SEVENTH

NATIONAL REPORT

HUNGARY

Prepared in the Framework of the
Convention on Nuclear Safety

Budapest, 2016

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1. Declaration

On behalf of the Government of Hungary, the Director General of the Hungarian Atomic Energy Authority, based on details of this National Report, makes the following declaration:

Hungary states that nuclear safety prevails during the application of nuclear energy and thus Hungary completely fulfils the conditions stipulated in the Convention and it is in compliance with its spirit on the basis of the following:

- the conditions stipulated in law;
- the organizational and financial independence of the Hungarian Atomic Energy Authority and the licensing and inspection activities thereof;
- the activities carried out by the operator who is committed to the priority and continuous improvement of safety.

Budapest, 1st September, 2016

Gyula Fichtinger
Director General of the Hungarian Atomic Energy Authority

2. Introduction[1]

National energy policy

On October 14, 2011 the Parliament adopted a resolution on the document titled as "National Energy Strategy until 2030". As the most important objectives, the *resolution identifies the security of energy supply, the competitiveness and sustainability, the co-realization of these long term primary objectives, the safe and economical satisfaction of the energy needs of the economy and the population taking account of the environmental protection aspects, strengthening the competition on the energy market and support of the community objectives established in the framework of the European Union.*

The resolution requested the Government to take the necessary governmental steps for the realization of the energy policy. Among the twenty-four listed tasks two tasks are in relation with the use of atomic energy. Accordingly, the Government:

- *shall commence the preparatory work for the decision on new nuclear capacities at the site of Paks Nuclear Power Plant, paying special attention to its costs;*
- *shall oversee the proper realization of programmes dealing with the safe management and final disposal of radioactive wastes, and the provision of the necessary conditions.*

The main objective of the Energy Strategy is to guarantee the security of national energy supply. The five tools recommended for the accomplishment of this objective are energy saving and energy efficiency, the use of renewable energy in the highest possible ratio, the development of the regional infrastructure, the active role of the Government in the energy market and the long term peaceful use of atomic energy.

Consequently, the "Common effort" concept that was judged as the most realistic vision and therefore decided to be implemented is represented by the "Atom-Coal-Green" scenario of the Energy Strategy from the electric power generation point of *view. One of the most essential element of this scenario is the long term sustaining of the atomic energy in the energy mix.*

Being in compliance with the international expectations and obligations, the national policy on the management of spent fuel and radioactive waste generated and to be generated in the country from their generation to their final disposal taking account of the decommissioning of nuclear facilities was established in accordance with the Council Directive 2011/70/EURATOM of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste.

[1] The modifications made in comparison with the Sixth National Report are indicated in Italics.

The role and contribution of nuclear energy

Paks Nuclear Power Plant, Hungary`s only nuclear power plant, operates as a joint stock company under the name of MVM Paks Nuclear Power Plant Ltd. *The contribution of atomic energy to the total generation of electric power was 51% in 2013, 54% in 2014 and 53% in 2015. Consequently, Paks Nuclear Power Plant plays an essential role in the Hungarian electrical power system.*

Significance of safety

Act CXVI of 1996 on Atomic Energy (hereinafter referred to as the Act on Atomic Energy) stipulates that "In the use of atomic energy, safety has priority over all other aspects", and that "The Licensee is obliged to undertake continuous activities to improve safety, *taking account of its operational experience and the new safety related information*" in harmony with the spirit of the Convention on Nuclear Safety.

International reviews

Since its commissioning, Paks NPP has paid special attention to utilizing international experience and, at the initiative of the NPP, *38* international reviews have taken place since 1984. These include all kinds of reviews organized by the International Atomic Energy Agency. *The last OSART review was hosted in 2014; its follow-up mission will be held in 2016. Additionally, the World Association of Nuclear Operators (hereinafter referred to as WANO) performs regular reviews at Paks Nuclear Power Plant. The follow-up of the 3rd peer review was conducted in 2014, the 4th peer review and the follow-up of the WANO corporate level peer review conducted in 2014 will be organized in 2016.*

International relations

The Hungarian institutes maintain wide-ranging relations with various international and national nuclear organizations, professional bodies, institutes, nuclear power plants abroad, companies involved in design, construction and installation of nuclear facilities, and research institutes.

These relations serve as a means of exchanging knowledge and experience. The fact that Hungarian experts are held internationally in high esteem is demonstrated by their active role in several committees, with many of them being board members of international organizations or invited as experts.

International partners of major importance are: the International Atomic Energy Agency (*hereinafter referred to as IAEA*), the OECD Nuclear Energy Agency (*hereinafter referred to as OECD NEA*), the European Union and its organizations, the European Atomic Energy Community (*hereinafter referred to as* Euratom), the World Association of Nuclear Power Plant Operators (*hereinafter referred to as* WANO), the VVER-440 operators' club, the VVER users' club, the International Nuclear Safety Program (the so-called Lisbon Initiative), the Nuclear Maintenance Experience Exchange (*hereinafter referred to as* NUMEX), the Western European Nuclear Regulators Association (the European Safeguards Research and Development Association (*hereinafter referred to as* WENRA), European Safeguards Research and Development Association (*hereinafter referred to as* ESARDA), the European Atomic Energy Society (*hereinafter referred to as* EAES) and *the Electric Power Research Institute (hereinafter referred to as EPRI). Additional important partners are the European Nuclear Security Regulators Association (hereinafter referred to as ENSRA), the Heads of the European Radiological Protection Competent Authorities (hereinafter referred to as HERCA) and the European Association of Competent Authorities (EURACA).* The Hungarian Nuclear Society is a member of the European Nuclear Society (*hereinafter referred to as* ENS), and the Radiation Protection Section of the Eötvös Loránd Physical Society is a member of the International Radiation Protection Association.

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Comments on the challenges and suggestions identified in Rapporteur's Working Document about the Sixth National Report

1. Integrated Regulatory Review Service Mission
The so-called Integrated Regulatory Review Service Mission (hereinafter referred to as IRRS Mission) conducted by the IAEA reviewed the work of the organizations overseeing the use of atomic energy in Hungary including the work of the HAEA in the period of May 11-22, 2016. The review concluded in 32 recommendations and 10 suggestions, the majority of which was related to the state organizations and authorities also having tasks related to the facilities overseen by the HAEA and their cooperation with the HAEA (see details in Chapter 3.8).

2. Implementation of the Hungarian post-Fukushima National Action Plan
The Hungarian National Action Plan complies with the set criteria and is in harmony with the relevant recommendations of the ENSREG. In order to follow the implementation of the plans, the international review was repeated in 2015. In relation to Hungary it was concluded that the task performance shows good progress, several tasks were completed by deadline or even before. By the end of 2015, 24 out of 46 tasks were completed and the completion of 6 tasks was under evaluation by the HAEA (see details in Chapter 3.5 and Annex 7).

3. Severe Accident Management Guideline containing new accident management strategy
The Severe Accident Management Guideline containing a new accident management strategy was introduced on Units 1-4 of Paks Nuclear Power Plant, the modifications

required for the prevention and management of accidents, as well as for the mitigation of their consequences were completed. After the completion of the severe accident management modifications, the Severe Accident Management Guideline package was introduced on each unit between 2011 and 2014 (see details in Chapter 14.3).

4. Licensing of the operation of Units 1-4 of Paks Nuclear Power Plant beyond their design service lifetime
Subsequent to the end of the design service lifetime of 30 years, lifetime extension of additional 20 years was performed on Unit 1 in 2012 and on Unit 2 in 2014. The operation licenses of Units 3 and 4 will cease to be in force at the end of their design service lifetime of 30 years, on December 31, 2016 and December 31, 2017, respectively. The licensee submitted the application to obtain the license for lifetime extension of Unit 3 on December 2, 2015 to the HAEA; its evaluation is in progress (see details in Annex 5).

5. Human resources
In view that Unit 5 can probably start its operation in 2025, while Unit 6 in 2026, the HAEA assessed the professional knowledge and staff number required for the new regulatory licensing and construction oversight tasks and the report on this assessment was submitted to the concerned government organizations. Accordingly, the HAEA got the opportunity to recruit significant number of new staff in 2015 to perform its tasks related to the new units and other new competences (i.e. oversight of radioactive waste repositories and radiation protection). The staff number of the HAEA was practically doubled with the recruitment of about 80 employers. This opportunity was facilitated by that amendment to the Act on Atomic Energy, which increased the salaries of the employees of the HAEA (see details in Chapter 11.2).

6. Knowledge management
The major elements of knowledge management are available at the HAEA. The training system of nuclear safety inspectors follows the systematic approach established by the IAEA. However, certain elements of knowledge management, especially the tools of knowledge sharing need further enhancement. In order to improve the situation, the HAEA started a project in 2015 aiming at enhancing the effectiveness of its knowledge management system (see details in Chapter 11.2.1).

7. Nuclear Safety Code (hereinafter referred to as NSC) for new nuclear power plant units
In addition to the continuous development of IAEA recommendations and WENRA reference levels, the Hungarian regulations were reviewed and revised more frequently than the 5-year review period stipulated by law. The reviews resulted in amendments to the Govt. decree 118/2011. (VII. 11.) Korm. on the nuclear safety requirements for nuclear facilities and the corresponding regulatory activity. In order to be prepared for the construction of the new nuclear power plant units, the Volume 3/A of the NSC on nuclear safety requirements to be applied during the design was published; in addition, the HAEA developed further the requirements for the design and construction period as well (see details in Chapter 7.2).

8. Independence of Technical Support Organizations

The HAEA professionals were satisfied with the performance of the technical support organizations. With their activities, these organizations contributed to the completion of regulatory works at a higher level, and thus to the safe operation of the nuclear facilities. The high level quality management systems of the technical support organizations guarantee the independence of the provided expert support. In such cases, where independence is concerned, the HAEA requests a special declaration from the technical support organization to justify that the technical support organization does not work in the given topic for the licensee (see details in Chapter 3.9).

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In *the present report* mainly the changes that have occurred since the closure of the previous national report are detailed, nevertheless all the basic principles that are still valid are repeated to provide the reader with a stand-alone report. Important processes that did not change in the reporting period have not been omitted from *the present document*, but the detailed descriptions have been placed to the Annexes.

The outcomes of the review conducted after the accident of Units 1-4 of TEPCO Fukushima Dai-ichi NPP were discussed in the report submitted to the Extraordinary Review Meeting held in August 2012. The National Action Plan established based upon the Targeted Safety Reassessment (hereinafter referred to as TSR) *and its implementation* is presented in Annex 7.

The data presented in this report reflect the situation as at *December 31, 2015*.

3. Summary. The most important changes since submission of the previous National Report

Since the submission of the *Sixth* National Report there is no change in the number of nuclear installations.

Throughout their work, both the HAEA and the Licensee have profited from the conclusions of the previous Review Meeting and special emphasis was given to evaluating the comments and general remarks addressed to the Report of Hungary.

The *main events that have taken place* since the submission of the previous National Report are the following:

3.1 Licensing of the operation of Units 1-4 of Paks Nuclear Power Plant beyond its design lifetime

Subsequent to the end of the 30-year design service life of Units 1 and 2, in 2012 and in 2014, the lifetime extension allowing further operation for additional 20 years was completed.
The operation licenses of Units 3 and 4 will cease to be in force at the end of the 30-year design service life on December 31, 2016 and December 31, 2017.
The application to obtain the license for lifetime extension of Unit 3 was submitted by the licensee to the HAEA on December 2, 2015; its evaluation is in progress.
The lifetime extension related licensing activity is described in Annex 5.

3.2 Introduction of the 15-month operation cycle at Paks Nuclear Power Plant

The MVM Paks Nuclear Power Plant Ltd declared in the beginning of 2013 its intention to operate the units of the nuclear power plant, instead of the current 12-month cycle period, based on a 15-month operation cycle. The most visible character of the increase of the cycle period is that only 4 main refuelling outages will be performed during 5 years at one unit, instead of the current 5 main refuelling outages, as it is shown by the figure below. The increased operation cycle requires the application of new type, higher enriched nuclear fuel.

Figure 3.2: The current and planned operation cycle

The MVM Paks Nuclear Power Plant Ltd informed the HAEA on its ideas regarding the realization of this modification. The planned modification is a complex technical one, which affects the basics of safe operation and thus requires the renewal of the operation license.

The planned introduction of the 15-month operation cycle and the application of the modified nuclear fuel made necessary the amendment to the environmental protection license of the nuclear power plant. The HAEA, at the request of the South-Trans-Danubian Environmental and Nature Protection Inspectorate, issued a co-authority opinion in September, 2014 in this proceeding. The environmental protection authority granted a new environmental protection license to the operation of the nuclear power plant.

In addition to the introduction of the 15-month operation cycle, in May 2014, the HAEA, in the proceeding conducted at the request of the licensee, licensed to load 12 pieces of new type nuclear fuel assemblies into the reactor of Unit 3 and its operation with these "mixed" core. This aimed at verifying and validating the accuracy of the reactor physics calculations of loads including new fuel assemblies.

The licensee submitted its license application for the operation with the 15-month operation cycle in November, 2014. The HAEA granted the license, in its resolution issued on December 1, 2015, to introduce the 15-month operation cycle at Units 1-4 of the nuclear power plant.

3.3 Development of regulations

The of Govt. decree 118/2011. (VII.11.) Korm. on the nuclear safety requirements for nuclear facilities and the related regulatory activities (hereinafter referred to as Govt. decree 118/2011. (VII.11.) Korm.) and the Nuclear Safety Code enacted as its annexes include the nuclear safety requirements for the entire life cycle of nuclear facilities. The regulations shall be periodically (at least every 5 years) reviewed as required by the Act on Atomic Energy. Although the Hungarian requirement system has been continuously developed for the recent years, the HAEA started the periodic review of the actual requirements system in the beginning of 2015.

An important aspect of regulation development was to take into account the recommendations of international organizations, especially the recommendations of the Western European Nuclear Regulators' Association on international good practice, the so-called reference levels, as well as the good practice of certain countries with developed nuclear technology.

Hungary is represented by the HAEA in the organization of WENRA. The WENRA reference levels were established for the first time in 2008, the review of the requirements was completed in 2013. The new reference levels have been incorporated by Hungary in the Nuclear Safety Code.

During the revision of the Nuclear Safety Code the relevant international construction experience, the IAEA recommendations and the WENRA reports were taken into account in terms of the requirements for new nuclear units. The legislator utilized the experience gained regarding the Finnish and British regulations, as well as the national licensing experience.

In addition to the continuous development of IAEA recommendations and WENRA reference levels, the update of the national regulations has been performed more frequently than every 5 years as required by law. The revision of the regulations resulted in several modifications of the Govt. decree 118/2011. (VII. 11.) Korm. The Nuclear Safety Code was modified most recently in July, 2015.

Accordingly, Hungary fulfilled its obligation undertaken for the sake of legal harmonization.

3.4 Establishment of the new safety zones of the overseen facilities

The Govt. decree 246/2011. (XI. 24.) Korm. on the safety zone of the nuclear facility and the radioactive waste repository changed the recent static concept on the establishment of safety zones primarily based on the impacts from the site towards the environment, which meant a safety zone having a radius of 3 km for the nuclear power plant.

The new law takes into account the radiation exposure to the public and environment occurring during the normal operation of the given facility, and thus defines the minimum dimensions of the safety zone for each facility type. The minimum dimensions shall be measured from the surface of the wall meaning the outmost technological protection; it is at least 500 meters for the nuclear power plant, at least 100 meters for the research reactors, at least 500 meters for the spent fuel interim storage facility, and at least 100 meters for the radioactive waste repository as measured from the boundary of the supervised area defined in law.

The actual boundary of the safety zones shall be determined based on the radiation protection regulation, which describes that the person permanently staying at the boundary of the safety zone shall not receive a radiation exposure greater than 100 μSv in a year from the radiation of radioactive materials discharged or released during the regular operation of the nuclear facility or the radioactive waste repository. The boundary of the safety zone shall be established by the HAEA.

The regulation on disaster management and nuclear emergency response system defines zones taking account of the normal operation of facilities that are different from the safety zones as established by the Atomic Act.

In addition to the rules for the establishment of safety zones, the law prescribes the determination, with analysis, of impact distances of industrial and other human

activities having effect on nuclear safety performed in the vicinity of the facilities regarding the effects from the environment towards the sites of the facilities. This analysis shall be made during the licensing of all those facilities and activities performed in the 30 kilometre vicinity of nuclear facilities and radioactive waste repositories qualified as hazardous from industrial safety and disaster management aspects defined by law, where the law requires the designation of a protection distance.
In the case of new industrial facilities or other human activities to be constructed or performed in the vicinity of facilities falling under the scope of the Atomic Act, the HAEA and the licensee of the concerned facility under its oversight participate as clients in the licensing procedure of facilities and activities qualified as hazardous based on industrial safety or disaster management aspects.

The boundaries of the safety zones shall be reviewed at least once every 10 years, in the framework of the Periodic Safety Review (hereinafter referred to as PSR). During the review of the boundary of the safety zone, the sustainability of the safety zone and protection distance designated before based on the analysis of facilities and activities qualified as hazardous based on industrial safety and disaster management aspects shall be analysed, taking account of the potential changes in industrial and human activities.

The safety zones of the nuclear facilities and radioactive waste repositories were reviewed in 2014-2015.

3.5 National Action Plan for the improvement of the safety of facilities

The European Union has not closed the European review after the accident which occurred at Units 1-4 of TEPCO Fukushima Dai-ichi nuclear power plant, but it declared its intention to follow the implementation of the corrective measures decided in the Member States as an outcome of the Targeted Safety Reassessments (so-called stress tests). In this spirit, a decision on the development of National Action Plans was made at the meeting of the European Nuclear Safety Regulators (hereinafter referred to as ENSREG) held on September 4-5, 2012, the plans of which had to be submitted to the European Commission by December 31, 2012.

The Hungarian National Action Plan was completed in December, 2012; it was stated that it complies with the established criteria and it is in harmony with the relevant recommendations of the ENSREG.

In 2015, the international review was repeated to track the implementation of the plans. In the case of Hungary it was stated that the accomplishment of tasks shows good progress, several tasks had been accomplished by the deadline or even before. The Hungarian report and its presentation had univocal positive receipt; two actions were evaluated as good practices that was an appreciation of the work of both the MVM Paks Nuclear Power Plant Ltd and the HAEA.

The major part of the National Action Plan consists of the actions developed based on the TSR of Paks Nuclear Power Plant, which should be, after approval of the HAEA and under its continuous oversight, accomplished by the MVM Paks Nuclear Power Plant Ltd by the end of 2018. The nuclear safety inspectors of the HAEA conduct inspections over the realization of the tasks and the due progress of their implementation. The MVM Paks Nuclear Power Plant Ltd prepares progress reports to the HAEA every six months. By the end of 2015 24 tasks were accomplished out of 46, the accomplishment of 6 tasks is currently under evaluation by the HAEA.

After the completion of the TSR, based on its outcomes and in line with the National Action Plan, in 2013 the HAEA started the preparations for the incorporation of the lessons learned from Fukushima to the nuclear safety regulations. The HAEA studied the requirements reviewed by the IAEA and the WENRA after the accident and ordered a study on the needs of modification of the Hungarian nuclear safety requirements.

After a several month long preparation phase the HAEA initiated the modification of the nuclear safety requirements at the Ministry of National Development in 2014. Altogether 50 new requirements were developed based on the proposal of the HAEA and further 29 requirements were determined for amendment. Special consideration was taken to fully incorporate the lessons learned in the requirements. The new requirements entered into force at the end of 2014, thus Hungary was a world-wide pioneer of the enforcement of the lessons learned from Fukushima.

The status of the identified tasks can be summarized as follows:

- *28 tasks were completed by deadline,*
- *additional 9 tasks were reported as complete by Paks Nuclear Power Plant, but the completion has not yet been closed by the HAEA,*
- *the deadline for 10 tasks is still due and can be kept,*
- *delay is expected in the case of 4 tasks,*
- *according to the current situation all the tasks will be completed by the end of 2018.*

The details of the Hungarian National Action Plan are described in Annex 7.

3.6. *Sustaining the capacity of the Paks Nuclear Power Plant*

In January, 2014 the Government of Hungary and the Government of the Russian Federation concluded an agreement on the cooperation in the field of peaceful use of nuclear energy, which was promulgated in the Act II of 2014. Among others, the Agreement deals with the cooperation in relation to new nuclear power plant units.

In April, 2014 the MVM Paks II Nuclear Power Plant Development Ltd. submitted its application for obtaining the license for site survey and evaluation, and started the preparation for fulfilling the obligations and tasks of its role as a licensee. On November 14, 2014 the HAEA approved the site survey and evaluation programme *with certain conditions. The fulfilment of the licensee functions is being continuously reviewed by the HAEA during inspections.*

In November, 2015 the MVM Paks II Nuclear Power Plant Development Ltd. submitted the Preliminary Safety Information Report (hereinafter referred to as PSIR) to the HAEA. The staff of the HAEA started reviewing the document consisting of about 10,000 pages. The legal basis for the submission and review of the PSIR is provided by the Act on Atomic Energy. Accordingly, prior to the planned commencement of the construction licensing process of the nuclear facility the licensee of the nuclear facility may inform the HAEA on the preliminary compliance of the planned nuclear facility with the safety requirements by submitting the PSIR.

The PSIR aims at providing sufficiently detailed preparatory information to the HAEA on the safety of the planned nuclear power plant. The PSIR submitted to the HAEA includes general design information, but it does not include the site specific design solution to be applied at the Hungarian new nuclear power plant units.

The licensee may submit an application to obtain the construction license at the earliest 12 months subsequent to the submission of the PSIR, in order to allow sufficient time for the HAEA to study the information material. Taking account of the submission and content of the PSIR, the administrative proceeding period of the construction license application is 12 months at maximum, which might be extended with additional 3 months, if needed. The review of the PSIR is not a formal regulatory licensing procedure. Basically it aims at allowing the HAEA to be aware of the major technology characters and technical solutions of the planned unit type and to be prepared for reviewing the construction license application.

3.7 Transfer of the safety oversight of radioactive waste repositories to the competence of the HAEA

As of July 1, 2014 the HAEA performs the regulatory oversight of the safety of radioactive waste repositories (the security and the exclusive peaceful use were overseen by the HAEA even before). The tasks of the HAEA in relation to this competence are established in Govt. decree 155/2014. (VI. 30.) Korm. on the safety requirements for repositories providing the storage and disposal of radioactive wastes and the corresponding regulatory activities (hereinafter referred to as Govt. decree 155/2014. (VI. 30.) Korm.).

3.8 Integrated Regulatory Review Service Mission

The Integrated Regulatory Review Service Mission (hereinafter referred to as IRRS Mission) reviewed the activities of the organizations regulating the use of atomic energy in Hungary, among them the regulatory work of the HAEA. The HAEA and the other participating authorities conducted a self-assessment in 2014, as a result of which a detailed action plan was established regarding the areas for improvement. The reviewer team composed of foreign experts conducted the review based on the

Advanced Reference Material (hereinafter referred to as ARM) provided one month in advance, interviews and visits between May 11-22, 2015.

