safety within which responsibilities are clearly allocated. The government shall promulgate laws and statutes to make provision for an effective governmental, legal and regulatory framework for safety.

Where several authorities are involved, the government shall specify clearly the responsibilities and functions of each authority within the governmental, legal and regulatory framework for safety.

GSR-1 Requirement 3: Establishment of a regulatory body

The government, through the legal system, shall establish and maintain a regulatory body, and shall confer on it the legal authority and provide it with the competence and the resources necessary to fulfil its statutory obligation for the regulatory control of facilities and activities.

GSR-1 Requirement 4: Independence of the regulatory body

The government shall ensure that the regulatory body is effectively independent in its safety related decision making and that it has functional separation from entities having responsibilities or interests that could unduly influence its decision making.

An independent regulatory body will not be entirely separate from other governmental bodies. The government has the ultimate responsibility for involving those with legitimate and recognized interests in its decision making. However, the government shall ensure that the regulatory body is able to make decisions under its statutory obligation for the regulatory control of facilities and activities, and that it is able to perform its functions without undue pressure or constraint.

To be effectively independent from undue influences on its decision making, the regulatory body:

(a) Shall have sufficient authority and sufficient competent staff;

(b) Shall have access to sufficient financial resources for the proper and timely discharge of its assigned responsibilities;

(c) Shall be able to make independent regulatory judgements and regulatory decisions, at all stages in the lifetime of facilities and the duration of activities until release from regulatory control, under operational states and in accidents;

(d) Shall be free from any pressures associated with political circumstances or economic conditions, or pressures from government departments, authorized parties or other organizations;

(e) Shall be able to give independent advice and provide reports to government departments and governmental bodies on matters relating to the safety of facilities and activities. This includes access to the highest levels of government;

(f) Shall be able to liaise directly with regulatory bodies of other States and with international organizations to promote cooperation and the exchange of regulatory related information and experience

No responsibilities shall be assigned to the regulatory body that might compromise or conflict with its discharging of its responsibility for regulating the safety of facilities and activities.

The staff of the regulatory body shall have no direct or indirect interest in facilities and activities or authorized parties beyond the interest necessary for regulatory purposes.

In the event that a department or agency of government is itself an authorized party operating an authorized facility or facilities, or conducting authorized activities, the regulatory body shall be separate from, and effectively independent of, the authorized party.

The regulatory body shall be conferred with the legal authority to require an authorized party or an applicant, whether a person or an organization, to make arrangements to provide:

(a) All necessary safety related information, including information from suppliers, even if this information is proprietary;

(b) Access, solely or together with the authorized party or applicant, for making inspections on the premises of any designer, supplier, manufacturer, constructor, contractor or operating organization associated with the authorized party.

GSR-1 Requirement 11: Competence for safety

The government shall make provision for building and maintaining the competence of all parties having responsibilities in relation to the safety of facilities and activities.

As an essential element of the national policy and strategy for safety, the necessary professional training for maintaining the competence of a sufficient number of suitably qualified and experienced staff shall be made available.

The building of competence shall be required for all parties with responsibilities for the safety of facilities and activities, including authorized parties, the regulatory body and organizations providing services or expert advice on matters relating to safety.

Competence shall be built, in the context of the regulatory framework for safety, by such means as, Technical training; Learning through academic institutions and other learning centres; Research and development work.

The government:

(a) Shall stipulate a necessary level of competence for persons with responsibilities in relation to the safety of facilities and activities;

(b) Shall make provision for adequate arrangements for the regulatory body and its support organizations to build and maintain expertise in the disciplines necessary for discharge of the regulatory body's responsibilities in relation to safety;

(c) Shall make provision for adequate arrangements for increasing, maintaining and regularly verifying the technical competence of persons working for authorized parties.

Criteria derived from GSR-1 - Responsibilities and functions of the Regulatory Bodies

GSR-1 Requirement 16: Organizational structure of the regulatory body and allocation of resources

The regulatory body shall structure its organization and manage its resources so as to discharge its responsibilities and perform its functions effectively; this shall be accomplished in a manner commensurate with the radiation risks associated with facilities and activities.

GSR-1 Requirement 17: Effective independence in the performance of regulatory functions

The regulatory body shall perform its functions in a manner that does not compromise its effective independence.