The review resulted in 32 recommendations and 10 suggestions, the majority of which related to the activities of the state organizations and authorities having competences over the facilities overseen by the HAEA and to their cooperation with the HAEA. The report of the IRRS mission is accessible in both Hungarian and English on the website of the HAEA.

In addition to the above mentioned findings, the review identified several good practices in the case of the HAEA, which were judged as ones that are worth following even on international level.

It should be noted that the mission reviewed the Hungarian regulatory system in such a period, when it was in the middle of a significant change due to the transfer of radiation protection competences to the HAEA. Solving the majority of the findings identified in the country report in this area has become the task of the HAEA as of January 1, 2016. The majority of these findings were addressed with the new radiation protection regulation by the end of 2015.

Based on the country report the HAEA revised its action plan established on the basis of its self-assessment, and then started its implementation. In general, the IRRS Mission is followed by a follow-up mission within 2-3 years, which aims at verifying the accomplishment of the recommendations and suggestions established in the country report. The follow-up mission is planned to be invited by the HAEA for 2018.

3.9 Technical Support Organizations

The integration of technical support organizations to facilitate nuclear safety related regulatory work is an international requirement. During the regular technical support programmes of the recent years the network of technical support organizations facilitating the regulatory work of the HAEA was developed. The majority of the more comprehensive tasks providing background to the regulatory activities of the HAEA was performed by these institutes also in the period of 2013-2015, giving fast expert support even to the immediate issues. The officials of the HAEA were satisfied with the work of these technical support organizations, their activity contributed to the high level performance of the regulatory works and thus to the safe operation of the nuclear facilities.

The independence of the expert support is guaranteed by the operation of high level quality management systems applied at these background institutes.

3.10 Human resources of the HAEA

Based on the study made by the HAEA on the professional knowledge and staff number needed for the regulatory licensing and facility oversight tasks regarding the new units, the HAEA had the possibility to recruit a significant number of new staff members in 2015. After the recruitment of about 80 new professionals the staff number of the HAEA was almost doubled. The employment of new staff members was *facilitated by the amendment to the Atomic Act that significantly increased the salaries of staff members of the HAEA.*

Independently of the construction of the new Hungarian nuclear power plant units, the HAEA shall flawlessly perform the oversight of the existing electric power generating units, the other three nuclear facilities and the waste repositories, which mean an increasing burden due to the ageing of facility equipment and the oversight of the consequent equipment replacements, modernization projects and ageing management processes. This should be also taken into account during the trainings of the professionals.

A. GENERAL PROVISIONS

4. General provisions

Nuclear Safety Convention, Article 4:
Each Contracting Party shall take, within the framework of its national law, the legislative, regulatory and administrative measures and other steps necessary for implementing its obligations under this Convention.

Hungary was one of the first states to sign the Convention on Nuclear Safety (hereinafter referred to as the Convention) signed in Vienna on September 20, 1994 within the framework of the International Atomic Energy Agency. The Convention was promulgated in the Act I of 1997, so *the Convention entered into force on October 24, 1996 for Hungary.*

5. Reporting

Nuclear Safety Convention, Article 5:
Each Contracting Party shall submit for review, prior to each meeting referred to in Article 20, a report on the measures it has taken to implement each of the obligations of this Convention.

This *seventh* National Report has been compiled in accordance with the requirements of the Convention and the "Guidelines Regarding National Reports under the Convention on Nuclear Safety – INFCIRC/572/*Rev.5*" together with the recommendations based on the conclusions of the *sixth* Review Meeting (*2014*).

The National Report, following the order of the Articles of the Convention, includes:
- fulfilment of general provisions, and description of existing nuclear installations, mainly Paks Nuclear Power Plant (Paks NPP) as this falls under the scope of the Convention;
- characteristics of Hungarian legislation and regulations, and the role of the HAEA;
- general issues of safety (including the state of financial and human resources, quality management system, radiation protection and emergency preparedness); and
- overview of the *safety status* of the only Hungarian nuclear installation that falls under the scope of the Convention.

6. Existing nuclear installations

Nuclear Safety Convention, Article 6:
Each Contracting Party shall take the appropriate steps to ensure that the safety of nuclear installations existing at the time the Convention enters into force for that Contracting Party is reviewed as soon as possible. When necessary in the context of this Convention, the Contracting Party shall ensure

that all reasonably practicable improvements are made as a matter of urgency to upgrade the safety of the nuclear installation. If such upgrading cannot be achieved, plans should be implemented to shut down the nuclear installation as soon as practically possible. The timing of the shut-down may take into account the whole energy context and possible alternatives as well as the social, environmental and economic impact.

6.1 Paks Nuclear Power Plant

The scope of the Convention covers the four operating units of Paks NPP. The units were commissioned between 1983 and 1987 and are currently in good technical condition.

MVM Paks Nuclear Power Plant Ltd is a company being in indirect state ownership. As of May 14, 2015 100% of the shares are held by the MVM Hungarian Electricity Ltd (within a competence transferred by the state to it).

6.1.1 Main technical characteristics

The main technical data of the units of Paks NPP are summarized in Table 6.1.1

Table 6.1.1: Main technical attributes of units of Paks NPP

Reactor type	Pressurized-water, water-cooled, water-moderated power reactor, type: VVER-440/V-213
Thermal power of the reactor	*1485 MW*
Electric power output of a unit	*500 MW*
Number of primary loops per unit	6
Volume of the primary circuit	237 m^3
Pressure in the primary circuit	123 bar
Average temperature of the primary coolant	*284 ±2 °C*
Height/diameter of the pressure vessel	11.8 m/ 4.27 m
Average enrichment of the fuel	*3,82-4,7%*
Fuel quantity per unit	*44* tons of uranium in 349 fuel assemblies
Number of *turbo-machine groups* per unit	2
Pressure of secondary circuit main steam line	43.15 bar

MVM Paks Nuclear Power Plant Ltd operates 4 pressurized-water nuclear units of the type VVER-440/V-213; both the moderator and the coolant of the reactors are light water. (On the basis of its safety philosophy, the power plant belongs to the group of second-generation VVER-440 nuclear power plants.) The reactor has 6 cooling loops, each one is connected to a steam generator. Each power plant unit is supplied with a so-called localizing tower (operating on the bubble condensing principle) connected to airtight compartments for handling any incidents caused by pipe ruptures. In these towers, trays filled with water containing boric acid are layered one above the other, completed with air traps. This system of hermetic compartments and localizing towers makes up the containment for the reactors.

Each unit is installed with 3 active safety systems, and in case of incidents their electrical supply might be ensured by diesel generators. These systems are supplemented by passive systems. Two *saturated (wet) steam turbines* operate in each unit. The original nominal thermal power of each unit was 1375 MW, and the nominal electric power outputs of each unit were 440 MW. As a result of the power uprating programme realized between 2006 and 2009, the thermal power of each unit has increased to 1485 MW and the electric power to 500 MW.

The designers of the power plant chose the so-called twin-unit version. The turbine hall is common for the four units and the reactor halls each shared by 2 units enable common use of high value maintenance equipment. At the same time, the main components and safety systems of the units are independent of each other. The only exception is the safety cooling water system, where the pressure line *at the water intake facility* from the pumps to the pressure-equalizing tank is shared by two units.

Taking advantage of a common site and adjacent location of units, the supply systems were designed to be shared by the whole power plant.

6.1.2 Safety reviews

The Hungarian regulatory body, namely the HAEA evaluates the safety reports of the facilities from the licensing of construction, during the entire life cycle of the facilities.

The construction of a nuclear facility ends with the completion of the Final Safety Analysis Report, which describes the realization of the design basis and provides a basis for operation. This report shall be updated in the case of technical and organizational modifications.

In Hungary a decree provides the conduct of periodic safety reviews, *in the framework of which, in line with the recommendation of the IAEA, the technical status and safety level of the facility shall be reviewed every 10 years, in comparison with the technical solutions and safety requirements complying with the actual international requirements. During the review those conditions have to be identified based on the risk given from any deflection from the requirements which have to be fulfilled by the facility in the next 10 years. As an outcome of the review, in order to decrease the risk, the licensee has to implement safety improvement measures in the next cycle. The HAEA publishes a guideline on the implementation of the Periodic Safety Review. In the first part of the PSR the licensee evaluates the status of the facility and then prepares the Periodic Safety Review Report, which is evaluated by the HAEA in the* *second part of the review. The PSR is closed by a resolution, in which the HAEA orders the implementation of the necessary safety improvement measures.*

In 2015 the law has incorporated the competence that the HAEA as the nuclear safety authority may revoke or limit the scope of the operation license of the facility based on the Periodic Safety Review of the licensee and the findings of the regulatory evaluation of the Periodic Safety Review Report, the construction license of the spent fuel interim storage facility if it identified the change of the conditions that had provided the basis for the issuance of the license or the increase of the risk. The nuclear safety authority may establish new conditions, other than the previous ones for the further operation of the facility, or in the case of the spent fuel interim storage facility for the extension, and may prescribe obligations to the licensee, including the implementation of safety improvement measures.

MVM Paks Nuclear Power Plant Ltd pays special attention on international reviews since the start of the operation. A list of international safety reviews performed at Paks NPP is included in Table *19.7.3 in Chapter 19.7.*

6.1.3 Safety improvement measures

As a result of the last PSR completed in 2008 at Paks Nuclear Power Plant the following more important safety improvement measures were implemented, which were overseen by the HAEA in the period of 2013-2015:

- *replacement of actuators of the essential service water system valves to water resistant ones;*
- *reinforcement of cooling circuit separation valves of the spent fuel pool and pipe sections between wall penetrations;*
- *management of primary to secondary leakage through blow down to the hermetic zone;*
- *hydrogen management during severe accident processes with the installation of severe accident recombiners;*
- *modifications reducing the effect of high energy pipe ruptures (within the hermetic zone);*
- *external cooling of the reactor pressure vessel by flooding of the reactor cavity in the case of melting of the core in order to prevent melt through of the vessel;*
- *modifications reducing the effect of high energy pipe ruptures (within the turbine hall);*
- *cable schedule modifications increasing system independence;*
- *independent electric supply to safety valves (autonomous supply system for accident management);*
- *modification of the actuator circuit of the cooling water pumps of the spent fuel pool;*
- *establishment of additional fire protection claddings and fire barriers;*
- *reduction of the load on safety distributors;*
- *relocation of transmitter cabinets of I&C systems affected by high energy pipe rupture and transponder cabinets;*

- *new severe accident measurement system;*
- *establishment of the Technical Support Centre within the Emergency Response Organization (hereinafter referred to as ERO).*

Each action shall be completed by the next review that is due in 2018.

The Severe Accident Management Guideline incorporating the new accident management strategy was introduced on Units 1-4, and the modifications needed for the prevention, management of accidents and the mitigation of consequences were completed (see details in Chapter 14.3).

As a consequence of the accident occurred at Fukushima on March 11, 2011 the MVM Paks Nuclear Power Plant Ltd conducted the TSR. Based on the evaluation made as an outcome of the TSR, at the end of 2012, the HAEA ordered the implementation of the developed safety improvement measures.

The completed TSR actions are as follows:

- *Analysis of the introduction of automatic SCRAM-1 based on seismic protection signal;*
- *Fixation of maintenance tools;*
- *Sealing the safety cooling water wall penetrations;*
- *Increasing the quantity of stored Diesel generator fuel;*
- *Making the 120kV substation earthquake resistant;*
- *Increasing the amount of stored demineralized water reserves;*
- *Reinforcing the Health and Laboratory Building for the protection of the demineralized water tanks on Installation II;*
- *Improvement of electric supply of machine racks and travelling band screens;*
- *Testing the external electric connection (from Gönyű);*
- *Establishing rapid connection to the demineralized water tanks;*
- *Developing the electric power supply of pebble bed wells;*
- *Establishment of cooling with fire water in severe accident conditions;*
- *Establishing and developing electric connections between the units;*
- *Verifying equipment belonging to low water level of the Danube, evaluating their condition;*
- *Seismic resistance analysis of protective shelters, implementing the needed reinforcements;*
- *Reviewing the rules of the transportation of the ERO staff;*
- *Purchasing a transport vehicle providing protection against radiation;*
- *Purchasing of mobile tools needed for external water supply (fire fighter hoses, pumps, fittings);*
- *Developing the Technical Support Centre within the ERO organization in order to be capable of managing multi-unit events;*
- *Establishing a software based severe accident simulator;*

- *Conception planning of the management of liquid radioactive wastes produced during a severe accident;*
- *Seismic resistance review of machine rack and travelling band screens;*
- *Evaluating the protection against electromagnetic effects;*
- *Reviewing the environmental radiation measurement systems, their seismic resistance evaluation;*
- *Evaluating the effect of building settlement and soil liquefaction and the effect of these on underground lines.*

The core damage probability due to internal initiating events decreased by a magnitude in comparison with the first assessment, both for the operating state and shutdown state (shutdown for either maintenance or refuelling) of the reactor.
The results of internal fire and internal flooding risk analyses are also better, than the results of recent analyses.

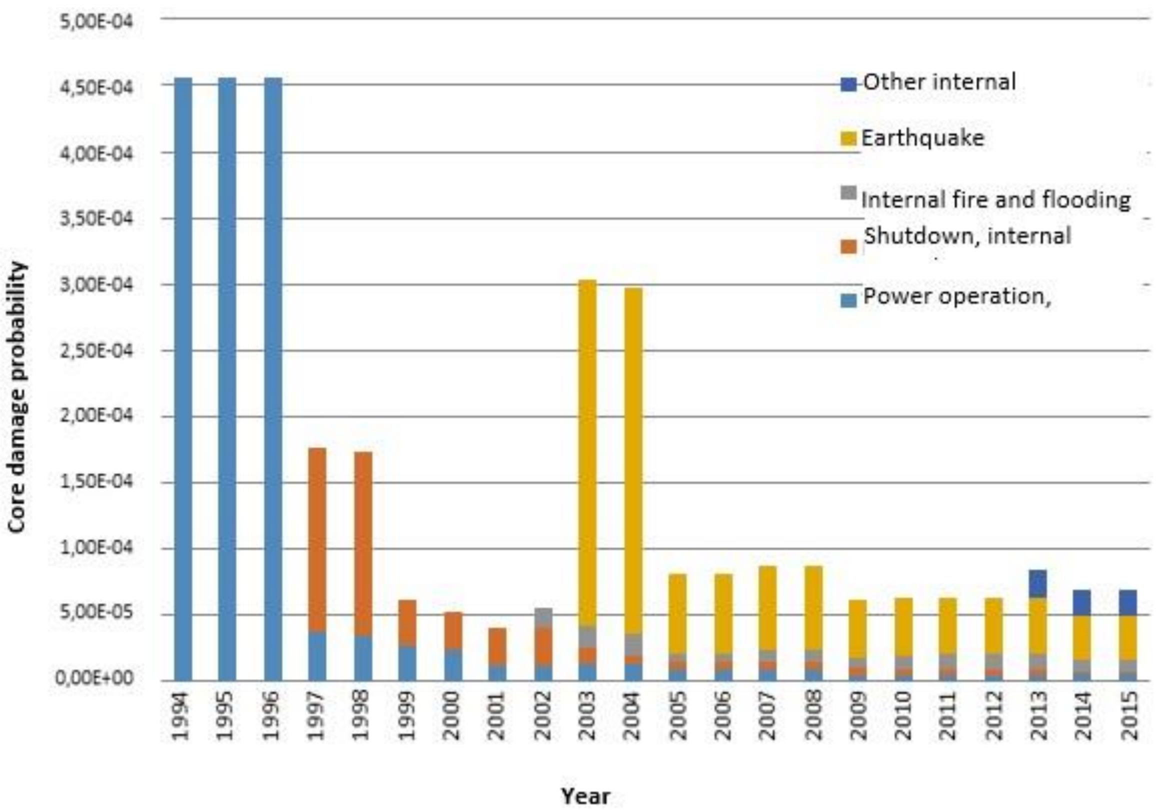
The PSA analysis of external hazard sources other than earthquakes was completed in 2012. The follow-up evaluation of this analysis is still in progress. Additional safety improvement measures are implemented to increase the resistance against external hazards. The deadline for the completion of the last actions is 2018.

The average (calculated for a year) probability of core damage induced by transient processes on Unit 3 (as a reference unit) is:

- $5.2x10^{-6}$ *for operation at nominal power, induced by initiating events having technology origin;*
- $2.0x10^{-6}$ *for shutdown to refuelling outage, induced by internal initiating events having technology origin;*
- $8.6x10^{-6}$ *for all operating states, induced by an internally originated fire and flood;*
- $3.3x10^{-5}$ *for all operating states, induced by an earthquake;*
- $2.0x10^{-5}$ *for all operating states, induced by other external hazards not quantified above.*

Figure 6.1.3 shows the core damage probability on Unit 3 in the period of 1994-2015 induced by internal originated events, and internal and external hazards.

*Figure **6.1.3:** Overview of core damage probability*



6.2 Spent Fuel Interim Storage Facility

In order to store the spent fuel assemblies removed from reactors of Paks Nuclear Power Plant for an interim period of 50 years, a modular type dry storage facility operates *on a site adjacent to the site of the plant*.

The holder of the operating license of the Interim Spent Fuel Storage Facility (hereinafter referred to as ISFSF) is the Public Limited Company for Radioactive Waste Management.

The modules that are capable of storing fuel assemblies can be extended in a modular system. The positioning of modules in a row allows *the use of* a common reception building and loading equipment. Spent fuel assemblies are stored individually in vertical tubes in the storage building. In order to prevent corrosion during long-term storage, the storage tubes are filled with nitrogen gas and are placed in vaults surrounded by concrete walls. The removal of residual heat generated by irradiated fuel takes place by natural flow of air through the vaults and the connected stack system. This cooling process is self-regulating. The cooling air does not come into direct contact with the fuel assemblies as they are in a hermetically sealed environment.

The ISFSF was extended by way of additional modules. Altogether 8,347 assemblies were stored in 19 storage modules at the end of 2015.

Currently, 20 storage modules have operation license in the facility, four others are under construction, according to the future storage needs.

6.3 Budapest Research Reactor and the Training Reactor of the Budapest University of Technology and Economics

Although these reactors do not belong to the scope of the Convention, they are considered worth mentioning here.

The **Budapest Research Reactor** operated by the Energy Research Centre of the Hungarian Academy of Sciences (formerly known as the KFKI Atomic Energy Research Institute) was built in 1959 and its full reconstruction was carried out between 1986 and 1993. *After its reconstruction, the periodic safety review of the Budapest Research Reactor was first completed in 2003 and then in 2013.* Based on the results of nuclear safety reviews, the HAEA issued a license for further operation and for performing activities described in the Final Safety Analysis Report. The operating license is valid until *December 15, 2023*.

Main technical data of the reactor:

- tank-type reactor, the tank is made of aluminium alloy;
- both coolant and moderator are light water;
- nominal thermal power is 10 MW.

In 2008, a part of the high enriched spent fuel assemblies *(232.5 kg)* of the Budapest Research Reactor was repatriated to the Russian Federation in the framework of the Global Threat Reduction Initiative financed by the United States of America.

In addition, unused fuel and other high enriched nuclear materials were repatriated *in the framework* of the above contract. The remaining high enriched spent fuel *(49.2 kg) was* repatriated in 2013.

The preparation for the application of low enriched (LEU) fuel assemblies (i.e. conversion) has been started with the repatriation of the high enriched fuel assemblies in 2008. The conversion is justified by the international effort to decrease the use of high enriched (HEU) fuel that is potentially suitable to produce nuclear weapons. The conversion *was* made gradually; transient core (i.e. containing both HEU and LEU fuel assemblies) *was* used through four campaigns by gradually increasing the quantity of new fuel elements. In the fifth campaign (that is considered as a test campaign) the core *was built* only from LEU fuel assemblies. The conversion was started in 2009, the last HEU fuel elements were removed from the reactor in 2012, the test campaign *was completed* in 2013. *The test operation was successful, thus the Budapest Research Reactor has been operating with LEU fuel since 2013.*

The reactor operated by the Institute of Nuclear Techniques at the Budapest University of Technology and Economics was built in 1971 for training and research purposes. The current operating license of the **Training Reactor** is valid until June 30, 2017.

Main technical data of the reactor:

- pool-type reactor;
- coolant and moderator: light water;
- fuel: EK-10, 10% enrichment

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B. LEGISLATION AND REGULATIONS

7. Legislative and regulatory system

Nuclear Safety Convention, Article 7:

1. Each Contracting Party shall establish and maintain a legislative and regulatory framework to govern the safety of nuclear installations.
2. The legislative and regulatory framework shall provide for:
   (i) the establishment of applicable national safety requirements and regulations;
   (ii) a system of licensing with regard to nuclear installations and the prohibition of the operation of a nuclear installation without a licence;
   (iii) a system of regulatory inspection and assessment of nuclear installations to ascertain compliance with applicable regulations and the terms of licences;
   (iv) the enforcement of applicable regulations and of the terms of licences, including suspension, modification or revocation.

7.1 The Act on Atomic Energy

The Hungarian Parliament approved the Act on Atomic Energy in December 1996 (hereinafter referred to as the Act on Atomic Energy) which entered into force on July 1, 1997. The Act on Atomic Energy as amended several times considers all regulatory-related and operational experience gained during the construction and operation of Paks NPP, it considers the technological development, all international obligations, and obviously integrates the requirements of the Convention. The main criterion and key point of this is reflected in the quoted article: "In the use of nuclear energy, safety has priority over all other aspects". Those who drafted the Act on Atomic Energy utilized the recommendations of the European Union, the IAEA and the OECD NEA. The main characteristics of the Act on Atomic Energy are as follows:

- declaration of the overriding priority of safety;
- definition and allocation of tasks of ministries, national authorities and bodies of competence in licensing and oversight procedures;
- entrusting the facility-level licensing authority of nuclear installations to the HAEA;
- declaration of the organizational and financial independence of the HAEA;
- declaration of the need for utilizing human resources, education and training, and research and development;
- definition of the responsibility of the Licensee for all damage caused by the use of nuclear energy, and fixing the sum of indemnity in accordance with the Revised Vienna Convention;
- giving the HAEA the right to impose fines should rules be violated.

7.2. Legislative and regulatory system

7.2.1 Implementation of the Act on Atomic Energy

Several government decrees and ministerial decrees have been and are issued to implement the requirements of the Act on Atomic Energy (see details in Annex 6). *During the period 2013-2015 the following relevant laws entered into force:*

<u>Acts</u>

- *Act CI of 2013 on the amendment to the act on atomic energy, certain acts related to energy, and to the Act CLIX of 1997 on armed security guard services, nature and field guard services;*
- *Act CCXXVII of 2013 on the amendment to certain acts relating to energy;*
- *Act VII of 2015 concerning the investment in relation to the maintenance of the capacity of the Nuclear Power Plant of Paks and modifying certain related acts;*
- *Act CXCVI of 2015 on the amendment to certain acts relating to energy.*

<u>Government decrees</u>

- *Govt. decree 213/2013. (VI. 21.) Korm. on the Special Committee of the Central Nuclear Financial Fund;*
- *Govt. decree 214/2013. (VI. 21.) Korm. on the rules of financial support to local government associations for oversight and information provided by the Central Nuclear Financial Fund;*
- *Govt. decree 215/2013. (VI. 21.) Korm. on the designation, activity and funding of the organization performing certain tasks in relation with radioactive wastes and spent fuel;*
- *Govt. decree 155/2014. (VI. 30.) Korm. on the safety requirements for facilities ensuring interim storage or final disposal of radioactive wastes and the corresponding authority activities;*
- *Govt. decree 357/2014. (XII. 29.) Korm. on the amendment to Govt. decree 118/2011. (VII. 11.) Korm. on the nuclear safety requirements of nuclear facilities and on related regulatory activities and Govt. decree 190/2011. (IX. 19.) Korm. on the physical protection requirements for various applications of atomic energy and the corresponding system of licensing, reporting and inspection;*
- *Govt. decree 487/2015. (XII. 30.) Korm. on the protection against ionizing radiation and the corresponding licensing, reporting and inspection system[2];*
- *Govt. decree 489/2015. (XII. 30.) Korm. on monitoring the radiation conditions relevant for public exposure of natural and artificial origin and on the scope of quantities obligatory to be measured[3];*

[2] *This government decree enters into force on January 1, 2016, thus it will be the subject of the Eighth National Report.*
[3] *This government decree enters into force on January 1, 2016, thus it will be the subject of the Eighth National Report.*

- *Govt. decree 490/2015. (XII.30) Korm. on notifications and measures relating to missing, found, seized nuclear and other radioactive material, and on other measures following notifications relevant to nuclear and other radioactive material* [4].

<u>*Ministerial decrees*</u>

- *Ministerial decree 51/2013. (IX. 6.) NFM on shipping, carrying and packaging of radioactive materials;*
- *Ministerial decree 5/2015. (II. 27.) BM on specific fire protection requirements related to the use of atomic energy and the method of their enforcement during the activities of authorities.*

<u>Nuclear Safety Code</u>

The Act on Atomic Energy requires the regular revision and update of the nuclear safety requirements for the application of atomic energy taking into account scientific results and international experience. The relevant governmental decree stipulates the periodicity as 5 years.

The Nuclear Safety Code was further developed in line with the EU nuclear safety directive, Council directive 2009/71/EURATOM of 25 June 2009 establishing a Community framework for the nuclear safety of nuclear installations, the Convention on the physical protection of nuclear materials, the safety recommendations published by the IAEA in the last five years as well as the WENRA reference levels. The nuclear safety requirements of the use of atomic energy in reactor facilities are regulated by the *NSC* issued as annexes of Govt. decree 118/2011. (VII. 11.) Korm. as follows:

1. Nuclear safety regulatory procedures of nuclear facilities;
2. Management systems of nuclear facilities,
3. Design requirements for nuclear power plants;
3a. Design requirements for new nuclear power plant units;
4. Operation of nuclear power plants;
5. Design and operation of research reactors;
6. Interim storage of spent nuclear fuel;
7. Survey and evaluation of the site of nuclear facilities;
8. Decommissioning of nuclear facilities;
9. Requirements for the design and construction periods of a new nuclear facility
10. Terminology used in the Nuclear Safety Code (definitions)

In addition to the continuous development of IAEA recommendations and WENRA reference levels the modification of the national regulations were performed more often than the required five year frequency. As a result of the review the amendments to the Govt. decree 118/2011. (VII. 11.) Korm. were issued in several steps.
The planned construction of new nuclear power plant units required the development of Nuclear Safety Code Volume 3a on advanced technical requirements to be applied

[4] *This government decree enters into force on January 1, 2016, thus it will be the subject of the Eighth National Report.*

during the design of new units. Additionally, the HAEA reviewed and further developed the requirements for the design and construction periods.

During the periodic review and revision of the Nuclear Safety Code the legislators shall take into account the text of the following legislations in force:

- *Act CXVI of 1996 on atomic energy;*
- *Act CXL of 2004 on the general rules of administrative procedures and services;*
- *Govt. decree 118/2011. (VII. 11.) Korm. on the nuclear safety requirements of nuclear facilities and on related regulatory activities;*
- *Govt. decree 112/2011. (VII. 4.) Korm. on the scope of authority of the HAEA in relation to European Union and international obligations in connection with atomic energy, on the designation of co-authorities contributing to the regulatory proceedings of the HAEA, and on the scientific council facilitating the work of the HAEA;*
- *Govt. Decree 246/2011. (XI. 24.) Korm. on safety area of nuclear facilities and radioactive waste repositories;*
- *Govt. Decree 247/2011. (XI. 25.) Korm. on the independent technical expert proceeding in the scope of the application of atomic energy;*
- *Govt. decree 190/2011. (IX. 19.) Korm. on the physical protection requirements for various applications of atomic energy and the corresponding system of licensing, reporting and inspection;*
- *Ministerial decree 55/2012. (IX. 17.) NFM on special professional education and training of workers employed at a nuclear facility, and the scope of those authorized to perform activities associated with the use of atomic energy;*
- *Ministerial decree 5/2015. (II. 27.) BM on specific fire protection requirements related to the use of atomic energy and the method of their enforcement during the activities of authorities.*

The working groups of WENRA develop reference levels for reactors, repositories (storage and disposal of radioactive wastes) and decommissioning, which were taken into account during the review of the Nuclear Safety Code by the HAEA. These publications are as follows:

- *Report – Safety of new NPP designs – Study by Reactor Harmonization Working Group RHWG March 2013;*
- *Report – WENRA Safety Reference Levels for Existing Reactors – Update in relation to lessons learned from TEPCO Fukushima Daiichi accident 24th September 2014 – Study by Reactor Harmonization Working Group RHWG September 2014;*
- *Report – Decommissioning Safety Reference Levels – Study by Working Group on Waste and Decommissioning WGWD March 2015.*

During the most recent NSC review conducted in the second half of 2015, the HAEA *studied the published recommendation and guidance level documents of the IAEA that were reviewed in the mirror of the lessons learned from the Fukushima accident, as well as the draft documents in which further modifications had not been expected. Additional modifications were proposed based on the recommendations of the IRRS mission given in the first half of 2015 regarding further development of the regulations.*

However, the Hungarian requirement system has been continuously developed in the recent years, the HAEA commenced the periodic review of the actual nuclear safety requirement system in the beginning of 2015.

As of July 1, 2014 the Act on Atomic Energy amended by Subsection 4 of Section 11 of the Act CI of 2013 and the Govt. decree 155/2014. (VI.30.) Korm. transferred the safety of the Hungarian radioactive waste repositories under the regulatory competence of the HAEA. These repositories operated by the Radioactive Waste Management Non-profit Public Limited Company are as follows:

- *Radioactive Waste Treatment and Disposal Facility (site: Püspökszilágy, task: acceptance and disposal of low and medium level radioactive wastes, which are originated at institutes other than the nuclear power plant)*
- *National Radioactive Waste Repository (site: Bátaapáti, task: final disposal of solid and liquid low and medium level radioactive waste from the nuclear power plant).*

Similar to the Nuclear Safety Code published as annexes to the Govt. decree 118/2011. (VII. 11.) Korm. the Repository Safety Code (hereinafter referred to as RSC) was developed, which volumes were published as annexes to the Govt. decree 155/2014. (VI. 30.) Korm.

The following two volumes of the RSC have been already published:

- *Volume 1: Management systems of the repository*
- *Volume 2: Design, construction, operation, decommissioning and institutional control of the repository*

The elaboration of additional volumes of the RSC and the preparation of the regulatory guidelines containing recommendations on how to comply with the legal requirements are in progress.

7.2.2 Licensing procedure *of facilities*

The basic licensing principles of the establishment of nuclear facilities *and radioactive waste repositories*, and the concerned authorities taking part in licensing proceeding are regulated by Chapter III of the Act on Atomic Energy.

To establish a new nuclear power plant or a new radioactive waste repositary the preliminary consent in principle of the Parliament is required for starting the preparatory work, whereas the acquisition of ownership of a nuclear power plant that is in operation or to transfer the right of operation the consent in principle of the Government is required.

In accordance with regulations in force, licenses shall be obtained from the authorities for all phases of life-cycle (site selection and evaluation, construction, expansion, commissioning, operation, decommissioning) of a nuclear power plant. Moreover, a separate license shall be obtained for all plant level or safety related equipment level modifications. Within the licensing proceedings, technical aspects are enforced by legally designated co-authorities, the opinions of which shall be taken into account by the HAEA.

When the installation of a new nuclear *facility* is being considered, the precondition for launching the licensing procedure is the existence of an environmental protection license. *According to the relevant European Union and international regulations the construction of a nuclear power plant shall be subject to environment impact assessment.* The environmental protection authority shall hold a public hearing as part of the environmental impact assessment procedure, *which was hold on May 7, 2015 in the environmental impact assessment procedure of the new nuclear power plant units to be constructed on the site of Paks Nuclear Power Plant. In line with the Govt. decree 148/1999. (X. 13.) Korm. on the promulgation of the Convention signed in Espoo (Finland) on February 26, 1991 on environmental impact assessment in a transboundary context a so-called international environmental impact assessment procedure was also conducted with the involvement of those countries, which had declared their intention to participate in the procedure. During the international environmental impact assessment procedure Hungary and the concerned states (i.e. those that decided to take part in the procedure) conducted personal and written consultations regarding the cross-border effects of the planned facility. The information exchange was realized in the framework of 11 open fora (public hearings) in 9 countries, which aimed at assuring the involvement of the public to the decision making process regarding the planned activity.*
Taking into account the environmental impact assessment submitted as an annex to the license application, the statements of the involved co-authorities and foreign authorities of participating states, as well as the public comments gained in Hungary and abroad the environmental protection authority issues a resolution. In the case of a positive decision, the environmental protection authority grants the environmental protection license, which is a condition of the actual use of the environment (i.e. the start of construction and future operation).

During the nuclear safety licensing procedure of the facilities, the HAEA, pursuant to the stipulation of the Act on Atomic Energy, conducts a public hearing, and makes its decision taking account of the public opinions. The license is effective for limited or unlimited time, and might be granted with certain conditions. The license granted for limited period can be extended, if requested. The Act on Atomic Energy and the Act

CXL of 2004 on the general rules of administrative proceedings and services (hereinafter referred to as KET) allow appealing against the resolutions and decision of the HAEA only in court.

7.2.3 Inspection and assessment

The Act on Atomic Energy stipulates that nuclear energy can be deployed only in the way defined by law, and the nuclear facility and the radioactive waste repository are under continuous regulatory oversight. An important tool of regulatory oversight is inspection. The HAEA is obliged to check compliance with all regulations contained in laws and licenses, and the safety of the application of nuclear energy.

The HAEA is entitled to perform inspections either with or without an advance notice, should it be justified. The HAEA prepares an annual inspection plan. The HAEA operates a multilevel inspection system to continuously assess the safety performance of facilities falling under the scope of the Act on Atomic Energy.

In addition to the HAEA's inspection activities, the co-authorities taking part in the licensing procedure also perform separate official inspections. Through agreements on cooperation in cases that concern different competences, the authorities may perform joint inspections.

In order to ensure the controlled deployment of nuclear energy and to evaluate the activity of the Licensee, the HAEA operates a reporting system. The reports are detailed so as to enable independent assessment, review and evaluation of operating activities and events that have taken place. The inspection of events affecting safety that have occurred during operation and the identification of causes and the implementation of measures in order to prevent their repeated occurrence is primarily the duty of the Licensee. Any event affecting nuclear safety is required to be reported by the Licensee to the HAEA in accordance with the regulations in force. On the basis of this notification and of the report prepared pertaining to the investigation carried out by the Licensee (or based on the significance of the event independently of the Licensee) the HAEA analyses and evaluates the event and initiates further actions if necessary.

The HAEA makes use of the evaluation results originating from various sources for evaluating the safety performance of the licensees.

In the case of the most important nuclear facility, namely the Paks Nuclear Power Plant the HAEA from 2001, in addition to traditional evaluation techniques, applies the system of safety indicators developed on the basis of the IAEA methodology. The term "safety indicators" means such measurable parameters, which measure the safety performance of the organization and the human factor.

Based on the nuclear power plant experience gained, the HAEA established the safety indicator system for other nuclear facilities overseen by the HAEA. In order to extend *its oversight capabilities, the HAEA has been applying the system to the Spent Fuel Interim Storage Facility, the Budapest Research Reactor and the Training Reactor of the Budapest University of Technology and Economics since 2005.*

The safety indicators can be categorized into three major groups:
- attributes of smooth operation,
- safety characteristics of operation, and
- attributes of commitment to safety.

The accumulated statistical set of indicators provides the possibility both for comprehensive evaluation and highlighting various issues. The HAEA annually evaluates the safety performance of the licensees. The lessons learned from evaluations are benefited during the organization of regulatory proceedings, e.g. during the elaboration of the annual inspection plan.

The HAEA developed and then started the application of the safety indicator system to the radioactive waste repositories in 2014 as well. The HAEA annually evaluates the safety performance of the radioactive waste repositories being under its regulatory competence, namely the Radioactive Waste Treatment and Disposal Facility (hereinafter referred to as RWTDF) and the National Radioactive Waste Repository (hereinafter referred to as NRWR). In the course of the evaluation the HAEA takes into consideration the potential hazards meant by the radioactive waste repositories. The evaluation criteria of the safety attributes are determined by the HAEA in a way that allows taking account of the reached level of safety performance, as well as the national and international experience regarding the safety of radioactive waste management, and at the same time supports the licensees in enhancing their safety performance.

Consequently, the evaluation takes into account the results of the safety indicator system in each facility. In addition to allow detecting potential safety issues in a timely manner, monitoring and analysing the safety characteristics of operation provide data for the oversight activity of the HAEA and may form the basis for regulatory actions.

7.2.4 Enforcement of legal mandates of the HAEA

Legal basis

The legal basis for enforcement of regulatory competences is provided by the Act CXL of 2004 on the general rules of public administrative proceedings and services, the Act on Atomic Energy and the Act C of 2012 on the Penal Code.

Among other forms of realization of the regulatory activity performed by the HAEA as the atomic energy oversight organization, the Act on Atomic Energy establishes the opportunity to conduct enforcement procedures to enforce legal requirements and the associated regulatory prescriptions in practice.

The HAEA shall regularly inspect the compliance with the legislation acts, the license, the nuclear safety regulations and the radioactive waste repository safety regulations, and the safety of the application of atomic energy, and shall take or shall initiate immediate measures to eliminate the observed incompliance. These measures of the HAEA are implemented in the framework of enforcement procedures.

Enforcement tools

The Act on Atomic Energy establishes the tools to be used during the enforcement procedure, as follows:

- *revoking licenses, limiting their validity period,*
- *revoking or modifying modification licenses (establishing conditions),*
- *claiming financial penalty.*

Additionally, the Act provides the police with the right to revoke the public security license from the person employed in the scope of the application of atomic energy.

The stipulations of the Act on Atomic Energy were completed with additional detailed rules in relation to the nuclear facilities and radioactive waste repositories.

The Govt. decree 118/2011. (VII. 11.) Korm. on the nuclear safety requirements for nuclear facilities and the corresponding regulatory activity provides additional details regarding the enforcement procedures of the HAEA on the basis of the safety importance of the violated regulations. In harmony with the principle of graded approach, it lists the enforcement tools as follows:

- *written warning, and corrective action to be implemented by deadline,*
- *prescription of additional conditions,*
- *limitation, termination of the activity, or revoking the license, and*
- *financial penalty.*

The Govt. decree 118/2011. (VII. 11.) Korm. obliges the licensee to investigate the identified divergences, to accomplish the necessary actions, and to prevent their repeated occurrence.

The HAEA has been overseeing the safety of radioactive waste repositories since July 1, 2014. The tasks associated with this competence of the HAEA are established in the Govt. Decree 155/2014. (VI. 30.) Korm. on the safety requirements for facilities ensuring interim storage or final disposal of radioactive wastes and the corresponding authority activities. Govt. Decree 155/2014. (VI. 30.) Korm. establishes rules that are practically identical with those established for nuclear facilities, thus the enforcement procedures conducted by the HAEA in relation to facilities providing temporary storage or final disposal of radioactive wastes also apply the principle of graded approach and the above mentioned enforcement tools.

Imposing financial penalty

The HAEA has the right to impose financial penalty if the Act on Atomic Energy or a decree issued for its implementation is violated, or if a resolution issued based on the act or the implementing decree is not complied with. The financial penalty as a tool of sanctioning can be used individually or together with other sanctions in parallel.

The above mentioned legislative stipulations are supplemented with the rules established in the Govt. decree 112/2011. (VII. 4.) Korm. on the scope of authority of the Hungarian Atomic Energy Authority in relation to European Union and international obligations in connection with atomic energy, on the designation of co-authorities assisting the regulatory proceedings of the Hungarian Atomic Energy Authority, and on the scientific council assisting the work of the Hungarian Atomic Energy Authority, the minimum and maximum amounts, and with the aspects to be taken into account by the HAEA when imposing a fine. The principle of graded approach is enforced on each level of the legislation.

The amount of fine shall be determined taking account of every circumstance, but specially

- *whether extraordinary event, nuclear emergency or nuclear damage has occurred,*
- *how severe is the violation of requirements, regulations,*
- *whether a reoccurring violation has taken place,*
- *whether the behaviour causing the rule violation or omission could have been imputed,*
- *whether the violator or the person committing omission has shown supporting, consequence mitigating behaviour in connection with the elimination of the state caused thereby.*

At least HUF 50,000, but maximum HUF 50,000,000 can be imposed against the licensee of the nuclear power plant; at least HUF 50,000, but maximum HUF 5,000,000 can be imposed against the licensee of another nuclear facility.
If an obligation established in the legislation on the application of safeguards stipulated in the Agreement for the Application of Safeguards in Connection with the Treaty on the non-Proliferation of Nuclear Weapons *or is violated, then at least HUF 50,000, but maximum HUF 5,000,000 can be imposed against the licensee of other nuclear facility.*

Commitment of a criminal crime

As prescribed by the Act XIX of 1998 on the criminal proceeding, if a crime defined in the Penal Code is committed, the HAEA has no right for deliberation, it is obliged to make a denunciation at the police. Subsequently, the investigating authority makes *decision on prosecution, and then the court makes decision on the measures to be applied, if appropriate.*

Enforcement experience

In the period of 2013-2015 the HAEA did not impose any financial penalty in the case of the nuclear facilities; however, it used this tool twice in connection with the use of radioactive material.

8. Authority

Nuclear Safety Convention, Article 8:

1. Each Contracting Party shall establish or designate a regulatory body entrusted with the implementation of the legislative and regulatory framework referred to in Article 7, and provided with adequate authority, competence and financial and human resources to fulfil its assigned responsibilities.
2. Each Contracting Party shall take the appropriate steps to ensure an effective separation between the functions of the regulatory body and those of any other body or organization concerned with the promotion or utilization of nuclear energy.

8.1 HAEA

In the case of nuclear installations as defined by Article 2 of the Convention, the competent authority in Hungary is the HAEA. The HAEA is an organizationally and financially independent, central public administration body with own competences and administrative acts operating in the field of peaceful use of nuclear energy, under the supervision of the Government. *As of December 31, 2015 the minister for national development, acting on behalf of the Government, supervises the HAEA independently of his portfolio.*

The HAEA, as a governmental office, cannot be directed in its scope of authority as defined in law.

The HAEA's scope of competence comprises nuclear safety licensing, *evaluation* and oversight of nuclear installations, the regulatory oversight of radioactive waste repositories, the registration and control of radioactive materials, the licensing of transportation and packaging thereof, the licensing of nuclear exports and imports, the evaluation and co-ordination of research and development, the performance of tasks related to nuclear emergency preparedness on the site, the approval of the emergency response plans of nuclear installations, and maintenance of international relations. Licensing, reporting and oversight activities related to physical protection relevant to the application of atomic energy also fall within the competence of the HAEA.

It is also the duty of the HAEA to perform the tasks generated by the Agreement for the Application of Safeguards in Connection with the Treaty on the non-Proliferation of Nuclear Weapons *between Hungary and the IAEA* , along with the registration and control of nuclear materials.

The organizational units under the supervision of the Deputy Director General for Nuclear Safety at the end of 2015 were as follows:

- *Supervision Department, which performs the licensing, inspection and assessment tasks defined by law, in regulatory proceedings corresponding to nuclear safety and technical aspects of radiation protection in relation to the units of Paks Nuclear Power Plant, the research reactors, the spent fuel interim storage facility and from the middle of 2014 of the radioactive waste repositories. The Department has two Sections, namely the Facility Section and the Resident Inspectorate; this latter one is located at the site of the Paks Nuclear Power Plant and deals with the nuclear power plant related tasks that can be performed on the site.*
- *Technical Department, which reviews the regular and casual reports of the nuclear facilities, investigates the causes of operational incidents, coordinates the inspections related to events, and assesses the safety of facilities. The Technical Department operates the training system of the HAEA, organizes the research, development and expert activities made by external technical support organizations in connection with regulatory activities. This Department prepares proposals and drafts regarding publication, withdrawal, development and updating of nuclear safety related legislations and regulatory guidelines, taking account of the development and revisions of the international nuclear safety regulations. In addition, this Department deals with the cooperation with co-authorities in relation to issues not regulated on the level of acts, government or ministerial decrees.*
- *Project Department, which was set up to support the nuclear safety regulatory activity in connection with the new nuclear power plant units to be constructed. This Department performs the preparation for the licensing of the construction, coordinates the development of regulations for new units with internal and external experts, coordinates on licensing issues with co-authorities, and within the framework established by law it participates as a co-authority in the environmental impact assessment procedure of the new nuclear power plant units.*

Other regulatory duties of the HAEA, such as tasks deriving from the safeguards agreement and the Convention on the physical protection of nuclear materials, licensing of nuclear export-import, the registration of radioactive materials, and maintenance of international relations, are generally undertaken by the other organizational unit of the HAEA, *namely the organizational units being under the supervision of the Deputy Director General for General Nuclear Matters*.

In the reporting period, the following major tasks were performed by the organization units being under the supervision of the Deputy Director General for General Nuclear Matters:

The information technology professionals working under the direct supervision of the deputy director general ensures the operable state of the computer hardware and software systems of the HAEA and maintains its computer security. The Department of Nuclear Security, Non-proliferation and Emergency Management oversees the nuclear security and exclusive peaceful use of nuclear and other radioactive materials, and the equipments generating ionising radiation, as well as the associated facilities and activities, including the physical protection system, safeguards system, as well as the computer security of programmable systems and the nuclear emergency preparedness and response activities. The Department of External Relations, Euratom and Legal Affairs coordinates the international, European Union related and public relations, provides the legal and public administration related support required for performing regulatory tasks.