4.6. Requirements 3 and 4 in Section 2 stipulate that the government establish and maintain a regulatory body that is effectively independent in its decision making and that has functional separation from entities having responsibilities or interests that could unduly influence its decision making. This imposes an obligation on the regulatory body to discharge its responsibilities in such a way as to preserve its effective independence. The staff of the regulatory body shall remain focused on performing their functions in relation to safety, irrespective of any personal views. The competence of staff is a necessary element in achieving effective independence in decision making by the regulatory body.

4.7. The regulatory body shall prevent or duly resolve any conflicts of interests or, where this is not possible, shall seek a resolution of conflicts within the governmental and legal framework.

4.8. To maintain the effective independence of the regulatory body, special consideration shall be given when new staff members are recruited from authorized parties, and the independence of the regulatory body, regulatory aspects and safety considerations shall be emphasized in their training. The regulatory body shall ensure that its staff operate professionally and within its remit in relation to safety.

4.9. To maintain its effective independence, the regulatory body shall ensure that, in its liaison with interested parties, it has a clear separation from organizations or bodies that have been assigned responsibilities for facilities or activities or for their promotion.

4.10. The regulatory body, consistent with its effective independence, shall exercise its authority to intervene in connection with any facilities or activities that present significant radiation risks, irrespective of the possible costs to the authorized party

GSR-1 Requirement 18: Staffing and competence of the regulatory body

The regulatory body shall employ a sufficient number of qualified and competent staff, commensurate with the nature and the number of facilities and activities to be regulated, to perform its functions and to discharge its responsibilities.

4.11. The regulatory body has to have appropriately qualified and competent staff. A human resources plan shall be developed that states the number of staff necessary and the essential knowledge, skills and abilities for them to perform all the necessary regulatory functions.

4.12. The human resources plan for the regulatory body shall cover recruitment and, where relevant, rotation of staff in order to obtain staff with appropriate competence and skills, and shall include a strategy to compensate for the departure of qualified staff.

4.13. A process shall be established to develop and maintain the necessary competence and skills of staff of the regulatory body, as an element of knowledge management. This process shall include the development of a specific training programme on the basis of an analysis of the necessary competence and skills. The training programme shall cover principles, concepts and technological aspects, as well as the procedures followed by the regulatory body for assessing applications for authorization, for inspecting facilities and activities, and for enforcing regulatory requirements.

GSR-1 Requirement 21: Liaison between the regulatory body and authorized parties

The regulatory body shall establish formal and informal mechanisms of communication with authorized parties on all safety related issues, conducting a professional and constructive liaison.

GSR-1 Requirement 22: Stability and consistency of regulatory control

The regulatory body shall ensure that regulatory control is stable and consistent.

GSR-1 Requirement 24: Demonstration of safety for the authorization of facilities and activities

The applicant shall be required to submit an adequate demonstration of safety in support of an application for the authorization of a facility or an activity.

[…]

4.33. Prior to the granting of an authorization, the applicant shall be required to submit a safety assessment, which shall be reviewed and assessed by the regulatory body in accordance with clearly specified procedures. The extent of the regulatory control applied shall be commensurate with the radiation risks associated with facilities and activities, in accordance with a graded approach.

[…]

GSR-1 Requirement 32: Regulations and guides

The regulatory body shall establish or adopt regulations and guides to specify the principles, requirements and associated criteria for safety upon which its regulatory judgements, decisions and actions are based.

GSR-1 Requirement 36: Communication and consultation with interested parties

The regulatory body shall promote the establishment of appropriate means of informing and consulting interested parties and the public about the possible radiation risks associated with facilities and activities, and about the processes and decisions of the regulatory body.

4.66. The regulatory body shall establish, either directly or through authorized parties, provision for effective mechanisms of communication, and it shall hold meetings to inform interested parties and the public and for informing the decision making process. This communication shall include constructive liaison such as:

(a) Communication with interested parties and the public on regulatory judgements and decisions;

(b) Direct communication with governmental authorities at a high level when such communication is considered necessary for effectively performing the functions of the regulatory body;

(c) Communication of such documents and opinions from private or public organizations or persons to the regulatory body as may be considered necessary and appropriate;

(d) Communication on the requirements, judgements and decisions of the regulatory body, and on the bases for them, to the public;

(e) Making information on incidents in facilities and activities, including accidents and abnormal events, and other information, as appropriate, available to authorized parties, governmental bodies, national and international organizations, and the public.