In the licensing procedures of the HAEA related to nuclear safety, the other competent administrative bodies take part as co-authorities and the regulations allow the involvement of professional experts (both institutions and individuals).

In accordance with the Act on Atomic Energy, the work of the HAEA is supported by a Scientific Council made up of nationally recognized individual experts.

8.1.1 International relations of the HAEA

In accordance with the Act on Atomic Energy the HAEA is responsible for the coordination of international cooperation in the field of peaceful use of nuclear energy and for the fulfilment of tasks originating from the cooperation with international and intergovernmental organizations.

Among the international organizations being in contact with the HAEA the most important ones are the European Union, the IAEA and the Nuclear Energy Agency of the OECD. The HAEA is a member of the Network of Regulators of Countries with Small Nuclear Programmes that was initiated by Switzerland, and *the so-called Multinational Design Evaluation Programme of the OECD NEA*. The HAEA actively participates in the work of the WENRA, the ENSRA, and the cooperation forum of the countries operating VVER type reactors (i.e. VVER Regulators Forum). The HAEA is a member of the ESARDA; *additional important partners are the HERCA and the EURACA.*

The HAEA represents Hungary in the European Union Instrument for Nuclear Safety Co-operation programme and in the Euratom 7th Research Framework Programme for Research and Development.

Wide scope cooperation has been developed with the competent authorities and nuclear facilities of neighbouring countries. The HAEA maintains close professional link with the competent authorities of countries operating VVER reactors (i.e. Czech Republic, Finland, Russian Federation, Slovakia). In the framework of mutual information exchange agreements the HAEA cooperates with the competent *authorities of the Czech Republic, Slovakia, the United States of America, the Russian Federation, Ukraine, Slovenia, Austria, Croatia and Romania. A direct link has been established with the Ministry of Environmental Protection of the Federal Republic of Germany in the framework of a scientific-technological cooperation, while close cooperation exists with Austria in the field of verification of software tools and methods used for dispersion calculations.*

Currently, the HAEA has 7 MoU's in force with the nuclear authorities of other states (the USA, Slovakia, Romania, Czech Republic). Most recently the HAEA concluded agreements with the Finish (STUK) and Turkish (TAEK) authorities at the first time, and with the Russian authority (Rosztyehnadzor) to renew the agreement that had been concluded in 2001.

Additional bilateral relations are the bilateral international agreements concluded in the field of the safe use of atomic energy, where the HAEA also participates in the implementation. In 2014, the list of these international agreements in force was expanded with bilateral agreements concluded with the Viet Nam Socialist Republic and the Republic of Korea. The agreement on early notification in the case of a radiological emergency concluded with the Republic of Serbia entered into force on November, 18, 2015.

In order to make the bilateral meetings more effective, the nuclear authorities of the Czech Republic, Hungary, Slovenia and Slovakia discuss the actual issues on mutual interest in quadrilateral meetings. The twenty-first bilateral meeting with Austria was held in October 12-13, 2015.

The technical support organizations of the HAEA take part in research activities coordinated by the US NRC (United States Nuclear Regulatory Commission) and in the activities of the working groups of the OECD NEA.

8.1.2 Communication policy of the HAEA

The most official form the of the communication activity of the HAEA is the report on the safe application of the atomic energy to be submitted to the Parliament annually, the preparation of which is coordinated by the HAEA. Additionally, the HAEA informs the public on the relevant facts regarding the safe use of atomic energy in Hungary through its continuously updated Hungarian and English website (www.oah.hu), by organizing press conferences and publishing press releases.

The HAEA continuously strives for providing more and more comprehensive information to professionals and the general public, who show interest in questions associated with nuclear safety. As a part of this process, the HAEA periodically provides information on its resolutions by publishing their concise summary. The list of resolutions is accessible on the website of the HAEA. An essential task of the HAEA is to inform the public about the nuclear safety related events that are worth public interest. Accordingly, the HAEA publishes on its website the events categorized as Level 1 or higher on the International Nuclear Event Scale, and the outcomes of regulatory investigations of other reportable events that are worth media interest. The

HAEA keeps regular contact with the representatives of the media. About fifty journalists participate in the annual press conference of the HAEA.

In the end of 2013, based on the proposal of the HAEA, the Act Atomic Energy was amended to facilitate transparency. Accordingly, the act regulates the procedures, when the HAEA shall hold public hearings. The public hearing provides the opportunity for the public and various organizations to be aware of the details of the given procedure and to present their opinions. Altogether, public hearings were organized five times by December 31, 2015.

The Association of Hungarian Professional Journalists organized, in cooperation with the HAEA, the Nuclear Journalist Academy, which aimed at supporting the participating journalists giving objective and professional information on the safe use of atomic energy. The HAEA organizes an open house every year in the framework of the Days of Cultural Heritage.

The HAEA continued that several-year-long tradition that it organizes, together with the TIT Studio Association, "To everybody about the atomic energy" conferences twice a year.

The HAEA strives for providing more information about its activity. The HAEA publishes annually a colourful, illustrated information booklet on its own activities and the safe use of atomic energy in Hungary. Furthermore, the HAEA prepares every six months an English summary (Bulletin) of the actual professional news, which are also accessible on the website of the HAEA. In addition, the HAEA informs the public on the most important facts associated with the safe use of atomic energy by organizing press conferences and publishing press releases.

The continuously developed internet-based information service is a part of the communication policy of the HAEA both via its own website and its Facebook page. In addition to other information materials this National Report is also accessible in both Hungarian and English.

8.1.3 Scientific technical background

8.1.3.1 Technical support organisations

During the regular technical support programmes of the recent years, the network of organisations supporting the regulatory work of the HAEA has been established. The most significant institutes of the network are: Hungarian Academy of Sciences Centre for Energy Research, Institute of Nuclear Techniques at the Budapest University of Technology and Economics, the PÖYRY ERŐTERV Ltd. (formerly known as ETV-ERŐTERV Ltd), the NUBIKI Nuclear Safety Research Institute Ltd, *VEIKI Energia + Ltd, the National Radiobiology and Radiohigieny Research Directorate of the National Public Health Centre, and the SOM System Ltd.*

It can be concluded based on the outcomes of this review that adequate contractual potential exists in each important field of expertise. *The independence of the expert* *support is guaranteed by the strong quality management systems of the background organisations.*

The technical support organizations carry out expert and scientific activities not only for the HAEA but for nuclear installations as well. These organizations may perform contractual work for several institutions, but a particular expert or scientist is allowed to provide expertise at a given time and for a particular issue exclusively for the operator or the HAEA but not for both simultaneously. The relatively comprehensive system of censure, the internal quality management system of the support organizations and the careful selection of the reviewers guarantee the appropriate consideration of different interests and independent decision-making of the HAEA.

8.1.3.2 Technical support activity

The HAEA is responsible for the harmonization of the research and development in connection with the safety of peaceful applications of nuclear energy, as well as for the financing of the technical activities providing basis for the regulatory oversight.

The strategic directions of technical support activities serving for the facilitation of the regulatory oversight of the safe use of atomic energy are established in the policy of the HAEA associated with the technical support activities, while the actual tasks are identified in the four-year programme. The priorities of technical support activities for the period of 2013-2016 were identified by the HAEA as follows:

- direct support to the regulatory activity;
- implementation of tasks initiated by the HAEA;
- support to the tasks connecting to the new units;
- management of expertise.

The HAEA evaluates the results of the current period at the end of 2016, and then starts the preparation, internal and external discussion of the technical support activities for the next four-year period (2017-2020).

The HAEA is a supporter and future beneficiary of the Sustainable Atomic Energy Technology Platform (hereinafter referred to as SAETP), which aims at developing the Hungarian research potential in the nuclear field. The short term and long term objectives of the national atomic energy research programmes are determined by the maintenance of the scientific-technological background of the safe operation of the existing nuclear facilities and the preparation for the new ones. The SAETP focuses on the strengthening and extension of these research areas. In line with these objectives, the HAEA supports several research activities in the framework of the SAETP, such as programmes associated with the development of the tools of safety analyses, fuel research and modelling of certain thermo-hydraulics processes.

8.1.3.3 Hungarian Nuclear Knowledge Management Database

In order to effectively manage the problems of screening, using, accessing and storing information, the HAEA *established a Hungarian Nuclear Knowledge Management Database (hereinafter referred to as HNKMD)*. The aim of the *HNKMD* is to store and actualize the expertise cumulated during the application of nuclear energy in Hungary, in harmony with the actual state of science and technology, for the present and future generations. In addition to the HAEA, licensees of nuclear installations and the lead institutes of nuclear expertise participate *in the management of the database*.

8.2 Independence of the HAEA

The HAEA is a government office established by law, a central state administration organization working under the supervision of the Government. It is overseen by the minister designated by the Prime Minister. The HAEA operates and deals with its budget independently; it is a state budget organization having chapter rights and individual title within the budget chapter of the ministry led by the minister overseeing the HAEA. The HAEA shall not be directed in the scope of its tasks established in act, its decisions shall not be amended or eliminated based on oversight right. The act determines that the HAEA overseeing the use of atomic energy shall be independent of any other organ or organization that has interest in the field of use or promotion of atomic energy. The above mentioned two, clearly and unambiguously formulated rules in the act guarantee its independent and uninfluenced decision making.

The financial resources of the HAEA are own revenues supplemented with state contribution as determined annually in the state budget. Its independent operation, financial management, and its independence within the state budget chapter is not of full-scope. In addition, the opportunity to request additional resources is not fully guaranteed during its annual operation if non-planned expenditures appear in connection with the regulatory work.

The minister responsible for health has regulatory tasks regarding issues related to radiation protection and concerning facility-level licensing and oversight of the radioactive waste repository[5]. Other competent administrative bodies take part as co-authorities in the licensing procedures of the ministry.

9. Responsibilities of the NPP as Licensee

Nuclear Safety Convention, Article 9
Each Contracting Party shall ensure that prime responsibility for the safety of a nuclear installation rests with the holder of the relevant licence and shall take the appropriate steps to ensure that each such licence holder meets its responsibility.

[5] *This competence has been transferred to the HAEA since January 1, 2016.*

The Act on Atomic Energy primarily makes the licensee responsible for the safe use of nuclear energy and the fulfilment of safety related requirements. The basic responsibilities of the licensee are as follows:

- *to ensure technical, technological, financial and personal conditions for the safe use of atomic energy, for maintaining and improving safety;*
- *to prevent the occurrence of an inadvertent and uncontrolled nuclear chain reaction;*
- *to prevent ionizing radiation or any other factor to cause any unacceptable damage to human life, health and living conditions of current and future generations, environment and material assets;*
- *to maintain the radiation exposure of employees and population to the level as low as reasonably achievable;*
- *to continuously monitor radiation conditions in accordance with the latest scientific results, international requirements and experience and to provide the population with regular, at least monthly, relevant information thereof;*
- *to keep the production of radioactive waste as low as reasonably achievable in terms of activity and quantity via appropriate design measures, operational and decommissioning procedures, especially via the reuse and reutilization of nuclear and other radioactive materials;*
- *to continuously carry out activities to improve safety, and to finance costs of the related research and development activities;*
- *to regularly revise and upgrade its own regulatory system serving to fulfil the safety related requirements;*
- *to take into account the potential and its limits of human performance from the aspect of safety throughout the entire lifetime of the nuclear facilities;*
- *to fulfil the obligations of Hungary arising from international agreements in the fields of peaceful use of atomic energy;*
- *to ensure that the qualifications, professional training and health conditions of employees meet the requirements;*
- *to hire only those subcontractors and suppliers that have an appropriate quality management system regulated by nuclear safety regulations;*
- *to ensure the financial coverage of civil liability (insurance) for nuclear damage;*
- *to appropriately manage extraordinary events, to ensure that the risk of occurrence thereof decreases, their occurrence can be prevented, their consequences can be managed as planned, the harmful effect of potentially released radioactive material and ionizing radiation can be decreased to as low as reasonably achievable;*
- *to recompensate within a limited time and under a certain amount for nuclear damage caused due to the application of atomic energy;*
- *to ensure the physical protection of the facility by armed guards, and to operate an effective physical protection system;*
- *to make regular payments into the Central Nuclear Financial Fund to cover costs related to the final disposal of radioactive waste, the interim storage of spent fuel, and the closure of the fuel cycle and in the case of nuclear power plant the decommissioning.*

C. GENERAL SAFETY ISSUES

10. Priority to safety

Nuclear Safety Convention, Article 10
Each Contracting Party shall take the appropriate steps to ensure that all organizations engaged in activities directly related to nuclear installations shall establish policies that give due priority to nuclear safety.

10.1 Safety policy of the HAEA

The various documents issued by the International Atomic Energy Agency set the basic principles of safety. These are the principles which the HAEA follows and applies taking into account the fact that each country has to follow its own practice during the actual implementation. The “Safety Policy and the Operational Principles of the HAEA” is the basic document of safety policy and it is supplemented by the Enforcement Policy.

10.1.1 Objectives

The key objective of the HAEA's activities is to *guarantee* that the local population, the environment, and the operating personnel do not suffer any damage due to effects originating from ionizing radiation. The HAEA exercises its oversight activities in order to achieve these objectives; these oversight activities comprise licensing, inspection, assessment and the enforcement of regulations.

It is also an objective of the HAEA to constantly raise the standard of safety culture both for its own operation and for the organizations under its supervision.

10.1.2 Responsibility

The HAEA is responsible for licensing, inspection and evaluation of nuclear installations, systems and components in order to enforce the full compliance of the Licensee with the official requirements.

In order to achieve these goals, the HAEA shall be independent, competent and duly prepared; it shall clearly understand all processes under its supervision; and it shall be open towards the co-authorities and to the society as a whole. Every reasonable effort must be made to gain and retain the confidence of the public and it shall make itself and its objectives fully transparent to the public. The HAEA meets all the above requirements.

10.1.3 Basic principles

The functioning of the HAEA is regulated by the Government in accordance with the Act on Atomic Energy. The regulations governing the work and activities of the HAEA are all aimed at keeping risks to a minimum, but the principle of reasonably low risk should be kept in mind at all times.

It is the responsibility of the Licensee to keep risks as low as reasonable. In the field of *safety improvement* measures, however, the HAEA should also set a priority list.

The HAEA *in order to permanently sustain nuclear safety* follows the principles below in its work:
- the primary task is to minimize the frequency of technical problems and human errors that are initiators of accidents.
- mitigation of any serious consequences originating from multiple failures is of second importance. To accomplish mitigation tasks, the importance and function of the various *components* in the process of accident evolution and the availability of systems suitable for mitigating interventions must be known.
- the deterministic approach complemented with probabilistic approach shall be used to reveal technical problems and incorrect practice.

10.1.4 Practical side of the HAEA's work

The HAEA, when performing regulatory tasks:
- makes every effort to handle issues in a rapid and precise manner, but speed must never be allowed to jeopardize precision. If, for any reason, any uncertainty arises, the HAEA always decides in favour of greater safety;
- endeavours to weigh every issue according to its importance. Importance is determined in relation to safety;
- takes the licensee’s viewpoints into consideration as reasonable *besides exquisite enforcement of the safety requirements*;
- assesses the severity of incidents that may occur by processing them in a precise manner and utilizes the feed-back of experience gained in the operation process.

10.2 Safety policy of the *MVM Paks Nuclear Power Plant Ltd.* as a licensee

Govt. Decree 118/2011. (VII. 11.) Korm. concerning the implementation of the Act on Atomic Energy obliges the Licensee to elaborate a safety policy that lists the Licensee’s concepts and objectives related to safety and demonstrates in a convincing manner that the fulfilment of the principle of nuclear safety has priority over all other aspects.

The Safety Policy of the MVM Paks Nuclear Power Plant Ltd. (hereinafter referred to as Safety Policy) summarizes the main requirements in relation to the safety of the nuclear power plant and proclaims the principle of the priority of safety. It deals with *particular methods of practical implementation only indirectly, since these are enforced through regulations, procedural orders, and instructions.*

The Safety Policy has uniform and thorough validity over each organizational unit and employee of the nuclear power plant, and also over subcontractors. It stresses out the importance of the general responsibility of the NPP`s Director General and the particular responsibility of the Safety Director for ensuring the safety. The Safety Policy emphasizes the importance of the commitment to safety, the necessity of maintaining positive approaches to safety, the need to reveal those factors compromising safety, and to prioritize endeavours to improve the safety culture. It also stresses out the importance of training, information and feedback mechanism for enhancing safety.

MVM Paks Nuclear Power Plant Ltd. reviews its Safety Policy on a regular basis to ensure its up-to-date status and correctness.

The management of the MVM Paks Nuclear Power Plant Ltd. supports the delivery and comprehension of the defined requirements to the executors with a conscious communication. The requirements established in the Safety Policy are regular items on the agenda of the internal and external fora and communication forms (e.g. suppliers' day) with the suppliers and contractors. The MVM Paks Nuclear Power Plant Ltd. has the necessary management, supervision and operational items and instruments to ensure compliance with the requirements formulated by the Safety Policy on the designated operational areas and functions.

10.2.1 Responsibility of the managers

The NPP`s Director General is responsible for the proper and safe operation of the power plant as well as for quality. He is assisted by the Director of Safety who holds a transferred right of competence.

The managers are responsible, within their respective organizations for the fulfilment and enforcement of safety requirements in addition to enforcement of the Safety Policy.

In order to define various tasks, responsibilities and competences together with rights, the NPP`s Director General set up the regulation hierarchy defined in the Management System Manual. Job descriptions also outline rights and competences.

10.2.2 Role of personnel in maintaining operational safety

All members of the operating staff hold qualifications and have had the necessary training for carrying out their particular function. Qualifying examinations are either performed within the plant in normal or advanced level plant exams or in front of representatives of the HAEA, depending on the potential effect on safety of the particular position. Qualifying examinations should be repeated at regular intervals.

The training and qualification requirements for operating staff working in shifts and employed by the operating organizations are outlined in the Ministerial decree 55/2012 (IX.17.) NFM on special professional education and training of employees of nuclear installations, and on the scope of professionals authorized to perform activities corresponding to the use of atomic energy and in the procedural orders describing the training activity.

Personnel doing shift work may transfer their responsibility to other individuals in a regulated manner only and under regulated circumstances, be it during normal operation or in the case of an incident.

As a part of the Final Safety Analysis Report, in line with the nuclear safety requirements, the NPP determined the so-called safety-related job positions, the requirements, training and qualifications requirements for which are specified.

The unit control room activities of non-shift personnel are also regulated. Direct intervention in the operation process can only be executed by those holding appropriate qualifications, and they can do so only if this is set out in their job descriptions and they are on shift according to the appropriate schedule. Other personnel are forbidden to intervene directly.

It is the task and responsibility of the maintenance staff to keep all power plant equipment in a reliable and operable condition. Maintenance of the nuclear power plant is an on-going process and follows a detailed, structured format with work instructions. An administrative instruction guarantees that only those works are carried out that are planned and well prepared and have received the appropriate licenses. Inspection and assessment functions are integrated into the work process in a way laid down in the procedural order.

The maintenance staff is prepared in the same training system as the operating staff. The well-equipped Maintenance Training Centre of the nuclear power plant contributes to the preparedness of the staff.

It is the task of maintenance departments to maintain and, where necessary, reconstruct any given installation, to handle equipment failures and to prepare them for official inspections, to execute all welding and technological assembly work, and to carry out repairs and assist in production tasks at the NPP, together with the planning and providing of all safety-, human resource-, and material-related conditions necessary for such work.

The tasks of the technical support organization are as follows:

- draw up of safety analyses;
- preparation of reactor physics calculations;
- definition of the scope, time schedules and cycle times of technological tests;

- preparation, conciliation, review and modification of operating instructions, operating schemes, programming and scheduling of tests;
- keeping records of tests performed in a manner sufficiently detailed to prepare reliability and trend analyses on the basis of which conclusions can be drawn concerning the adequacy of components and systems;
- preparation of and commenting on production regulations and the upgrading thereof within the required time intervals, along with keeping records of these;
- planning and preparation of refuelling outages, weekend maintenance and weekly operative works, together with the control and co-ordination of the accomplishment thereof;
- planning of in-service works and the definition of methods and conditions of implementation thereof;
- collection, arranging, recording and evaluation of data concerning refuelling outages;
- composition and time scheduling of service walk-down activities;
- ensuring the availability of appropriate documentation necessary for work performance, of appropriate documentation and archiving of work performed.

Activities performed by auxiliary personnel have no direct influence on safety.

10.2.3 Responsibility and safety related issues concerning the employment of external suppliers

On the premises of the nuclear power plant, *on safety class systems, structures and components* work may be performed only by external suppliers holding a valid qualification approved by MVM Paks Nuclear Power Plant Ltd. Outside contractors are required to undergo re-qualification on a regular basis. Such qualifications are implemented following the requirements of the Nuclear Safety Code and the *internal procedures of the plant* the HAEA, under regular inspection by the HAEA. MVM Paks Nuclear Power Plant Ltd is responsible as auditor for lawfully carrying out the auditing and evaluating procedure and further to ensure that the conditions for qualification remain fulfilled.

The fulfilment of requirements of the Management System Manual – and those of the more detailed internal regulations – is mandatory for all external organizations and suppliers performing work on the site of the nuclear power plant. The hiring organization inspects all work performed by a supplier by appointing a technical inspector for all work.

In the area of engineering services, analyses, calculations and assessments requiring professional knowledge are performed by research institutes, universities, or engineering offices. Co-ordination and inspection of outside work are carried out by the hiring organization.

10.3 Safety policy of the MVM Paks II Nuclear Power Plant Development Ltd as a licensee

Pursuant to Subsection 1 of Section 8 of the Govt. Decree 118/2011. (VII. 11.) Korm. on the nuclear safety requirements of nuclear facilities and the corresponding regulatory activity obliges the licensee to prepare a safety policy before the submission of the commissioning license application. As the safety objectives need to be satisfied throughout the lifecycle of the nuclear facility (including the design, site selection, fabrication, construction, commissioning, operation, final shutdown, decommissioning and closure, furthermore in relation to radioactive materials also the transportation and radioactive waste management) the management of the MVM Paks II Nuclear Power Plant Development Ltd decided to prepare and implement the safety policy of the company already after obtaining the site survey and assessment license (November 14, 2014). The safety policy finally entered into force on January 1, 2015. The policy declares the commitment of the management towards safety and requirements for each contributor.

For the continous implementation of the measures needed to achieve the objectives declared in the safety policy, the MVM Paks II Nuclear Power Plant Developer Ltd established, operates and develops an effective management system. The fundamental safety objective of the management system is to achieve and maintain safety and to ensure the priority of safety over every other competing aspects.

The MVM Paks II Nuclear Power Plant Development Ltd has designated long term tasks to promote the development of safety culture, on the basis of which the concept and methods of measurement, assessment and development of safety culture can be elaborated.

10.3.1. Responsibility of the managers

The management identified those key factors and attributes that support a strong safety culture and takes care of sharing it with the employees and making the employees understand it. They provide regular training for the employees and created the opportunity for the employees to submit any safety related proposals.