[…]

Criteria derived from SSR-2/1, SSR-2/2 and NS-R-3 (SSR-1) - National requirements for NPP Design

Requirements with a grey background were not assessed.

SSR-2/1 - Safety of Nuclear Power Plants: Design

- Requirement 1: Responsibilities in the management of safety in plant design
- Requirement 2: Management system for plant design
- Requirement 3: Safety of the plant design throughout the lifetime of the plant
- Requirement 4: Fundamental safety functions
- Requirement 5: Radiation protection in design
- Requirement 6: Design for a nuclear power plant
- Requirement 7: Application of defence in depth
- Requirement 8: Interfaces of safety with security and safeguards
- Requirement 9: Proven engineering practices
- Requirement 10: Safety assessment
- Requirement 11: Provision for construction
- Requirement 12: Features to facilitate radioactive waste management and decommissioning
- Requirement 13: Categories of plant states
- Requirement 14: Design basis for items important to safety
- Requirement 15: Design limits
- Requirement 16: Postulated initiating events
- Requirement 17: Internal and external hazards

- Requirement 18: Engineering design rules
- Requirement 19: Design basis accidents
- Requirement 20: Design extension conditions
- Requirement 21: Physical separation and independence of safety systems
- Requirement 22: Safety classification
- Requirement 23: Reliability of items important to safety
- Requirement 24: Common cause failures
- Requirement 25: Single failure criterion
- Requirement 26: Fail-safe design
- Requirement 27: Support service systems
- Requirement 28: Operational limits and conditions for safe operation
- Requirement 29: Calibration, testing, maintenance, repair, replacement, inspection and monitoring of items important to safety
- Requirement 30: Qualification of items important to safety
- Requirement 31: Ageing management
- Requirement 32: Design for optimal operator performance
- Requirement 33: Safety systems, and safety features for design extension conditions, of units of a multiple unit nuclear power plant
- Requirement 34: Systems containing fissile material or radioactive material
- Requirement 35: Nuclear power plants used for cogeneration of heat and power, heat generation or desalination
- Requirement 36: Escape routes from the plant
- Requirement 37: Communication systems at the plant
- Requirement 38: Control of access to the plant
- Requirement 39: Prevention of unauthorized access to, or interference with, items important to safety
- Requirement 40: Prevention of harmful interactions of systems important to safety
- Requirement 41: Interactions between the electrical power grid and the plant
- Requirement 42: Safety analysis of the plant design
- Requirement 43: Performance of fuel elements and assemblies
- Requirement 44: Structural capability of the reactor core
- Requirement 45: Control of the reactor core
- Requirement 46: Reactor shutdown
- Requirement 47: Design of reactor coolant systems
- Requirement 48: Overpressure protection of the reactor coolant pressure boundary
- Requirement 49: Inventory of reactor coolant
- Requirement 50: Cleanup of reactor coolant
- Requirement 51: Removal of residual heat from the reactor core
- Requirement 52: Emergency cooling of the reactor core
- Requirement 53: Heat transfer to an ultimate heat sink
- Requirement 54: Containment system for the reactor
- Requirement 55: Control of radioactive releases from the containment
- Requirement 56: Isolation of the containment

- Requirement 57: Access to the containment
- Requirement 58: Control of containment conditions
- Requirement 59: Provision of instrumentation
- Requirement 60: Control systems
- Requirement 61: Protection system
- Requirement 62: Reliability and testability of instrumentation and control systems
- Requirement 63: Use of computer based equipment in systems important to safety
- Requirement 64: Separation of protection systems and control systems
- Requirement 65: Control room
- Requirement 66: Supplementary control room
- Requirement 67: Emergency response facilities on the site
- Requirement 68: Design for withstanding the loss of off-site power
- Requirement 69: Performance of supporting systems and auxiliary systems
- Requirement 70: Heat transport systems
- Requirement 71: Process sampling systems and post-accident sampling systems
- Requirement 72: Compressed air systems
- Requirement 73: Air conditioning systems and ventilation systems
- Requirement 74: Fire protection systems
- Requirement 75: Lighting systems
- Requirement 76: Overhead lifting equipment
- Requirement 77: Steam supply system, feedwater system and turbine generators
- Requirement 78: Systems for treatment and control of waste
- Requirement 79: Systems for treatment and control of effluents
- Requirement 80: Fuel handling and storage systems
- Requirement 81: Design for radiation protection
- Requirement 82: Means of radiation monitoring