The management developed such management principles and supports such behaviours (also by showing own examples) that promote the continuous development of the safety culture.

At all level of the organization the managers promote such behaviours, values and basic perceptions that lead to build up a strong safety culture and that make employees paying attention during their acts to those early signs that indicate the deterioration of safety culture.

10.3.2. Role of the employees

The management system founded such a working atmosphere in which the employees could raise matters of safety concern without being apprehensive of vexation, punishment, intimidation, or discrimination.

The management of the company requires from the employees to show a responsible behaviour towards safety and with their acts, activities and decisions to maintain and reinforce safety, and to be prepared to questioning the prevailing practice if it endangers safety.

The employees learn and comprehend the safety effect and significance of their work. They perform all their activities and take all their decisions by keeping safety in mind.

10.3.3. Safety issues of employing external suppliers

In order to maintain the capacity of Paks Nuclear Power Plant, the MVM Paks II Nuclear Power Plant Development Ltd involves only such contractor partners to the implementation of construction of the new units at the Paks site that are prepared, have high skills and professional experience and that are acknowledged within the industry, whose professional applicability must be proven and audited according to the standards. In addition, during the selection of the partners, the preliminary examination of their capacity and assessment of their performance during their activities must take place via a qualification and evaluation process in the mirror of safety requirements. The MVM Paks II Nuclear Power Plant Development Ltd strives for constructive and proactive cooperation with the partners and institutes involved in the implementation.

11. Financial resources

Nuclear Safety Convention, Article 11

1. Each Contracting Party shall take the appropriate steps to ensure that adequate financial resources are available to support the safety of each nuclear installation throughout its life.
2. Each Contracting Party shall take the appropriate steps to ensure that sufficient numbers of qualified staff with appropriate education, training and retraining are available for all safety-related activities in or for each nuclear installation, throughout its life.

11.1 Financial resources

11.1.1 Financial resources of the HAEA

In order to ensure the normal operation of the HAEA, the Act on Atomic Energy provides two financial sources:

- a specific sum is provided annually from the state budget:

- to cover the costs of technical support activities assisting the regulatory work of the HAEA;
- to cover the development costs related to the emergency preparedness and response activities; and
- to cover the costs of the HAEA as a consequence of its international obligations.

- Licensees of nuclear installations and radioactive waste repositories are obliged to pay a supervision fee to the HAEA in the manner and to the extent defined in the Act on Atomic Energy.

Accordingly, the HAEA is financially independent of nuclear installations and its funding is sufficient for carrying out its duties efficiently. *The income of HAEA, except for income from fines, shall be used exclusively for covering its operation, it shall not be used for any other purpose. At the same time, the financial resources of the HAEA can be used only by taking account of the state administration rules and actual status of the state budget.*

11.1.2 Financial resources of the Licensee

The MVM Paks Nuclear Power Plant Ltd and the MVM Partner Power Trading Ltd has concluded an "Electric Power Trading Agreement". The agreement provides the basis for the sale of the energy produced by the Producer to the Trader until 2017.

The Act on Atomic Energy called for a fund, namely the Central Nuclear Financial Fund (hereinafter referred to as the Fund), be created in 1998 for financing the tasks related to final disposal of radioactive wastes and storage of spent fuel, closure of the nuclear fuel cycle, decommissioning of nuclear installations and to support the associations of municipalities established for monitoring and public information. Those users of atomic energy that generates radioactive wastes or spent fuel during their activities are obliged to bear the costs of the waste management. The financial instruments of the fund shall be used exclusively to finance these activities. The income side of the Fund consists of the annual payments by Paks Nuclear Power Plant Ltd, support from the central budget and other occasional incomes.

The manager of the Fund from January 1, 2014 is the ministry led by the minister assigned to oversee the activities of the HAEA (currently the Ministry of National Development).

The tasks related to the management of wastes and spent fuel generated by Paks Nuclear Power Plant and the decommissioning of the facility are summarized by annually updated medium and long term plan as approved by the competent minister. This plan contains the costs arising with respect to the implementation of the above tasks. Paks Nuclear Power Plant shall cover the costs through annual payments to the Fund evenly distributed over the entire service life. The determination of the sum to be paid is performed by the method of net present value calculation, the point of which is that the present value of the future costs shall be equal to the present value composed *of the sum from the Fund and the further payments of the MVM Paks Nuclear Power Plant Ltd.*

The payments performed by the MVM Paks Nuclear Power Plant Ltd. are meant to meet the demands raised by the tasks with respect to waste management, decommissioning and spent fuel management until 2084. The objective of the Fund is to provide coverage for financing these activities, thereby avoiding any unjustified financial burden on the future generations.

According to Law-Decree 24 of 1990 (II. 7.) on the ratification of the 1963 Vienna Convention on civil liability for nuclear damages signed May 21, 1963, pursuant to Subsection 52 (1) of the Act on Atomic Energy the absolute liability of the licensee of a nuclear power plant, nuclear district heating plant and a facility producing or processing nuclear fuel shall not exceed SDR (Special Drawing Rights) 100 million on each occasion of a nuclear accident arising in the facility, and SDR 5 million on the occasion of each nuclear accident arising in other nuclear facilities and in nuclear accidents arising during the transport or storage of nuclear fuel.

The nuclear damage in excess of the amount defined above shall be compensated by the State of Hungary; however, the total amount devoted to the compensation shall not be greater than SDR 300 million even in this case.

The MVM Paks II Nuclear Power Plant Development Ltd is the property of the State of Hungary in 100%. The owners' rights are exercised by the minister heading the Office of the Prime Minister. The resources for the operation of the company and the construction of new units will be provided by the State of Hungary for the company.

The coverage of waste management and decommissioning costs of the currently operating Paks Nuclear Power Plant units will be ensured by the payments of the MVM Paks Nuclear Power Plant Ltd. to the Fund.

11.2 Human resources

The Hungarian system of higher education offers a wide range of professional knowledge through the education of mechanical engineers, electrical engineers, chemical engineers, *physicists and engineering-physicists*. At the Faculty of Mechanical Engineering and Faculty of Natural Sciences of the Budapest University of Technology and Economics, the syllabus covers power plants and nuclear power plants within the framework of subjects related to energetics; in addition, there is a postgraduate course on nuclear engineering.

11.2.1 Human resources of the HAEA

97% of the employees of the HAEA have a higher education degree, 44% of which have two or three diplomas and 11% of which have a PhD or a university doctor title. 71% of the whole staff have state language exam from one or more languages.

Those employed by the HAEA may perform official activities on their own, i.e. licensing, inspection and assessment according to the general rules of public administration, only if they pass a *inspector's examination. The inspector's examination authorizes the employee of the HAEA to perform individual work. The exam terminates the whole induction training process.*

To acquaint the staff of the HAEA with the practices of the *facilities*, their training is done *in the facilities* mostly at the nuclear power plant or in the form which conforms to the training system of the *facility*. International courses are also integrated into the training along with "on-the-job training", which forms an integral part of the above-mentioned training system.

A systematic approach to training has been prepared by the HAEA for training inspectors. The plan is based on individual training profiles and consists of three basic training types: introductory training, re-training, and advanced courses.

The basic principles governing the training system of the HAEA are as follows:

- *learning is a continuous task to maintain the level of expertise and to acquire new knowledge;*
- the most important value of the HAEA are the highly qualified humans; therefore it expects and urges the acquisition and maintenance of the work-related knowledge.

A knowledge management system was established to support the training system of the HAEA, which *also appeared in the processes of the HAEA. Its development is continuous, one of its objectives is to* facilitate the transfer of knowledge from the experienced colleagues to the new ones.

In addition to new professional challenges the regulatory work is more and more seriously hindered by the exodus of the nuclear and radiation safety graduate workers, required for the regulatory work, from the public administration. Only a few qualified professionals can be found in these areas of expertise, and despite the challenging tasks, the higher salary offered by engineering consultancies, expert organizations, the nuclear industry (also preparing for the new challenges) and international organizations are so attractive to the professionals needed that they cannot be offered adequate compensation within the public sector.

As planned, Unit 5 can start its operation in 2025 and Unit 6 in 2026. The HAEA prepared a study on the professional and staff demand for the regulatory licensing and *construction oversight tasks required for it. The HAEA delivered the study to the concerned government organizations.*

Based on this study, in 2015, the HAEA was provided with the opportunity to hire a significant number of new staff with respect to the new units and the other new tasks (oversight of radioactive waste repositories and radiation protection). The staff of the HAEA was practically doubled by hiring 80 new co-workers. The opportunity to find new staff members was facilitated by an amendment of act that improved the salary conditions of the employees of the HAEA.

Today the staff number of the departments of the HAEA dealing with the facilities is 109.

The HAEA, if a new nuclear power plant unit is constructed, shall perform regulatory supervision over the existing four units along with the other three nuclear facilities *and the waste repositories*, which means an increasing work load required by the regulatory supervision of the ageing of nuclear equipment, equipment replacement, modernization projects and ageing management procedures. All these shall be taken into account during the training of the professionals.

11.2.2 Human resources of the Licensee

On December 31, 2015 the number of individuals employed by MVM Paks Nuclear Power Plant Ltd was 2,532 of whom 91 were heads of divisions or higher level executives. The number of those engaged in operations was 859; the number of maintenance staff was 597, and the number of others ensuring support (safety, security, technical, economical and human) activities 1076. 39% of the employees have a higher education degree. Of the operating personnel, 408 have a valid regulatory or advanced plant exam.

Within the nuclear power plant works a system of expert training that the financial, material and personal conditions are also assured by the plant for. The expert training system established at MVM Paks Nuclear Power Plant Ltd meets the international requirements and the Hungarian legal requirements. The training, in accordance with the Systematic Approach to Training methodology preferred by the IAEA is job oriented and consists of a series of modules. Theoretical training is always followed by practical training that consists of practical training on the simulator, in the Maintenance Training Centre or in the plant. The training is completed by way of practice under supervision in a real work environment. Each training phase is ended by an exam; at the end of a training programme the candidate obtains the right to work individually based on company, advanced company or regulatory exams. However, training does not come to an end on obtaining the qualification or the right to perform duties: training courses and evaluations aimed at increasing knowledge continue together with periodic adequacy tests. Periodic exams must be passed every five years by workers employed in job positions requiring regulatory or advanced company license, while it is every three years by workers employed in job positions requiring company license. Annual medical and psychological fitness tests are also a prerequisite.

The general rule of the development and implementation of training programmes, the list of job positions and activities having an obligation to obtain special nuclear expertise, the content elements of training programmes are regulated in the Nuclear Safety Code, the Ministerial decree 55/2012. (IX. 17.) NFM, and in internal procedures.

The radiation protection training involves the greatest numbers of employees. The education of those professionally engaged in radiation protection, of the operative staff, of the maintenance staff and of those performing technical assistance activities takes place separately. Workers engaged from outside on a contractual basis also have to meet the qualification and examination requirements.

MVM Paks Nuclear Power Plant Ltd trains its experts at its own cost and in its own training centres. The training infrastructure is suitably developed; facilities of the training centres are well equipped. Teachers and instructors are well qualified and well prepared.

A full-scope simulator has been in operation in the Simulation Centre since 1989, serving all four units. The simulator has been continuously developed so as to follow the various modifications performed on the units. In addition to training of operators, the simulator plays an important role in technological development projects.

The Maintenance Training Centre, which started its operation with the support of the IAEA in 1997, is unique in the world with its genuine primary components and mechanical equipment for training workshops. A special feature is that training and education make use of full-scale primary main components (reactor vessel, steam generator, main circulating pump, etc.) under inactive conditions, equipment identical with the components built in technology systems as well as training mock-ups.

12. Human factors

Nuclear Safety Convention, Article 12
Each Contracting Party shall take the appropriate steps to ensure that the capabilities and limitations of human performance are taken into account throughout the life of a nuclear installation.

12.1 Consideration of human factors

Both the HAEA and the Licensee take into account the role of the human factor throughout the entire process of design, construction, licensing and operation of nuclear installations. The annually updated and repeated probabilistic safety analyses are always carried out taking the human factor into consideration and assessing numerical values of probabilities of human error during various activities. When evaluating simulator training and potential incidents, further data can be derived concerning the probabilities of the occurrence of events originating from human error. In accordance with the requirements of the HAEA, the Licensee shall put emphasis on the identification of human and management errors during event investigations. During the assessment of the events, also the HAEA puts emphasis on the human and management errors.

As in the past, the Hungarian Electricity Group wishes to take into account the opinions and comments of employees regarding their employer, work conditions and personal carrier opportunities in the future; therefore it conducted a group level commitment survey *in 2013 and 2015.*

The MVM Paks II Nuclear Power Plant Development Ltd, corresponding to its operation, puts emphasis on the human factor in the design phase of the new nuclear facilities, with special attention to those job positions, to which certain control obligations are assigned according to law.

12.2 Recruitment

Paks Nuclear Power Plant Ltd constantly enforces the requirement that only such individuals may carry out work in the nuclear power plant, who have the necessary qualifications, skills and examinations set out for the given job and in addition meet the appropriate medical, psychological and public security requirements.

The recruitment and employee selection process requires close cooperation between the professional organizations and the human division, since the manager of the requesting organization defines the professional requirements for the position to be filled, while the human division performs preparation, screening and evaluation.

The selection system applied by MVM Paks Nuclear Power Plant Ltd consists of psychology aptitude test and measurement of competencies required for a given job or position. The psychologist provides the manager with a detailed evaluation on the results of aptitude tests and competence measurements, and then prepares the priority list of candidates. The most appropriate candidate is selected by the relevant leader.

In order to professionally prepare the new employees or those moved to a new position for a new job, the Paks NPP Ltd operates the system of mentor programmes.

The MVM Paks II Nuclear Power Plant Developer Ltd shall determine the list of job positions important to safety and of those determining from the aspect of safety taking into account the attributes of the nuclear facility under design and the design related tasks. The list shall appear in the Preliminary Safety Report and the respective design documentation to be developed by the company and submitted to the HAEA according to the formal requirements determined by law. The development of the organization shall follow the life cycle phases of the construction.

12.3 Improvement of working conditions

The Collective Contract of the MVM Paks Nuclear Power Plant Ltd limits overtime work to 300 hours a year for an employee. The rules in force at the plant are in accordance with the related stipulations of the Act I of 2012 on the Labour Code. The Human Affairs Directorate keeps comprehensive records of the workload of employees.

In order to ensure undisturbed work, the NPP established and has ever since been operating a social system whose scope in several areas reaches beyond the services usually available in Hungary.

The nuclear power plant was awarded "The Healthiest Work Place" in 2011, "Family Friendly Work Place" in 2012 and in 2014, *"Family Friendly Company" in 2014, and "Cyclist Friendly Work Place" in 2014.*

12.4 Future aspects of the characteristics of human resources

In order to ensure a supply of adequately trained workers, the Human Affairs Directorate of the NPP constantly measures the optimum manpower demands and handles the manpower shortage or redundancy on the basis of the probable lifetime of the plant.

One of the strategic goals of the company is to extend the service life of all four units of the NPP by 20 years beyond the design lifetime. With the lifetime extension, the possibility of the perspective of life-long careers opens up.

The performance and competence assessment system established in 2009 operates fruitfully. The system covering each of the employees makes regular and real feedback possible, as well as facilitates the differentiated motivation based on personal performance. The motivating financial budget separated in the salary agreement contributes to the effective operation of the system .

12.5 Feedback of experience in order to enhance safety

It is laid down in the safety policy of the nuclear power plant that commitment to safety should manifest itself, among other ways, in open detection of factors compromising safety and in an endeavour to enhance safety and safety culture. The objective of event investigations is to draw conclusions rather than to call personnel into account.

Investigation and analysis of non-planned events in the Paks Nuclear Power Plant are regulated in a separate procedural order. Any human error found during an investigation should be analysed in detail. Specialists help to identify initiating causes, take part in the psychological analysis work as well as in defining the direction of necessary changes and modifications. The results of the investigations with definitions of the related concrete tasks and measures needed are strictly recorded.

12.6 Safe working conditions

Healthy working conditions in accordance with standard values are created . If there is doubt that any of these conditions in a particular workplace does not meet the requirements, accurate measurements are performed on the basis of which supplementary measures are taken. The proper use of personal protective equipment (the use of which depends on the given working conditions) is enforced by regular check-ups and the possibility of imposing sanctions.

It is a usual practice to modify or change the external conditions, the ergonomic environment or the man-machine interface so that the probability of repeating errors and mistakes is reduced. All tools, measuring instruments, maintenance and all other special equipment, meet the requirements both for quality and quantity.

13. Quality management

> **Nuclear Safety Convention, Article 13**
> Each Contracting Party shall take the appropriate steps to ensure that quality assurance programmes are established and implemented with a view to providing confidence that specified requirements for all activities important to nuclear safety are satisfied throughout the life of a nuclear installation.

13.1 Basic principles

In operating and developing quality management systems, nuclear safety is always the key objective. The design, manufacture, installation, assembly, commissioning, in-service inspections, testing, etc. of the components are performed on the basis of requirements of the Nuclear Safety Code and of associated guidelines. During the regulation of the activities, in addition to the domestic regulatory requirements, the HAEA follows the standards and guidelines of the international organizations (e.g. IAEA) and other countries having advanced nuclear industry (e.g. USA). It is important that the suppliers of the nuclear power plant have to be in possession of a valid qualification for the relevant activity.

13.2 Description of the national quality management system

The Act on Atomic Energy requires that "Only those institutions, organizations, companies which possess appropriate quality management systems can take part in activities related to nuclear facilities, nuclear systems and equipment". Moreover the Act on Atomic Energy also requires that in the field of application of nuclear energy only such individuals can be employed who meet all the necessary requirements, such as qualifications, and the necessary personal and health condition, *integrity* etc. The adequacy of the management system shall be examined and certified.

The principles of the quality management system were included in Volume 2 of the Nuclear Safety Code, and these requirements were elaborated according to the requirements GS-R-3 of the IAEA, based on WENRA reference levels and by taking account of ISO 9001:2000 standard. The Volume on quality management and the associated guidelines define the quality management requirements not only towards the operator but also towards the suppliers.

13.3 Quality management system of the HAEA

The HAEA was among the first of the administrative bodies of the Hungarian central public administration, which introduced a quality management system according to the standard MSZ EN ISO 9001:2001 (ISO 9001:2000).

Pursuant to the standard, the certification shall be renewed every three years and supervisory audit shall be conducted every year. As a result of the renewing audit that was conducted in 2015, the certification has been validated for another 3 years, until March 2018.

13.4 Quality management system of the MVM Paks Nuclear Power Plant Ltd.

13.4.1 Management

MVM Paks Nuclear Power Plant Ltd, as the operator and licensee of the nuclear power plant, established, operates and develops its management system in line with the requirements of Volume 2 of the Nuclear Safety Code. The fundamental principles of the management system are described in the Management System Manual, while the compliance of the system with the requirements is verified in Chapter 17 of the Final Safety Analyses Report. The plant has an integrated system, thus the environmental protection, physical protection, labour safety, radiation protection and fire protection requirements for the personnel were all considered beyond the quality requirements during the development thereof. The integrated approach assures that these requirements are complied with besides the overriding priority of safety. The integrated management system is a complete system, it covers the full scope of the basic activity; consequently it covers each process as well as defines the related requirements. The quality policy definitely describes the general quality related intention and direction of the higher management.

An indicator system is used to assess the correct functioning of the quality management system of MVM Paks Nuclear Power Plant Ltd. The indicators indirectly reflect the adequacy of the functioning of the quality assurance system, and necessary measures can be determined upon the evaluation of these indicators.

Based on annual *programme*, the quality management organization regularly reviews the operation of the system. The auditors reviewing the system are trained in special training; well experienced experts contribute to their work during audit of certain special areas.

Any non-conformance detected during the operation of the nuclear power plant is in all cases followed by evaluation. Depending on the severity of the non-conformance, evaluation is performed either by the HAEA, the quality assurance experts of the power plant, or by experts of the given professional areas.

One of the most effective elements for developing quality assurance systems is the investigation of events at different levels and the feedback of experience. Accordingly, the nuclear power plant investigates events according to their severity and in a way regulated by procedural orders. When performing such investigations the initiating causes and necessary measures are identified.

For evaluating the efficiency of the management system and to determine the necessary corrective actions the plant management holds a management review every year.

13.4.2 Execution

Design work necessary for the operation of the nuclear power plant is performed by or on behalf of the various technical support organizations.

The process of procurement is fully regulated from ordering, through import to delivery, and to inspection of the delivered product.

Operating activities are accomplished in a way regulated in procedures and execution instructions, and in the Technical Specifications. Operations are performed on the basis of handling and operating instructions. Special attention is paid to the clear identification of equipment at all times and the continuous monitoring of the condition of the given equipment. When shift changes take place, they are performed in a documented way in all cases, with a clear indication of the status of equipment valid at the moment of hand over. All necessary temporary modifications are performed according to procedural orders. Regulated fuel management procedures covering the entire cycle also form an important element of quality management of operation.

The procedures and execution orders ensure the proper control of the management of maintenance process. The maintenance activities are performed based upon plans, maintenance technologies and work programmes.

Control over technical background activities is also performed according to procedures. Requirements concerning reactor physics, diagnostic analyses, and the process for waste treatment have also been defined.

13.4.3 Audits

The safety and quality assurance organizations of MVM Paks Nuclear Power Plant Ltd exercise internal control over the executing organizations.

Control manifests itself with regard to approval of documents describing execution conditions for daily activities and during on-site supervision of real execution. Additionally, control appears in the form of audits that assess the system level and practical compliance with requirements as defined for a given operational area.

Organizations and process-owners monitor the operational efficiency of their organisations and processes run by them through self-assessment process.

The suppliers of MVM Paks Nuclear Power Plant Ltd are assessed and qualified according to the safety relevance of their work. The qualification or assessment process audits the adequacy of the quality management systems of suppliers in a planned and documented way, particularly the efficiency of their operation.

13.5 Quality management system of MVM Paks II. Nuclear Power Plant Development Ltd

13.5.1. Structure of the integrated management system

MVM Paks II. Nuclear Power Plant Development Ltd is the designated project company to construct the new nuclear power plant units at the Paks site to maintain the capacity of Paks Nuclear Power Plant. The HAEA issued the license approving the site survey and assessment programme on November 14, 2014, via which the project company became the licensee of the nuclear facility.

In accordance with Volumes 2 and 9 of the Govt. decree 118/2011. (VII. 11.) Korm. on the nuclear safety requirements of nuclear facilities and the corresponding regulatory activity the MVM Paks II. Nuclear Power Plant Development Ltd has elaborated and introduced an integrated management system, which is operated, evaluated and continuously further developed. Requirements for the integrated management system are described in the manual, internal procedures, process instructions and work instructions.

The MVM Paks II. Nuclear Power Plant Developer Ltd is responsible also for those processes and the services generated by the processes, which it partially or fully purchases from external suppliers or contractors. The differentiation of processes,respective products and services are managed according to their significance from safety aspects.

The management has expressed and enforced its commitment towards the integrated management system. It developed policies, objectives and ensures the needed resources, assigned the management representative and ensures the regular management audit and review of the integrated management system.

The management developed the policies as follows:

- *Safety policy,*
- *Quality policy,*
- *Training policy,*
- *Cyber Security Policy.*

The management takes care of making the policies known at each level of the organization and publicly available for everyone.

The operation model of the MVM Paks II. Nuclear Power Plant Development Ltd has been determined on the basis of the competencies and determination of professional areas required to effectively perform the tasks related to the construction of the new nuclear power plant units also taking into account the relevant legal requirements. An attribute of the operation model is the project-based activity of the Ltd, which is implemented as a coordinated programme within the framework of the functional organizational units.

13.5.2. Audit programmes

The method of internal audits is used to monitor/review the processes. The objective of the internal audits is to monitor and develop the operation and the integrated management system on a continuous basis, to provide effective and quality work, to comply with the laws, standards and regulatory requirements. The management monitors the performance of the main objectives on a continuous basis. In addition to the management reports prepared during the operation and the checkpoints built in the processes, the management evaluates the performance of the objectives in the framework of annual management reviews.

13.5.3. Audit of suppliers

MVM Paks II. Nuclear Power Plant Development Ltd, as a nuclear licensee, in compliance with the laws in force, especially the Act on Atomic Energy and the Govt. decree 118/2011. (VII. 11.) Korm. developed an audit system and started its operation concerning the selection and capability audit of the suppliers.

The nuclear qualification procedures related to facilities with safety class ABOS 1-3 systems, structures and components are implemented with a graded approach via:

- *review of requested documents and with an on-site audit, or*
- *review of requested documents without an on-site audit.*

13.6 Role of the HAEA in verifying the quality assurance system

The HAEA performs a comprehensive inspection either as a system audit or a process audit. Audits are carried out on previously designated areas by internal auditors; any attempt to eliminate remarks recorded in the audit-minutes must be reported.

Pre-planned inspections are performed according to the annual schedule of the HAEA. Non-scheduled single inspections are performed relating to events adversely affecting quality, or upon the individual decision of the HAEA.

The areas of the operator's quality management system regularly inspected by the HAEA are as follows:
- structure of the organization,
- training and qualification of staff,
- documentation,
- management of non-compliances;
- normal operation,
- maintenance and repair work,
- nuclear fuel management,
- selection of contractors,
- design,
- acceptance inspection at manufacturers,
- modifications.

Inspection of audits includes both independent reviews and those performed by the management. Official inspections are carried out according to written procedural orders approved by the HAEA's Director General and are made known to the Licensee.

The HAEA requires the Licensee to decide upon improvement measures related to findings identified during the inspections. If this is neglected or not performed adequately, the HAEA in a special resolution will itself order for the improvement measures.

The HAEA held a comprehensive inspection to examine the operation of the management of Paks Nuclear Power Plant Ltd as the operating organization in the end of 2014. The site inspection phase had not revealed any deficiency that endangered nuclear safety and needed immediate regulatory action. The evaluation of the internal documentation of the company and management processes pointed out that further specification is needed in terms of the regulation of some processes, namely concerning internal communications, event investigations, validated computerized management of technical documentation and certain human relations issues. On the basis of the regulatory findings the MVM Paks Nuclear Power Plant Ltd decided to carry out improvement actions.

In 2015, the HAEA examined the implementation of the action plan aiming at the development of the management system of MVM Paks II Development Ltd in the framework of several inspections. The on-scene inspections had not revealed such non-compliance or deviation jeopardizing nuclear safety, which required immediate regulatory action. The HAEA summarized the lessons learned from the inspection and their evaluation in a report. Based on the regulatory assessment the MVM Paks II Development Ltd made a decision on the implementation of corrective actions.

14. Assessment and demonstration of safety

Nuclear Safety Convention, Article 14

Each Contracting Party shall take the appropriate steps to ensure that:

(i) comprehensive and systematic safety assessments are carried out before the construction and commissioning of a nuclear installation and throughout its life. Such assessments shall be well documented, subsequently updated in the light of operating experience and significant new safety information, and reviewed under the HAEA of the regulatory body;

(ii) verification by analysis, surveillance, testing and inspection is carried out to ensure that the physical state and the operation of a nuclear installation continue to be in accordance with its design, applicable national safety requirements, and operational limits and conditions.

14.1 Assessment of safety

14.1.1 *Preliminary and final* safety analysis reports

The method of preparation and implementation of safety analysis reports is set out in acts and at Government Decrees. The official procedure related to a nuclear construction is based on the Preliminary Safety Analysis Report necessary for the commencement of commissioning that is followed by the Final Safety Analysis Report necessary for the commencement of operation of a given nuclear installation.

The requirements regarding the contents of safety reports are based on the requirements of Reg. Guide 1.70 of the US NRC (United States Nuclear Regulatory Commission) taking into account national characteristics into consideration.

Govt. decree 118/2011. (VII. 11.) Korm. stipulates that the Final Safety Analysis Report should be updated annually, so that the safety analysis report can serve as an authentic and continuous basis assessing the safety of the nuclear installation throughout its entire life-time.

The HAEA performs a periodic nuclear safety review within ten years of the first day of the validity of the Operating License issued for the initial commencement of operation, and it repeats this review every ten years following the first one.

The HAEA issues a decision based on its own safety assessment and the Periodic Safety Review Report of the Licensee, in which it lays down the conditions for future operation.

14.1.2 Periodic Safety Review

The IAEA issued its recommendations concerning Periodic Safety Reviews (Periodic Safety Review of Operational Nuclear Power Plants, Safety Series No. 50-SG-O12 and NS-G-2.10 documents). This recommendation schedules regular reviews approximately every ten years thereby providing a comprehensive view of safety of nuclear power plant units and, by virtue of their systematic approach, they are suitable for defining necessary safety improvement measures and priorities.

Licensees are liable to perform their own internal assessment one year before the deadline set for the performance of the assessment and to submit a Periodic Safety Review Report on the results of this assessment to the HAEA. In the review the HAEA performs the analysis and evaluation of the technological and safety level of the operated nuclear installation on the base of the report of the licensee, and compares it with the known, most recently developed international technology and safety levels. The HAEA appraises whether or not the risk, from any deviation revealed, can be tolerated during the next 10 year operating cycle and the operation of the installation complies with internationally accepted good practice. The HAEA terminates the review with a resolution, in which it may limit the validity of the license if the risk justifies it, or may order the implementation of safety improvement measures to reduce any unacceptable risk. The safety improvement is conducted under regulated conditions; the HAEA inspects the improvement actions decided upon and grants permission for the relevant necessary modifications.

In Hungary, the HAEA issues a guideline to each specific PSR, which sets the objectives, principles of implementation, legal regulation, and technical background of the review and its related documents.

The first Periodic Safety Review of Units 1&2 of Paks NPP took place in 1995-1996. The Periodic Safety Review of Units 3&4 was performed in 1997-1998 by the operator in accordance with the new Act on Atomic Energy, entered into force in 1997, and the related regulations.

The next PSR was conducted for all 4 units at the same time. The Periodic Safety Review Report was approved by the HAEA on December 15, 2008 and 169 safety improvement measures were ordered to be executed in the approval resolution. The HAEA follows the implementation of the improvement measures of the PSR and the experiences gained were used in the evaluation of the Service Life Extension Programme of Paks NPP *units.* (See details in Chapter 6.2.1. and 6.2.3.)

14.1.3 Further safety assessments

Safety assessments are performed also for those modifications, failures or ageing-related equipment and device replacements that do not require an amendment to the Final Safety Analysis Report.

Safety assessments are also performed if technical problems, events or accidents take place. Those safety assessments have to be also mentioned which include lessons learned from events abroad, when the potential occurrence of a similar event in a domestic facility has to be considered. External hazard factors, risks from natural phenomena belong to this scope, but there was also such a case when a notification was provided by a relevant organization having a technical problem with a product commonly used in various countries. In this case it has to be examined whether the revealed technical problem of the product might cause any failure under the operating conditions of another facility.

14.2 Verification of safety at the MVM Paks Nuclear Power Plant Ltd

14.2.1 In-service inspections and tests, material testing

The proper technical condition of nuclear power plant systems and components fulfilling safety functions shall be maintained. The proper technical condition and functionality is demonstrated by in-service inspections, inspections and tests performed in connection with refuelling outages, as well as by periodic material testing of pressure retaining equipment and valves. A detailed description of the in-service inspections, tests and examinations is given in Annex 1.

14.2.2 Ageing management of equipment

The Nuclear Safety Code, issued as an annex to Govt. Decree 118/2011 (VII. 11.) Korm. dedicates separate sub-sections to the topics of ageing and lifetime management. Ageing management of equipment at Paks NPP is being performed according to the Nuclear Safety Code. Its detailed description can be found in Annex 2.

14.2.3 Seismic safety

Between 1996 and 2002, the total seismic safety review and the implementation of complex reinforcements took place up to the final seismic input, which had been determined as 0.25g free surface horizontal acceleration.

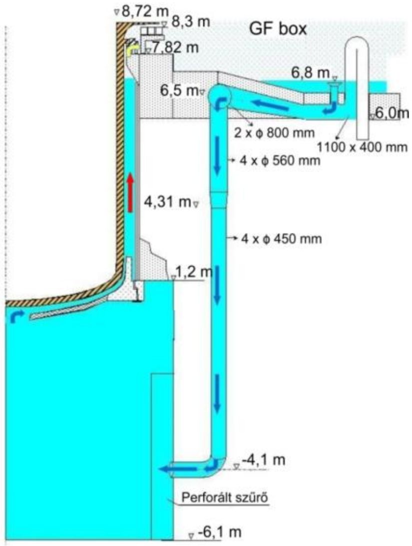
In addition to free-surface measurements, several triaxial acceleration gauges are located within each twin unit: three of them are fixed onto the base plate and three additional pieces are installed at different locations of the reactor building important from both structural and mechanical points of view. The earthquake monitoring system provides sufficient measurement data for the evaluation procedure. *The renewal of the free-surface station and increasing the number of measurement stations to three are in progress.*

Since the safety and control rods drop down in their full length into the reactor within 10 seconds, it is not justifiable to initiate automatic reactor protection operation for earthquakes of any free surface acceleration or duration. In order to prevent unit shutdowns triggered by false signals, the earthquake alarm and protection system currently operates off-line, so it does not shut down automatically the reactor. In earthquake alarm the personnel takes a decision on the shutdown. In accordance with international recommendations and with modern practice, the criterion for unit shutdown is the transgression of limit values set for the cumulative absolute velocity and for the response spectrum. Actions to be taken in case of an earthquake are laid down in Technical Specifications and in Emergency Operating Procedures.

14.2.4 Improvement of technical conditions for severe accident management

After the implementation of the severe accident management modifications at Paks Nuclear Power Plant between 2011 and 2014, the set of Severe Accident Management guidelines was introduced.

The Licensee has completed the modifications necessary to be able to implement the severe accident management guidelines. These modifications are as follows:



- The possibility of external cooling of the reactor pressure vessel has been established. The objective of that is to provide the capability of in-vessel retention of the molten corium in a severe accident situation, whilst the integrity of the reactor pressure vessel is maintained. The task has been accomplished by external cooling of the reactor pressure vessel by way of creating the route for draining the water reserves of the bubble condenser trays into the reactor cavity via the ventilation system of the reactor cavity. The coolant can return to the hermetic compartments from there, meanwhile it cools the vessel wall. *The modification has been completed in each unit.*

- In order to ensure an appropriate method of management of the hydrogen generated during a severe accident phenomenon, in addition to the already hydrogen recombiners in existence, a further 60 high power recombiners have been installed in the hermetic compartments for severe accident management purposes. Hydrogen explosion and endangering of integrity of the hermetic compartments can be avoided by means of these pieces of equipment which reduce the potential for release of radioactive materials. This development was completed for all units in 2011.

- In order to realize the severe accident management strategy, such an accident management electric power supply system had to be constructed, which can ensure the power supply for reduction of the pressure in the main circulation loops, the equipment required for external cooling of the reactor pressure vessel and for the accident measurement and instrumentation chains should a total loss of electrical power occur should the occasion arise when there is no onsite and off-site safety power supply available. The independent electric power system has been constructed by way of the installation of mobile diesel generators *of 4x100 kW* and connection routes from the *diesel* generators towards the principal safety distributors. This development took place for all units during 2011.

- Accurate monitoring, and knowledge of the technical parameters, is indispensable for the usage of the severe accident management guidelines and for correct technical decision-making. *The measurement system that is operable independently of the operational measurements even if severe accident conditions occur include measurement means for reactor pressure, core outlet temperature, water level in hermetic compartments, water level in reactor cavity, hermetic compartment pressure and temperature, hermetic compartment hydrogen and oxygen concentration, spent fuel pool level, dose-rate in reactor hall and release measurements. The system has been implemented in each unit. The measurements are accessible from the Main Control Rooms and Backup Control Room of the units and from the Protected Command Post.*

- The safety improvement modification of the cooling circuits within the spent fuel pools and service shafts of the units *was also completed. According to PSA Level 1* results that such am *excludable* loss of coolant accident within the spent fuel pool cooling system would entail the most severe consequences for the spent fuel assemblies, which would take place in the compartments of the safety equipment of the pools at a water level of the spent fuel pool used during refuelling. In order to reduce the risk, motor-operated valves, controlled by level gauges, *were* constructed in place of the currently used manual valves. In this way the amount of coolant lost can be kept within acceptable limits and it will be easier to start up the backup coolant circuit. The frequency of a break in unenclosed pipelines can be reduced by replacement of the existing pipeline sections and by applying fewer welds. As a consequence of the modification the damage frequency of the fuel in the spent fuel pool, due to loss of coolant, decreases by two orders of magnitude. *The modification was implemented in each unit.*

14.3 Safety measures of MVM Paks II Nuclear Power Plant Development Ltd with respect to design of the nuclear facility

MVM Paks II Nuclear Power Plant Development Ltd conducts regular and documented reviews in accordance with the integrated management system of the company in order to ensure compliance with the requirements prescribed by laws, international and national regulations and the maintenance of compliance (see details in Section 13.5). MVM Paks II Nuclear Power Plant Development Ltd conducts its activities in line with the Nuclear Safety Code including the licensing and design of the new units.

15. Radiation protection

Nuclear Safety Convention, Article 15
Each Contracting Party shall take the appropriate steps to ensure that in all operational states the radiation exposure to the workers and the public caused by a nuclear installation shall be kept as low as reasonably achievable and that no individual shall be exposed to radiation doses which exceed prescribed national dose limits.

15.1 Legal background

The regulation of radiation protection belongs to the minister responsible for health (at the completion of the report: Ministry of Human Resources), the technical issues of plant radiation protection is the task of the atomic energy supervision organization (HAEA) [6]. The issue of releases and thus the protection of the environment belongs to the minister responsible for environmental protection (at the completion of the report: *Ministry of Agriculture*); tasks related to the radioactivity of the soil, vegetation and feedstuffs belong to the competence of the minister responsible for supervision of the food chain (at the completion of the report: *Ministry of Agriculture*).

The Act on Atomic Energy allocates regulatory and professional administrative tasks to several authorities and defines the tasks of the users of nuclear energy. The major regulations that are currently applied in the field of general radiation protection are as follows:

- Ministerial Decree 16/2000. (VI. 8.) EüM of the Minister of Health on the implementation of certain provisions of the Act on Atomic Energy lays down the basis of radiation protection according to the recommendations of the ICRP (International Commission on Radiological Protection) 60 and the IAEA Safety Series-115. It is in line with the Council Directive 96/29/Euratom laying down general standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation. The decree stipulates that a radiation protection service should be set up in all installations applying nuclear energy. *All users are obliged to prepare the rules of work place radiation protection, which should be approved by the Office of the Chief Medical Officer of the National Public Health and Medical Officer Service (hereinafter referred to as OCMO) regarding important facilities and the Department of Public Health of the 7 County Government Offices, as regional radiation health authorities proceeding in radiation health scope of competence regarding other facilities.* The annexes of the Decree specify the limits of doses of workers and members of the public; the radiation safety principles of workplaces, rules of radiation protection training; dosimetry control; the treatment of those suffering from a radiation injury; the tasks of the radiation protection service, emergency preparedness, and the special radiation protection requirements for nuclear power plants.

[6] *The scope of tasks and competences of the HAEA changed from January 1, 2016, and the radiation protection related tasks and competences of the ministry responsible for health was transferred to the HAEA.*

- The Ministerial Decree 15/2001. (VI. 6.) KöM of the Minister of Environmental Protection *on radioactive releases to the atmosphere and into waters during the use of atomic energy and on monitoring of the release* derives the annual release limits based on the dose constraints determined by the Office of the Chief Medical Officer.

- Govt. Decree 275/2002. (XII. 21.) Korm. on monitoring of national radiological conditions and radioactive material concentration aims at implementing the recommendation 2000/473/Euratom (VI. 8.) of the European Commission into the Hungarian legal system. The recommendation, in which foodstuffs also appear besides environmental issues, requires monitoring of radioactivity in the environment in order to assess public exposure. The governmental decree has created the database and organization of the National Environmental Radiation Control System whose tasks are:
  - acquisition of measurement results on environmental dose-rates, on radioactive isotopes in environmental elements, in foodstuffs, in structural and raw materials, on concentration of radon activity, on radioactive contamination of human bodies;
  - public information on monitoring results;
  - co-operation in informing of the European Commission;
  - publication of inspection results in annual reports.

- Ministerial Decree 47/2003. (VIII. 8.) ESZCSM of the Minister of Health, Social and Family Affairs on certain issues of interim storage and final disposal of radioactive wastes, and on certain radio hygiene issues of naturally occurring radioactive materials concentrating during industrial activity stipulates the conditions of interim storage and final disposal of radioactive wastes. Concerning the final disposal, after closure, the public limit is set at 100 μSv/year effective dose, while the risk limit for beyond design basis events is set at 10^{-5} case/year. *The Ministerial decree 47/2003. (VIII. 8.) ESzCsM was replaced by the Govt. Decree 155/2014. (VI. 30.) Korm. on the safety requirements for facilities ensuring interim storage or final disposal of radioactive wastes and the corresponding authority activities on June 30, 2014, which does not any more contain the requirement regarding the effective dose limit and risk limit for the public concerning final disposal.*

- *Govt. decree 118/2011. (VII. 11.) Korm.* trandferred the technical issues of radiation protection related to nuclear installations and their systems and equipment in the HAEA's scope of competence. These issues are addressed in the Nuclear Safety Code, the volumes of which are the appendices of the Decree.
  - Volume 1 of the Nuclear Safety Code prescribes the regular analysis of radiation protection indicators of operation and utilization of experience within the framework of the PSR.
  - Volume 3 sets out the main radiation protection principles related to the design of nuclear power plants, the stipulations concerning the handling

of fresh and irradiated fuel and radioactive waste, and requirements for dosimetry control systems, biological shielding, and systems influencing radioactive release.

- Volume 4, containing the requirements for operation, summarizes requirements concerning the execution and documentation of radiation protection activities. The same volume deals with the requirements relating to management of nuclear fuel and radioactive wastes.

15.2 System of dose limitation

The following table summarizes the dose limits set in the domestic regulations.

Table 15.2 *Annual dose limits for workers and for members of the public*(1)

Limited quantity	*Persons subjected to exposure*		
	Workers (2) *(above 18 years)*	*Students and trainees*(3)	*Members of the public*
Effective dose	*20 mSv/year*	*6 mSv/year*	*1 mSv/year*
Dose equivalent for the lens of an eye	*20 mSv/year*	*15 mSv/year*	*15 mSv/year*
Dose equivalent in skin and limbs	*500 mSv/year*	*150 mSv/year*	*50 mSv/year*

Remarks:

(1) These limits apply to all exposures received from external and internal man-made sources, except for medical exposures. *The radiation exposure of natural origin (e.g. radon) also shall be accounted in occupational radiation exposure.*
(2)*Pregnant or breast-feeding employer shall not be employed in radiation dangerous job position. Under special circumstances higher exposures, but a maximum of 50 mSv effective dose may be permitted by the OCMO of the National Public Health and Medical Officer Service for a particular year provided that in any 5 consecutive years the annual average dose does not exceed 20 mSv.*

(3) *These limits apply to trainees and students aged between 16 and 18 years who are obliged to work with radiation sources during their courses. For all other trainees and students, the dose limits are to be applied with the limits for members of the public.*

15.3 Occupational exposure at Paks Nuclear Power Plant

15.3.1 Patterns of annual exposure

Based on the Workplace Radiation Protection Rules of MVM Paks Nuclear Power Plant Ltd, every worker employed in a radiation hazardous post (including both outside and plant employees) are monitored by a regulatory dosimeter. In the regulatory dosimetry system, from March 2013 TL dosimeters are used instead of film dosimeters. *Besides the regulatory dosimeters, to monitor the external radiation exposure, TL dosimeters, working level neutron dosimeters and dosimeters applicable to measure local dose are used. The internal rules of MVM Paks Nuclear Power Plant Ltd require full-scope operative dosimetry monitoring. In accordance with these rules, every such worker has to wear an electronic dosimeter who performs activity within the controlled area. From March 21, 2013 operative dosimetry is mandatory for all workers in the controlled area of the sanitary building.*

The following charts demonstrate the maximum individual doses of workers and the annual collective doses, based on evaluated measurements of regulatory dosimeters:

Figure 15.3.1-1. *Maximum annual individual doses according to regulatory dosimeter controls*