SSR-2/2 - Safety of Nuclear Power Plants: Commissioning and Operation

- Requirement 1: Responsibilities of the operating organization
- Requirement 2: Management system
- Requirement 3: Structure and functions of the operating organization
- Requirement 4: Staffing of the operating organization
- Requirement 5: Safety policy
- Requirement 6: Operational limits and conditions
- Requirement 7: Qualification and training of personnel
- Requirement 8: Performance of safety related activities
- Requirement 9: Monitoring and review of safety
- Requirement 10: Control of plant configuration
- Requirement 11: Management of modifications
- Requirement 12: Periodic safety review
- Requirement 13: Equipment qualification
- Requirement 14: Ageing management
- Requirement 15: Records and reports
- Requirement 16: Programme for long term operation

- Requirement 17: Consideration of objectives of nuclear security in safety programmes
- Requirement 18: Emergency preparedness
- Requirement 19: Accident management programme
- Requirement 20: Radiation protection
- Requirement 21: Management of radioactive waste
- Requirement 22: Fire safety
- Requirement 23: Non-radiation-related safety
- Requirement 24: Feedback of operating experience
- Requirement 25: Commissioning programme
- Requirement 26: Operating procedures
- Requirement 27: Operation control rooms and control equipment
- Requirement 28: Material conditions and housekeeping
- Requirement 29: Chemistry programme
- Requirement 30: Core management and fuel handling
- Requirement 31: Maintenance, testing, surveillance and inspection programmes
- Requirement 32: Outage management
- Requirement 33: Preparation for decommissioning

NS-R-3 Chapter 3: Specific requirements for evaluation of external events

EARTHQUAKES AND SURFACE FAULTING

Earthquakes

3.1.The seismological and geological conditions in the region and the engineering geological aspects and geotechnical aspects of the proposed site area shall be evaluated (see Refs [3, 4]).

3.2.Information on prehistoric, historical and instrumentally recorded earthquakes in the region shall be collected and documented.

3.3.The hazards associated with earthquakes shall be determined by means of a seismotectonic evaluation of the region with the greatest possible use of the information collected.

3.4.Hazards due to earthquake induced ground motion shall be assessed for the site with account taken of the seismotectonic characteristics of the region and specific site conditions. A thorough uncertainty analysis shall be performed as part of the evaluation of seismic hazards.

Surface faulting

3.5. The potential for surface faulting (i.e. the fault capability) shall be assessed for the site. The methods to be used and the investigations to be undertaken shall be sufficiently detailed that a reasonable decision can be reached using the definition of fault capability given in para. 3.6.

3.6. A fault shall be considered capable if, on the basis of geological, geophysical, geodetic or seismological data (including palaeoseismological and geomorphological data), one or more of the following conditions applies:

(a) It shows evidence of past movement or movements (significant deformationsand/or dislocations) of a recurring nature within such a period that it is reasonable to infer that further movements at or near the surface could occur. In highly active areas, where both earthquake data and geological data consistently reveal short earthquake recurrence intervals, periods of the order of tens of thousands of years may be appropriate for the assessment of capable faults. In less active areas, it is likely that much longer periods will be required.

(b) A structural relationship with a known capable fault has been demonstrated such that movement of one could cause movement of the other at or near the surface.

(c) The maximum potential earthquake associated with a seismogenic structure is sufficiently large and at such a depth that it is reasonable to infer that, in the geodynamic setting of the site, movement at or near the surface could occur.

3.7. Where reliable evidence shows the existence of a capable fault that has the potential to affect the safety of the nuclear installation, an alternative site shall be considered.