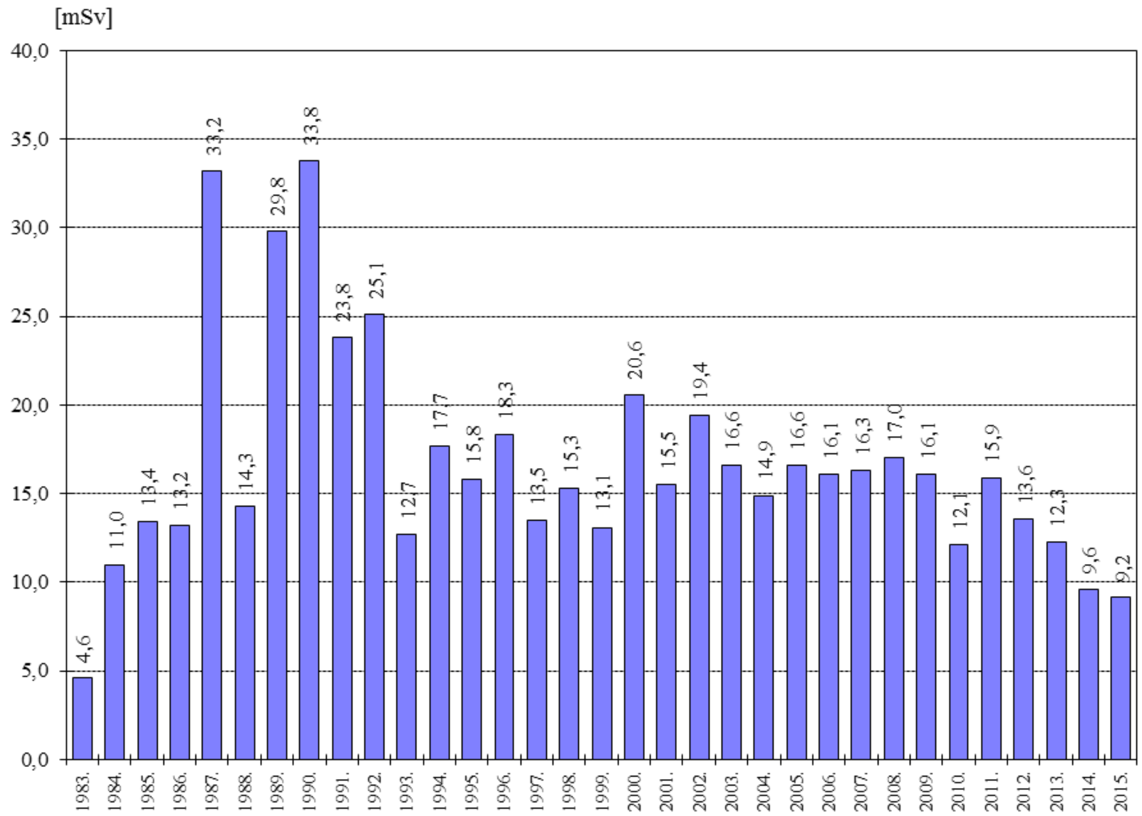
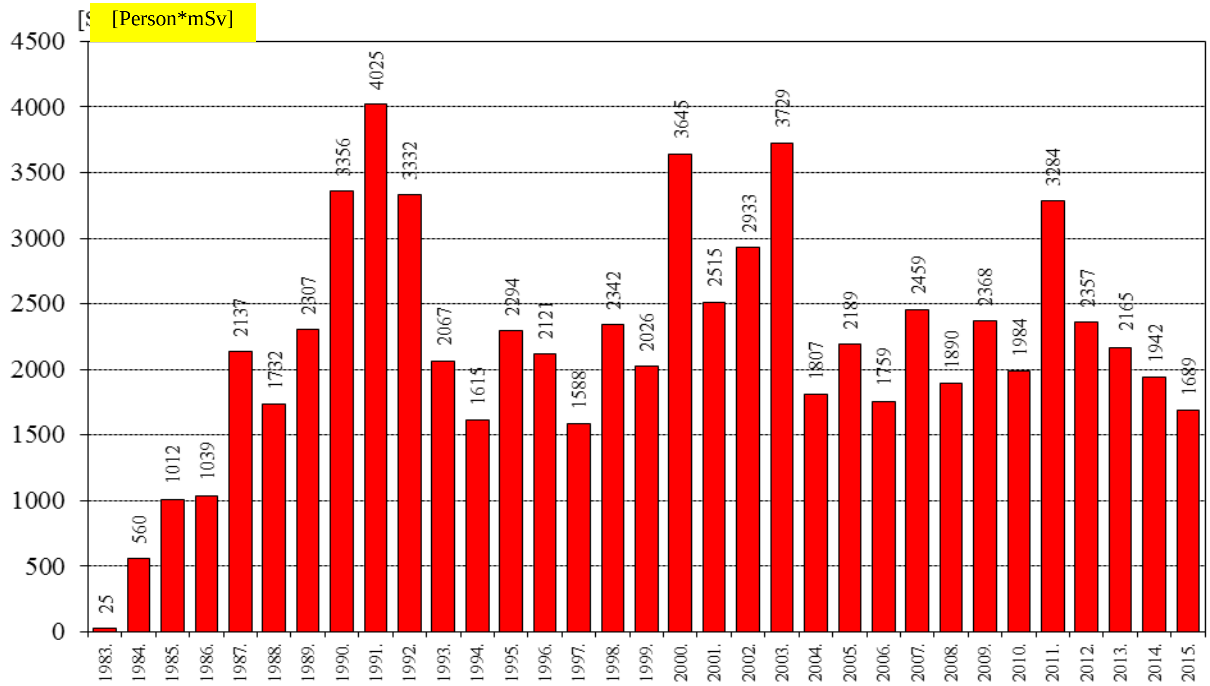


Figure 15.3.1-2 Annual collective doses according to regulatory film dosimeter readings



15.3.2 Radiation exposure in refuelling outage

At Paks NPP most radiation exposure of the personnel originates from activities during refuelling outages. Taking into account the low share of the radiation burden during operational periods, it is well worth while to evaluate the radiation exposure of personnel by analysing the radiation exposure received during refuelling outages.

The dose planning, radiological permission of particular operations in refuelling outages and identification of necessary radiation protection measures are based on the comprehensive radiation level measuring programme performed by the health physics personnel in the introductory phase of the refuelling outage period just after shutdown of the unit in the immediate surroundings of main components and in rooms involved in refuelling outage work. Data gathered on the radiation conditions could be used for dose planning for the coming years.

As for the personnel performing the maintenance and maintenance related activities, the dose values were determined on the basis of dosimetry data of Paks Nucelar Power Plant.

Collective doses for the period 2013-2015 can be found in the following table.

Table 15.3.2-1: *Exposure of maintenance personnel between 2013 and 2015*

unit/year	***collective dose [person*mSv]***		
	2013	***2014***	***2015***
I	*328*	*242*	*639*
II	*204*	*270*	*243*
III	*1140*	*254*	*220*
IV	*144*	*725*	*128*

Paks Nuclear Power Plant also regularly checks the evolution of internal exposure, via thyroid and tritium excretion measurements, and via whole body measurements. Internal exposure generally has a very low contribution to the annual exposure of workers. *In 2013 internal exposure exceeding the investigation level of 0.1 mSv took place once, the committed effective dose was 0.15 mSv. The 0.1 mSv investigation level was not exceeded by any of the employees in 2014 and 2015. Concerning the tritium activity-concentration measurement in urine, values reaching or exceeding the recording level (2.5 Bq/cm3) are included in the following table:*

Table 15.3.2-2: *Tritium activity-concentration values measured in urine exceeding the recording level of 2.5Bq/cm^3*

year	*number of events*	*max. concentration [Bq/cm^3]*	*max. committed effective dose [µSv]*
2013	*11*	*6.21*	*13*
2014	*6*	*8.44*	*17*
2015	*0*	*-*	*-*

The nuclear power plant itself performs the dosimetry control of workers employed from external companies.

Summing up, it can be established that the official dose limits have not been exceeded during the operation of the nuclear power plant. The radiation exposure of the personnel shows an acceptably low level - also in terms of international comparison.

15.3.3 Application of the ALARA principle

At Paks NPP, optimal radiation protection is ensured by administrative and technical measures.

Technical standards comprise measures aimed at providing protection through distancing, reduction of the radiation field, and minimization of the time spent in the radiation field. During unit refuelling outages, a technical measure that is used is the shutdown cooling schedule, aimes at reducing the deposition of corrosion products during cool-down.

The majority of the collective dose is received during the refuelling outages, so the anticipated collective dose of the maintenance works important from radiation protection aspect and the radiation protection measures to reduce the doses are analysed and optimized before the refuelling outages. Subsequent to the refuelling outages, an evaluation is prepared on the effectiveness of the radiation protection measures and, if necessary, further radiation protection measures are decided regarding the upcoming refuelling outages.

When making preparations for work under particularly dangerous radiation conditions, a qualitative ALARA programme is developed for all activities where this is justified by the radiation dose rate of the working area (> 4 mSv/h) or by the type of the activity. The programmes contain all technical and administrative measures that are needed to achieve the optimal radiation protection of the activity in question.

15.4 Radiation exposure of the public in the vicinity of the nuclear power plant

15.4.1 Atmospheric and liquid release

The dose constraint for radiation dose increment as a consequence of a release considering the most affected group of the population in the vicinity of Paks site is 100 μSv/year (90 μSv/year for Paks NPP units and 10 μSv/year for the Spent Fuel Interim Storage Facility). The release limitation system, required by the Ministerial Decree 15/2001. (VI. 6.) KöM of the Minister for Environment on radioactive releases to the atmosphere and into waters during the use of atomic energy and on monitoring of the release, compares both the effluent and atmospheric releases to the isotope specific release limits derived from the dose constraints (90 μSv) determined for the plant. Compliance with limits shall be demonstrated by calculating the release limit criterion.

The release limit shall be derived for all types of releases and for all such radionuclide or radionuclide groups that are assumed to be released.

Calculation of release limit criterion:

$$\sum_{ij} \frac{R_{ij}}{El_{ij}} \leq 1;$$

where:
El_{ij}: *release limit for radionuclide i for release type j (Bq/year);*
R_{ij}: *annual release of radionuclide i for release type j (Bq/year);*

The usage of the release limit during the last three years is outlined in Table 15.4.1. The data of the table clearly show that the releases were very low.

Table 15.4.1. *Usage of release limit at the four units*

year	*number of operating units*	*limit usage [%]*
2013	*4*	*0.25*
2014	*4*	*0.28*
2015	*4*	*0.30*

15.5 Radiation protection control and the environmental monitoring system of the nuclear power plant

The site of the power plant is divided into 2 zones: a free access zone and a controlled zone of the aspect of radiation protection. Radiation levels in the free access zone may not exceed 1 μSv/h. Within the controlled zone, compartments are classified into 3 categories according to permitted radiation levels and surface contamination. These are manageable, restricted manageable and not manageable compartments. Radiation protection is continuously monitored on the plant`s premises by a radiation protection system with 625 measurement channels. Control includes measurement of dose rates and air-activity concentrations in the various compartments, and measurement of the activity of different technological media. Signals from detectors are transmitted to the Dosimetry Control Room, where they are visually displayed with visual and audio warning (alarm and emergency levels) and the measurement results are displayed and archived on computers. In addition to the radiation protection system, local measurements and laboratory tests of samples are performed as well.

Release and environment monitoring is carried out in two fundamental ways at the nuclear power plant:

- the on-line system has a telemetric system the units of which are situated at stacks (iodine and noble gas activity, aerosol and airflow measurement), at water sampling stations (total gamma activity measurement), at the meteorological tower, at Type-A environmental monitoring stations (air aerosol and iodine activity, gamma dose rate) and at type-G environmental monitoring stations (gamma dose rate) set up at about 1.5 km from the power plant.
- off-line laboratory measurements serve to enhance the accuracy of data given by the remote measuring system.

The remote data are complemented with sensitive laboratory measurements of a large quantity of samples taken from emissions and from the environment. The stations perform off-line measurements of fall-out, grass, soil, aerosol, iodine, ^{14}C, atmospheric tritium activities and doses (via TL detectors).

In addition, type-C sampling stations, which measure doses (via TL detectors), are situated within a 30 km radius of the nuclear power plant. Regular replacement and evaluation is part of the environmental monitoring programme. Moreover, numerous samples are collected in the environment surrounding the nuclear power plant, e.g. water, mud, fish, plants, milk and soil. So far, measurements have shown only in some cases and only insignificant amounts of radioisotope activity generated by the nuclear power plant in the environment; the additional dose of the population from releases is below the nSv/year range.

At the SFISF radiation protection monitoring was also commenced on both the site and the surroundings of the facility. Experience so far shows radiation levels to be very low, and the additional exposure of the population caused by releases is below the nSv/year range.

Monitoring of releases and the environment is constantly carried out by the competent authorities as well, independently of the monitoring system operated by the Licensee. Basically the same monitoring results were obtained.

15.6 Radiation protection activities of the authorities

As described under Section 15.1, as far as general radiation protection is concerned the competences are shared among the HAEA, *the Office of The Chief Medical Officer of National Public Health and Medical Officer Service, the 7 County Government Offices, as regional radiation health authorities proceeding in radiation health scope of competence, and the Ministry of Agriculture*. The measurement system of authorities consists of several monitoring networks completing each other, which belong to departments in accordance with the task-sharing specified in the Act on Atomic Energy.

The Radiation Health Decentre of the Department of Public Health of the Tolna County Government Office, with the involvement of the National Research Directorate for Radiobiology and Radiohygiene of the National Public Health Centre, as a professional organization, regularly inspects the workplace radiation protection conditions of the nuclear power plant.

Regular and unscheduled inspections of the HAEA include partly the analysis of documentation on such inspections and partly the performance of site inspections in the following fields of technical radiation protection:

- assessment of source of radiation;
- operation of systems providing operational adequacy;
- technical radiation protection during maintenance;
- management and collection of radioactive wastes;
- abnormal radiation situations.

The territorially competent inspectorate of the Department of Environmental Protection and Nature Conservation of the Baranya County Government Office verifies the fulfilment of requirements related to release limits and other environmental stipulations contained in resolutions applicable to Paks NPP. *The Department of Environmental Protection and Nature Conservation of the Baranya County* Government Office is an environmental protection licensing authority of the first instance but it also participates in other licensing procedures as a special authority.

Various activity concentrations of soil, veterinary and foodstuff are monitored by *the Radiation Health Decentre of the Department of Public Health of the Tolna County Government Office, National Research Directorate for Radiobiology and Radiohygiene of the National Public Health Centre*, *Department of Environmental Protection and Nature Conservation of the Baranya County Government Office* and the laboratories of the Department of Food Chain, Plant and Soil Protection of the territorially competent Government Office.

The Environmental Radiation Protection Monitoring System of the authorities performs, independently of Paks Nuclear Power Plant, local measurements, sampling and laboratory tests in order to check the fulfilment of radiation protection requirements, bearing in mind however that monitoring is primarily the task of the operator. The Data Acquisition, Evaluating and Processing Centre of the system was set up in the *National Research Directorate for Radiobiology and Radiohygiene of the National Public Health Centre*. The HAEA has evaluated the radiation protection aspects of the operation of the plant in annual reports published since 1984. As it is generally not possible to trace radioactive substances released by the plant into the environment, or it is possible only in a few specific cases, the radiation doses of the public can be estimated only by migration and food-chain models. Annual effective doses estimated for a distance of 3 km fell into the 100-500 nSv range.

Besides the regulatory system, other monitoring systems also operate within the country. In order to collect monitoring results measured at various places into one central database the Government created, at the end of 2002, the National Environmental Radiation Monitoring System (hereinafter referred to as: OKSER). The chairperson of the committee managing OKSER is a professional designated by the minister supervising the HAEA, while the Information Centre operates in the *National Research Directorate for Radiobiology and Radiohygiene of the National Public Health Centre*. OKSER, in its annual report, publishes the most important data with a summary evaluation.

16. Emergency preparedness

Nuclear Safety Convention, Article 16

1. Each Contracting Party shall take the appropriate steps to ensure that there are on-site and off-site emergency plans that are routinely tested for nuclear installations and cover the activities to be carried out in the event of an emergency. For any new nuclear installation, such plans shall be prepared and tested before it commences operation above a low power level agreed by the regulatory body.
2. Each Contracting Party shall take the appropriate steps to ensure that, insofar as they are likely to be affected by a radiological emergency, its own population and the competent authorities of the States in the vicinity of the nuclear installation are provided with appropriate information for emergency planning and response.
3. Contracting Parties which do not have a nuclear installation on their territory, insofar as they are likely to be affected in the event of a radiological emergency at a nuclear installation in the vicinity, shall take the appropriate steps for the preparation and testing of emergency plans for their territory that cover the activities to be carried out in the event of such an emergency.

16.1 Emergency response plans and programmes

16.1.1 Regulatory framework

The Act CXVIII of 2011 on disaster management, and on the amendment of the related acts and its implementation laws, the Govt. Decree 234/2011. (XI.10.) Korm. and the

Govt. Resolution 1150/2012 (V.15.) Korm. on establishment along with the rules of organization and operation of the Disaster Management Coordination Inter-ministerial Committee regulate the structure of the national disaster management system, the prevention, preparation and response related tasks of the ministers and state organizations involved in the response to disasters as well as the tasks of the disaster management coordination organization of the government.

16.1.2 Operation of the Hungarian Nuclear Emergency Response System

The structure and tasks of the National Nuclear Emergency Response System are outlined in the Govt. Decree 167/2010 (V. 11.) Korm. on the national nuclear emergency response system.

Under normal circumstances, organizations of the Hungarian Nuclear Emergency Response System are in the state of readiness and carry out preparatory work and training. The concerned organizations perform on-going tasks related to measurement data acquisition, information acquisition, radiological data exchange and planning, information or co-operation.

In nuclear emergency, it is the task of the Nuclear Emergency Response Working Committee to provide the professional decision support. *Implementation of tasks related to the coordination of public radiation protection on the national level are performed by the central organ of the professional disaster management organization.*

Within the nuclear installation, the person responsible for implementing tasks related to the response to a nuclear emergency is the chief executive of the installation; at national level it is the chairperson of the Disaster Management Co-ordination Inter-ministerial Committee (hereinafter referred to as GCC); while in in the counties and in the capital it is the chairperson of the regionally competent County (Capital) Defence Committee.

The chairperson of the County (Capital) Defence Committee is the government's commissioner, his/her deputy is, as far as response to disasters is concerned, the manager of the regional office of the professional disaster management organization.

A National Radiation Monitoring and Warning System (hereinafter referred to as NRMWS) system - responsible among others for monitoring the radiation situation in Hungary - operates to provide the information required for the decision support and decision making activities of the GCC.

The central body of the NRMWS is the Nuclear Emergency Information and Evaluation Centre working at the Directorate General for National Disaster Management of the Ministry of Interior. The tasks of the NRMWS include the continuous monitoring, warning and verification of the national radiation situation, as well as supporting warnings and notifications according to the operating status of the

NERS by maintaining the early notification conditions of the national nuclear emergency response.

In a nuclear emergency, it is the task of the HAEA to evaluate the nuclear safety and radiation conditions. *Data and information for evaluation are provided* by the Centre for Emergency Response, Training and Analysis (CERTA) operating within the organization of the HAEA and the Nuclear Emergency Information and Evaluation Centre operated by the National Directorate General for Disaster Management. Early detection tasks on the basis of monitoring of the national radiological conditions are fulfilled by the National Directorate General for Disaster Management. The nuclear emergency response related Real-time, On-line, Decision Support System – RODOS also operates there, *as well as the Hungarian Centre for the European Radiological Data Exchange Platform (EURDEP).*

16.1.3 The National Nuclear Emergency Response Plan

The HAEA operates a High Level Working Group consisting of the state administration organizations concerned for the regular review of the National Nuclear Emergency Preparedness and Response Plan (hereinafter referred to as NNERP). The National Nuclear Emergency Preparedness and Response Plan is approved by the *Disaster Management Co-ordination Inter-ministerial Committee*.

The High Level Working Group revised the NNERP again by the end of 2015 and renewed the NNERP taking into consideration the legislative changes. In order to provide more detailed technical regulation and guidance containing good practices, guidelines and expert aids pertaining to certain chapters and annex of the plan were published. The list of guidelines published to date is the following:

- Legal basis of the *NNERP;*
- *Emergency situations of domestic and foreign nuclear and radiological facilities;*
- Critical tasks of the National Nuclear Emergency Preparedness System;
- Evaluation of critical tasks of the National Nuclear Emergency Preparedness System
- Organized help in defence;
- Structure and operation of the National Radiation Monitoring, Control and Notification System;
- Accident monitoring strategy;
- Planning work of the organizations related to preparedness participating in the National Nuclear Emergency Preparedness System;
- *Communication between the organizations participating in the National Nuclear Emergency Response System;*
- Development and continuous maintenance of nuclear emergency response plans;
- Preparation, execution and evaluation of nuclear emergency exercises;

- Decision-making with reference to, introduction and implementation of urgent protective actions;
- Local management of radiological emergencies;
- Organization of treatment of radiation injured.

16.1.4 Nuclear emergency response system of the nuclear power plant

The emergency preparedness of the nuclear power plant is adapted to the National Nuclear Emergency Response System; its framework is laid down in the Comprehensive Emergency Response Plan.

One starting point to the preparation for emergency situations is the system of emergency classification, which is a pre-defined set of technological and radiation protection criteria, and which characterizes the severity of an emergency situation. The classification of an emergency situation entails the implementation of predefined measures. Classification enhances the uniform international and domestic understanding of severity and response to the impact of the emergency.

In emergency, the actions determined upon the declaration of the emergency class shall be introduced or shall be prepared for their introduction in zones designated by concentric circles around the installation. Among the planning zones, the smallest in radius (3 km) is the “precautionary action zone”, in which the measures shall be prepared for in advance and implemented without undue delay in emergency. This circle is surrounded by the next, “urgent protective action zone” (30 km) and then the largest one (300 km), the “zone of restriction of foodstuff consumption” is located. Concerning the latter two zones (to be more accurate the Hungarian parts of the 300 km), specific laws determine the intervention levels, taking account of which shall be provided for determining the protective actions to be introduced.

Evaluation of radiological conditions is supported by the on-line, real time computer *based dispersion* simulator of the NPP, which calculates the expected and averted doses by taking the environmental radiation and meteorological data into consideration, *even in case of simultaneous or delayed releases from more units.*

The 30 km urgent protective action zones of foreign nuclear power plants located near the country borders do not affect Hungary. Within the 300 km protective actions zone of food consumption restrictions, the same legally determined intervention levels shall be applied as for the similar planning zone of Paks Nuclear Power Plant.

16.1.5 Comprehensive Emergency Management Plan of Paks Nuclear Power Plant

The main document of emergency preparedness in the nuclear power plant is the Comprehensive Emergency Management Plan. The structure of the plan is modular; besides regulation of the general emergency operation it contains different modules for different types of emergencies, such as nuclear emergency, general disaster, fire and civil emergency. The plan contains organizational and technical measures aimed at the assessment, limitation and management of emergencies.

Based on the assessment of emergencies, it lays down the current emergency class, defines the procedure of emergency management and control, the composition and operation of the Emergency Response Organization of the nuclear power plant, and the emergency responsibilities of particular individuals. Emergency tasks and necessary tools and resources are specified in emergency response scenarios. An alerting system ensures the rapid activation of the Emergency Response Organization of the nuclear power plant.

The plan stipulates the order of internal and external alerts and communication and the method of operation and control of the necessary telecommunication devices. The protection of personnel, i.e. registering their whereabouts, arranging their rescue, dealing with the method of their protection and their decontamination, is regulated in detail. The plan also includes a list of materials and technical equipment used for emergency response. The detailed regulation of the prescribed tasks is contained in the modules and in the related procedures and implementation instructions of the plan. The plan also sets out regulations concerning the preparation, training, and exercises of the personnel.

The Comprehensive Emergency Management Plan is regularly revised and modified based on experience obtained in practice and according to changes introduced in domestic and international requirements.

16.1.6 National system of preparedness and exercises

On-site and off-site exercises, including national and international exercises, are organized regularly in accordance with long term and annual plans.