METEOROLOGICAL EVENTS

3.8.The extreme values of meteorological variables and rare meteorological phenomena listed below shall be investigated for the site of any installation. The meteorological and climatological characteristics for the region around the site shall be investigated (see Ref. [5]).

Extreme values of meteorological phenomena

3.9.In order to evaluate their possible extreme values, the following meteorological phenomena shall be documented for an appropriate period of time: wind, precipitation, snow, temperature and storm surges.

3.10.The output of the site evaluation shall be described in a way that is suitable for design purposes for the nuclear installation, such as the probability of exceedance values relevant to design parameters.

Rare meteorological events

Lightning

3.11.The potential for the occurrence and the frequency and severity of lightning shall be evaluated for the site.Tornadoes

3.12. The potential for the occurrence of tornadoes in the region of interest shall be assessed on the basis of detailed historical and instrumentally recorded data for the region.

3.13. The hazards associated with tornadoes shall be derived and expressed in terms of parameters such as rotational wind speed, translational wind speed, radius of maximum rotational wind speed, pressure differentials and rate of change of pressure.

3.14.In the assessment of the hazards, missiles that could be associated with tornadoes shall be considered.

Tropical cyclones

3.15.The potential for tropical cyclones in the region of the site shall be evaluated. If this evaluation shows that there is evidence of tropical cyclones or a potential for tropical cyclones, related data shall be collected.

3.16.On the basis of the available data and the appropriate physical models, the hazards associated with tropical cyclones shall be determined in relation to the site. Hazards for tropical cyclones include factors such as extreme wind speed, pressure and precipitation.

3.17.In the assessment of the hazards, missiles that could be associated with tropical cyclones shall be considered.

FLOODING

Floods due to precipitation and other causes

3.18.The region shall be assessed to determine the potential for flooding due to one or more natural causes, such as runoff resulting from precipitation or snowmelt, high tide, storm surge, seiche and wind waves, that could affect the safety of the nuclear installation (see Ref. [5]). If there is a potential for flooding, then all pertinent data, including historical data, both meteorological and hydrological, shall be collected and critically examined.

3.19. A suitable meteorological and hydrological model shall be developed with account taken of the limits on the accuracy and quantity of the data, the length of the historical period over which the data were accumulated, and all known past changes in relevant characteristics of the region.

3.20. The possible combinations of the effects of several causes shall be examined. For example, for coastal sites and sites on estuaries, the potential for flooding by a combination of high tide, wind effects on bodies of water and wave actions, such as those due to cyclones, shall be assessed and taken into account in the hazard model.

3.21. The hazards for the site due to flooding shall be derived by the use of appropriate models.

3.22. The parameters used to characterize the hazards due to flooding shall include the height of the water, the height and period of the waves (if relevant), the warning time for the flood, the duration of the flood and the flow conditions.

3.23. The potential for instability of the coastal area or river channel due to erosion or sedimentation shall be investigated.

Water waves induced by earthquakes or other geological phenomena

3.24. The region shall be evaluated to determine the potential for tsunamis or seiches that could affect the safety of a nuclear installation on the site.

3.25. If there is found to be such a potential, prehistoric and historical data relating to tsunamis or seiches affecting the shore region around the site shall be collected and critically evaluated for their relevance to the evaluation of the site and their reliability.

3.26. On the basis of the available prehistoric and historical data for the region and comparisons with similar regions that have been well studied with regard to these phenomena, the frequency of occurrence, magnitude and height of regional tsunamis or seiches shall be estimated and shall be used in determining the hazards associated with tsunamis or seiches, with account taken of any amplification due to the coastal configuration at the site.

3.27. The potential for tsunamis or seiches to be generated by regional offshore seismic events shall be evaluated on the basis of known seismic records and seismotectonic characteristics.

3.28. The hazards associated with tsunamis or seiches shall be derived from known seismic records and seismotectonic characteristics as well as from physical and/or analytical modelling. These include potential draw-down and run-up4 that could result in physical effects on the site.

Floods and waves caused by failure of water control structures

3.29. Information relating to upstream water control structures shall be analysed to determine whether the nuclear installation would be able to withstand the effects resulting from the failure of one or more of the upstream structures.

3.30. If the nuclear installation could safely withstand all the effects of the massive failure of one or more of the upstream structures, then the structures need be examined no further in this regard.

3.31. If a preliminary examination of the nuclear installation indicates that it might not be able to withstand safely all the effects of the massive failure of one or more of the upstream structures, then the hazards associated with the nuclear installation shall be assessed with the inclusion of all such effects; otherwise such upstream structures shall be analysed by methods equivalent to those used in determining the hazards associated with the nuclear installation to show that the upstream structures could survive the event concerned.

3.32. The possibility of storage of water as a result of a temporary blockage of rivers upstream or downstream (e.g. caused by landslides or ice) so as to cause flooding and associated phenomena at the proposed site shall be examined.

GEOTECHNICAL HAZARDS

Slope instability

3.33. The site and its vicinity shall be evaluated to determine the potential for slope instability (such as landslides, rockslides and snow avalanches) that could affect the safety of the nuclear installation (see Ref. [3]).

3.34. If there is found to be a potential for slope instability that could affect the safety of the nuclear installation, the hazard shall be evaluated by using parameters and values for the site specific ground motion.

Collapse, subsidence or uplift of the site surface

3.35. Geological maps and other appropriate information for the region shall be examined for the existence of natural features such as caverns and karstic formations and human-made features such as mines, water wells and oil wells. The potential for collapse, subsidence or uplift of the site surface shall be evaluated.

3.36. If the evaluation shows that there is a potential for collapse, subsidence or uplift of the surface that could affect the safety of the nuclear installation, practicable engineering solutions shall be provided or otherwise the site shall be deemed unsuitable.

3.37. If there do seem to be practicable engineering solutions available, a detailed description of sub-surface conditions obtained by reliable methods of investigation shall be developed for the purposes of determination of the hazards.

Soil liquefaction

3.38. The potential for liquefaction of the sub-surface materials of the proposed site shall be evaluated by using parameters and values for the site specific ground motion.

3.39. The evaluation shall include the use of accepted methods of soil investigation and analytical methods to determine the hazards.

3.40. If the potential for soil liquefaction is found to be unacceptable, the site shall be deemed unsuitable unless practicable engineering solutions are demonstrated to be available.

Behaviour of foundation materials

3.41. The geotechnical characteristics of the sub-surface materials, including the uncertainties in them, shall be investigated and a soil profile for the site in a form suitable for design purposes shall be determined.

3.42. The stability of the foundation material under static and seismic loading shall be assessed.

3.43. The groundwater regime and the chemical properties of the groundwater shall be studied.

EXTERNAL HUMAN INDUCED EVENTS

Aircraft crashes

3.44. The potential for aircraft crashes on the site shall be assessed with account taken, to the extent practicable, of characteristics of future air traffic and aircraft (see Ref. [6]).5

3.45. If the assessment shows that there is a potential for an aircraft crash on the site that could affect the safety of the installation, then an assessment of the hazards shall be made.

3.46. The hazards associated with an aircraft crash that are to be considered shall include impact, fire and explosions.

3.47. If the assessment indicates that the hazards are unacceptable and if no practicable solutions are available, then the site shall be deemed unsuitable.

Chemical explosions

3.48. Activities in the region that involve the handling, processing, transport and storage of chemicals having a potential for explosions or for the production of gas clouds capable of deflagration or detonation shall be identified.

3.49. Hazards associated with chemical explosions shall be expressed in terms of overpressure and toxicity (if applicable), with account taken of the effect of distance.

3.50. A site shall be considered unsuitable if such activities take place in its vicinity and there are no practicable solutions available.

Other important human induced events

3.51. The region shall be investigated for installations (including collocated units of nuclear power plants and installations within the site boundary) in which flammable, explosive, asphyxiant, toxic, corrosive or radioactive materials are stored, processed, transported and otherwise dealt with that, if released under normal conditions or accident conditions, could jeopardize the safety of the nuclear installation. This investigation shall also include installations that could give rise to missiles of any type that could affect the safety of the nuclear installation. The potential effects of electromagnetic interference, eddy currents in the ground and the clogging of air or water inlets by debris shall also be evaluated. If the effects of such phenomena and occurrences would produce an unacceptable hazard and if no practicable solution is available, the site shall be deemed unsuitable.