As a member state of the OECD Nuclear Energy Agency, Hungary regularly takes part in the INEX international nuclear emergency exercises. Similarly, Hungary is a regular participant of the CONVEX nuclear emergency response exercises organized by the IAEA and also participates in the exercises organized within the framework of the ECURIE system of the European Union.

According to the annual training and exercise plan approved by the Disaster Management Coordination Interministerial Committee the organs of the National Emergency Response System take part in the following type of exercises:

- *alerting exercises to test the readiness and availability of the contact points of the organization, and the availability of the staff;*
- *methodological exercises, when the NERS organization alone without the other participants is to solve and drill the emergency tasks based on a specific emergency scenario;*
- *full scope exercises to inspect the performance of the whole NERS;*

- *international communication tests initiated by the European Commission, the IAEA and other countries bases on bilateral relations.*

The individual organizations hold partial exercises independently of the central emergency management. The sectoral emergency response plans also set out the order of communication test to inspect the availability and reliability of the contact points.

The whole personnel of the nuclear facilities shall be prepared for the emergency tasks. The members of the facility emergency response organization are regularly trained for their specific tasks. The facility level exercises are carried out according to the annual training and exercise plan approved by the HAEA that is *derived from the long term training and exercise plan*. Types of exercises are grouped according to their objective (practicing or testing), participation (complex, management or partial) and to type of initiation (announced or unannounced). During the preparation of complex and management exercises, the nuclear facility communicates with the off-site emergency organizations to facilitate the cooperation.

The national and international nuclear emergency response exercises held in recent years demonstrated the adequacy of the laws governing the disaster management and national emergency response system developed within the modern state administration structure.

16.2 Communication to the public and neighbouring countries

16.2.1 System of public communication in a nuclear emergency; media relations

In emergency the alarm process is carried out with the help of the *disaster management system* and the public media. An acoustic alarm and information system is operated by the National Directorate General for Disaster Management in the 30 km radius of the nuclear power plant. 227 modern public alarm and information devices operate in 74 settlements. The acoustic heads have local uninterrupted power supply, thus they are still operable in case of short circuit. The high power sound emitters are applicable to broadcast voice besides siren signals. The system may be launched upon the order of the chairperson of the general assembly of the three counties concerned from the Protected Management Post of the plant, from the nuclear power plant management centre, from mobile equipment, *from central duty service of the National Directorate General for Disaster Management* and from the duty service of the Tolna county Disaster Management Directorate. In emergency, it is the duty of the national public media to provide appropriate information, but the nuclear power plant is also ready and prepared to issue press releases and to notify the public via the media, i.e. through local and nation-wide radio, television and the press, in agreement with the HAEA. As a means of providing rapid information, mayors of settlements located in the vicinity of Paks NPP and the authorities involved in the emergency response receive SMS notification as well on the related events of the nuclear power plant.

Supported by MVM Paks NPP Ltd, itself, municipalities located around the NPP have established the so-called Association for Social Control and Information. This organization ensures a more direct link between the nuclear power plant and the settlements involved, and it also serves for information and preparation of the public for emergency situations. It supplies regular information about emergency preparedness activities of Paks NPP based on links with national media.

Regarding emergencies occurring near the Hungarian borders, the central organizations of the national emergency response system, based on the information received from the partner authorities via the public media would inform the public about the emergency and the actions to be taken during the emergency.

In these days the social media has a growing role in informing the public, so the National Directorate General for Disaster Management of the Ministry of the Interior, together with its strategic partners, has developed a freely downloadable application for smart phones and tablets called Emergency Information Service (VÉSZ). By means of this system those having a smart phone can immediately be informed of actual emergency situations in a county or in the country, issued alert messages and alert signals around their place of residence, their destination or monitored road if travelling.

The user who has downloaded the application can set for himself/herself that from which part of Hungary he/she wants to obtain prompt notification to the device. He/she can designate the notification zone as adjusted to the place of residence, some counties, the vicinity of larger domestic lakes or as the whole country. The system is also able to monitor the actual position of the user via the GPS sensor of the mobile device, and to send the requested notifications to the smart device as adjusted to the position. It is able to display the notifications on a map.

Beyond the mobile application, both the National Directorate General for Disaster Management of the Ministry of the Interior and the HAEA maintain Facebook sites to inform a wide number of people. Visitors of social sites may have insights to the daily activities of the organizations, more and more people can learn about the activities meant to prevent or respond to emergencies or disasters and about the regulatory activities for the peaceful use of atomic energy.

16.2.2 International relations

International agreements

Hungary was among the first nations to sign the following multilateral conventions concluded in 1986:
- the Convention on early notification of a nuclear emergency;
- the Convention on assistance in the case of a nuclear accident or radiological emergency.

In order to prepare for the implementation of the convention on assistance in the case of a nuclear accident or radiological emergency the IAEA established the international Response Assistance Network (RANET) and the corresponding database, which contains the available assistance capabilities (such as field survey of contaminated area, appropriate treatment of radiation injuries, local professional support) of the member states.

The capabilities of the following parties are appeared in the database of the International Atomic Energy Agency: Hungarian Academy of Sciences Institute for Energy Research, Ministry of Foreign Affairs and Trade, HAEA, National Directorate General for Disaster Management, Hungarian Meteorological Service, National Research *Directorate* for Radiobiology and Radiohygiene, MVM Paks Nuclear Power Plant Ltd. Laboratory capabilities, measurement devices and radiation protection and nuclear expertise were offered for assistance by Hungary with the stipulation that the conditions for providing the actual assistance shall be specified by Hungary on a case-by-case manner.

Hungary, as a Member State to the Vienna Convention, signed the Joint Protocol relating to the Application of the Vienna Convention on Civil Liability for Nuclear Damage and the Paris Convention on Civil Nuclear Liability in 1990.

In 1991, Hungary agreed to utilize the International Nuclear Event Scale (INES), which was introduced by the IAEA.

From its beginning, Hungary is an active participant of the regional harmonization project related to emergency preparedness and response launched by the International Atomic Energy Agency. This project provided significant assistance to the revision and renewal of the National Nuclear Emergency Response Plan.

Hungary is member of the European Community Urgent Radiological Information Exchange (ECURIE) system, in the framework of which the accident country shall provide direct notification to the European Commission and the affected member states.

The European Commission awarded the RESPEC (Radiological Emergency Support Project for the European Commission) tender to the HAEA. In the project running *from April 1, 2007 till March 31, 2016* the HAEA Emergency Response Organisation shall provide technical support to the European Commission in nuclear or radiological emergencies affecting or threatening the European Union and during the emergency exercises serving the preparation for such situations. The support covers the registration and hand over of technical data of nuclear installations, analysis of the situation, evaluation of atmospheric dispersion of a release, the recommendations on the introduction of protective actions related to foodstuff restrictions and public information.

Bilateral inter-governmental agreements

Bilateral agreements have been concluded with the following countries in the areas of early notification, of information on mutual interest, and co-operation: Austria (1987); the Czech Republic (1991); Slovakia (1991); the Federal Republic of Germany (1991); Slovenia (1995); Romania (1997); Ukraine (1997); Croatia (2000) *and Republic of Serbia (2014)*.

International data exchange

Hungary pursues bi-lateral radiation data exchange with Austria, Croatia, Slovenia and Slovakia. Beyond that data is also forwarded to the European Radiological Data Exchange Platform (EURDEP). Data exchange is managed by the Nuclear Emergency Information and Evaluation Centre operated in the National Directorate General for Disaster Management.

Based upon the Austrian-Hungarian bilateral agreement, a piece of modern high-sensitivity radiation monitoring equipment is operating in Gerjen, in Tolna County. The station provides data every half hour to the Nuclear Emergency Information and Evaluation Centre of the National Directorate General for Disaster Management that is forwarded to the Austrian Federal Alarm Centre.

At the same time, the National Directorate General for Disaster Management also monitors the radiation data obtained from the 10 similar measuring stations of Austria and is provided with access to the national background monitoring data.

The planned extension of Mochovce Nuclear Power Plant in the territory of the Slovak Republic is in progress, which initiated further development of the radiological data exchange existing between the two countries in the following areas:

- *three radiological remote monitoring stations are to be installed and operated by the Hungarian disaster management organizations in Slovakian territory between Mochovce NPP and the Hungarian national border;*
- *mutual exchange of measurement data of aerosol measurement stations operated by the Austrian government within the territory of Hungary and Slovakia.*

Through the development of radiological data exchange Hungary and the Republic of Slovakia demonstrate their commitment to improve nuclear safety in a way that reinforces the confidence and safety perception of the public. The early detection capability of the radiological remote monitoring stations facilitates the credible and timely information of the public as well as alerting of them should it be necessary.

D. THE SAFETY OF INSTALLATIONS

17. Site selection

Nuclear Safety Convention, Article 17

Each Contracting Party shall take the appropriate steps to ensure that appropriate procedures are established and implemented:

(i) for evaluating all relevant site-related factors likely to affect the safety of a nuclear installation for its projected lifetime;

(ii) for evaluating the likely safety impact of a proposed nuclear installation on individuals, society and the environment;

(iii) for re-evaluating as necessary all relevant factors referred to in sub-paragraphs (i) and (ii) so as to ensure the continued safety acceptability of the nuclear installation;

(iv) for consulting Contracting Parties in the vicinity of a proposed nuclear installation insofar as they are likely to be affected by that installation and, upon request, providing the necessary information to such Contracting Parties in order to enable them to evaluate and make their own assessment of the likely safety impact on their own territory of the nuclear installation.

17.1. Site characteristics

17.1.1 Location and surroundings of the site

Paks NPP is situated about 115 km south of Budapest. The nuclear power plant is situated 5 km to the south of the town of Paks, 1 km to the west of the River Danube and 1.5 km to the east of National Main Road No. 6. Its geographical co-ordinates are 46°34'24" (northern latitude) and 18°54’53” (eastern longitude). The site is used exclusively for activities related to the generation of nuclear energy.

The technological components may be delivered to the power plant by road, rail or water.

Detailed evaluation of the site from meteorological, hydrological and geological aspects is included in Annex 3.

17.1.2 Public, external and human hazards

About 200 000 persons live in the 30 km vicinity of the nuclear power plant.

The region is mainly characterized by cultivated land. The only industrial installation in the vicinity of the plant is the Spent Fuel Interim Storage Facility. This facility is independent of the plant; it has own Safety Analysis Report and as the licensee of the interim storage facility, the Public Limited Company for Radioactive Waste Management holds the operating license.

There is no airport (neither civil nor military), there are no take-off or landing safety zones or military establishments either in the near or wider vicinity of the power plant. According to regulations related to airspace usage, flights are permitted to cross the area in a radar-controlled airspace only above an altitude of 2,400 m above sea-level; while flying is completely prohibited within a 3-km zone around the nuclear power plant. Based on conservative estimates the probability of heavy transport or military aircraft crashing and falling on the nuclear power plant onto the most sensitive area from safety point of view is under the regulated screening value ($1x10^{-7}$/year).

Analysis of road and waterway accidents during the transport of hazardous substances based on up-to-date statistics indicates that the probability of a release of hazardous substances that would reach the plant site and cause processes actually jeopardizing the safe shutdown of the units (e.g. poisoning or explosion) is under the regulated screening level.

18. Design and construction

Nuclear Safety Convention, Article 18

Each Contracting Party shall take the appropriate steps to ensure that:

(i) the design and construction of a nuclear installation provides for several reliable levels and methods of protection (defence in depth) against the release of radioactive materials, with a view to preventing the occurrence of accidents and to mitigating their radiological consequences should they occur;

(ii) the technologies incorporated in the design and construction of a nuclear installation are proven by experience or qualified by testing or analysis;

(iii) the design of a nuclear installation allows for reliable, stable and easily manageable operation, with specific consideration of human factors and the man-machine interface.

18.1 Requirements concerning design and construction in the Hungarian system of regulations

Volume 3 of the Nuclear Safety Code issued as an appendix to Govt. Decree 118/2011. (VII.11.) Korm. contains general nuclear safety-related requirements concerning the design of nuclear power plants. The requirements lay down in detail the principles and rules well known from international practice. The requirements reflect the most recent nuclear safety standards and stipulate in detail the principles being commensurate with the international practice.

18.1.1 Application of defence-in-depth

The above regulation requires that the defence-in-depth principle shall apply to each safety related activity in such a way that any failure can be compensated for or corrected, and the occurrence of a severe accident situation can be prevented.

In addition, such specific supplementary systems, structures or components shall be provided for the protection of the public and the operating staff that are designed to mitigate the consequences of beyond design basis events and accidents.

18.1.2 Application of proven and verified technologies

Equipment based on proven and verified technologies shall be available for the following functions:

- shut down the reactor safely and to maintain it in a safe shutdown condition in each operating state;
- removal of residual heat after reactor shutdown;
- reduction of release of radioactive materials and meeting of regulatory release limits.

The classified safety systems, structures and components shall meet the strictest applicable manufacturing, structural, inspection, maintenance and operational standards.

New design constructions are only acceptable for use provided that they are based on adequate research and development efforts. Before commissioning and during the service, all constructions shall be tested, paying special attention to new characteristics.

The scope of those safety-related systems, structures and components shall be determined which shall be designed to be inherently safe and/or as far as possible insensitive to any human error. The potential failure modes shall be identified, in support of which acknowledged probability analysis methods should be applied, where appropriate.

18.1.3 Reliable, stable and easily manageable operation

In order to achieve a reliable, stable and easily manageable operation, the nuclear power plant regulations lay down, among others, the following principles in the fields of instrumentation, informatics and control engineering:

- Control and measuring instrumentation shall be installed in order to control safety parameters, systems, structures and components during normal operation, anticipated operational events, and design basis incidents.
- An adequate communication system shall be established between different locations.
- The monitoring of operational parameters (important to safety and indicative of the condition of the plant) shall be ensured. Systems shall ensure the automatic registration and archiving of measurement data and instructions given to certain systems and components.
- Adequate control and regulating instruments shall be utilized in order to maintain the operational parameters, systems and components within the prescribed operational range.

Moreover, the regulations require the establishment of a unit control room, a back-up control room, and an emergency control room, and they also specify requirements to be considered for their construction.

18.2 Fulfilment of requirements at the Paks Nuclear Power Plant

The design of units of Paks NPP was completed in two phases and was based on Soviet standards. When preparing the design bases, a strictly conservative engineering practice was used.

Paks NPP was designed in such a manner that during normal operation and in case of anticipated operational occurrences, the first three physical protective barriers (fuel pellets, fuel cladding and pressure boundary of the cooling circuit) must not be breached (thus the fourth barrier i.e. the containment inhibiting the release of radioactive substances had no function here). During those design basis incidents that were used for the design of the nuclear power plant, with a low probability of occurrence, the fuel matrix shall not be damaged or melted. However, to a certain extent the cladding of the fuel elements and the tightness of the primary circuit may be damaged, thus the containment function becomes necessary. The nuclear power plant was designed in such a way that as a consequence of design basis incidents the amount of radioactive substances released into the environment and the radiation dose of workers may not exceed corresponding health limits. Management of incidents and accidents that are more severe than design basis incidents but the probability of which are very low was not directly taken into account among the design principles of the units.

Elements of the defence-in-depth principle were accomplished in the nuclear power plant according to the requirements of Soviet standards.

Based on the experience gained from deterministic incident analyses, probabilistic safety analyses (level 1 and 2), severe accident analyses and on the summarized evaluation of all results, recommendations were made for safety improvement modifications and further complex analyses *(See details in Section 14.2.)*.

As a consequence of the implemented measures, the safety of the units was further increased; this is clearly revealed by the core damage probability data in Chapter 6.1.3 and figure 6.1.3. According to the regulatory requirements the extension of the service lifetime of units is possible only if all planned safety improvement measures are completed, including the measures and modifications designed for management of potential severe accidents. *The required safety improvement actions and the actions designed for severe accident management were accomplished in all units of Paks Nuclear Power Plant in 2014.*

19. Operation

Nuclear Safety Convention, Article 19

Each Contracting Party shall take the appropriate steps to ensure that:

(i) the initial authorization to operate a nuclear installation is based upon an appropriate safety analysis and a commissioning programme demonstrating that the installation, as constructed, is consistent with design and safety requirements;

(ii) operational limits and conditions derived from the safety analysis, tests and operational experience are defined and revised as necessary for identifying safe boundaries for operation;

(iii) operation, maintenance, inspection and testing of a nuclear installation are conducted in accordance with approved procedures;

(iv) procedures are established for responding to anticipated operational occurrences and to accidents;

(v) necessary engineering and technical support in all safety-related fields is available throughout the lifetime of a nuclear installation;

(vi) incidents significant to safety are reported in a timely manner by the holder of the relevant licence to the regulatory body;

(vii) programmes to collect and analyze operating experience are established, the results obtained and the conclusions drawn are acted upon and that existing mechanisms are used to share important experience with international bodies and with other operating organizations and regulatory bodies;

(viii) the generation of radioactive waste resulting from the operation of a nuclear installation is kept to the minimum practicable for the process concerned, both in activity and in volume, and any necessary treatment and storage of spent fuel and waste directly related to the operation and on the same site as that of the nuclear installation take into consideration conditioning and disposal.

19.1 Safety analyses

When the Paks NPP was established and commissioned, Hungarian practices followed those accepted in developed countries. Based on the Technical Design provided by the supplier, a Pre-construction Safety Analysis Report was prepared, which was followed by the Pre-commissioning Safety Analysis Report that was aimed at providing the basis for the Final Safety Analysis Report.

As time passed gradually more deficiencies were revealed in the Safety Analysis Reports when compared to Western requirements. For this reason, the safety of the nuclear power plant needed to be re-evaluated in the framework of the AGNES project in 1992 to reassess the safety of Paks NPP to bring it in line with standards of the 1990's. The AGNES project brought reassuring results, it did not reveal any major deficiency. Analyses of the first PSR performed for the units were based on the above results of the AGNES project with the addition of some other elements.

In the framework of PHARE projects, with the support of the European Union, in 2003 testing of the applicability of the accident localization system (confinement, bubble condensers) of the VVER-440/213 type units came to an end. The confinement used at the VVER-440/213 reactors of Paks NPP was proved by the complex assessments to be adequate for design objectives; in other words, when a design basis incident takes place the environmental release can be managed within the regulatory limits.

Within the framework of the continuously developed and extended level-1 probabilistic safety analyses (PSA), probabilistic safety analysis concerning events of technological origin for full power and shutdown states, and also those concerning internal flooding, fire, high energy pipe ruptures and events of seismic origin have been completed. The value of core-damage frequency was calculated and sensitivity and uncertainty analyses were performed. All probable external effects jeopardizing safety were assessed.

Probabilistic safety assessments of external hazards have been completed. According to the results of Level 1 PSA the frequency of core damage, taking into consideration all operating states further taking account of the internal and external hazard factors and earthquakes, is under 10^{-4}/year which is the limit specified for operational units *(See Figure 6.1.3.)*.

In order to determine the risk of a large radioactive release, a Level 2 PSA containing all formerly analyzed operational states and initiating events was elaborated. In the framework of this analysis the load bearing capacity of the containment was determined for internal pressures occurring during severe accidents and significantly exceeding the design pressure.

Incident analyses were made for the full scope of the design basis. The documentation of the PSR described the accepted methodology of analyses and also presented the results of the analyses that had been performed. The list of applied initiating events includes all events considered to be globally important plus the cases characteristic for VVER reactors. The most sophisticated and up to date computer programs were used for analyses.

All accident analyses were repeated at first to substantiate the elevated thermal power of the units, and then again to justify the acceptability of application of modernized fuel containing burn-up poisons.

Based on the analysis of basic accident scenarios performed within the framework of severe accident analyses, conclusions were drawn about processes inside the reactor and phenomena inside the containment, including the dispersion of radioactive materials. Based on the analyses the new accident management *strategy and the scope of modifications necessary to implement were determined. The Severe Accident Management Guidelines containing the new accident management strategy were introduced in Unit 1-4 and the modifications necessary for the prevention, management of accidents and for consequence mitigation have also been implemented (see more details in Section 14.3.).*

In compliance with the latest international recommendations and the requirements of the European Union, the analyses of incidents in the extended design basis and demonstration of the compliance with the respective criteria have taken place, as well as the safety analysis of external hazard factors was achieved.

The Final Safety Analysis Report shall be updated in line with the regulatory requirements. It is a living document, which follows and analyses the safety impact of different measures and modifications and evaluates safety performance according to international practice.

MVM Paks Nuclear Power Plant Ltd. reviewed the Final Safety Analysis Report in 2004. The aim of the work was to prepare such an advanced basic document which would serve as the basis for the licensing process for extending the lifetime of Paks Nuclear Power Plant. Extension of time limited ageing analyses required for supporting the extension of design lifetime is completed, while the renewed ageing management programmes have been started.

The plant regularly updates the Final Safety Analysis Report. The last version was sent to the HAEA at the end of 2015.

19.2 Operational conditions and limits

As the key element of the operating documentation the Technical Specifications contains the operational limits and conditions of safe operation of Paks Nuclear Power Plant.

The operator shall maintain the document in up-to-date condition. Technical modifications of the plant, implementation of safety improvement measures, and technical modernization and scientific development may be introduced after regulatory approval.

19.3 Documents regulating operation

The quality management system of MVM Paks Nuclear Power Plant Ltd encompasses the regulations (codes, procedures), instructions (maintenance, handling, operation, inspection etc. instructions) relating to the processes necessary for operating the units, and the respective forms and records. The scope of regulating documents covers procedures to be followed during both normal, accident and emergency situations.

The procedures include activity level regulations or, if it is justified due to the complexity or safety impact of the given activity or it is stipulated by an individual requirement, it may be regulated at instruction level corresponding directly to the activity within the specific process.

The valid version of each element of the regulation system is available in printed form for those participating directly in operation, and it is also downloadable from the Intranet of the company. Information for the contractors should be provided as specified by the contracts. Process of entering into force, review, holding time and of withdrawal is regulated.

19.4 Emergency operating procedures

The plant began the development of the system of symptom-based operating procedures in 1996, the completed procedures were introduced in 2003 after validation on the plant simulator and after full training of the personnel.

Subsequent to the introduction of symptom-based operating procedures for power operation it is the objective of Paks Nuclear Power Plant to create such system of procedures that are built on each other and by the application of which the personnel can handle every operational incident and severe accident.

In order to achieve the above objective the whole system that had been introduced in 2003 was reviewed by the end of 2009. Accordingly, the shutdown symptom-based operating procedures for the non-power operation states and for the incidents of the spent fuel pool as well as the severe accident guidelines were completed.

The procedures for non-power states were introduced in 2011 for all units. The introduction of severe accident management guidelines, unit-by-unit, was accomplished during the years *2011-2014* in accordance with the plans, following the implementation of the related technical modifications.

19.5 Technical support

19.5.1 Maintenance

The maintenance organization of the nuclear power plant is divided into professions (mechanical engineering, electrical and civil engineering) but each operates according to unified principles.

The system and implementation of maintenance and refuelling outages in details is described in Annex 4.

19.5.2 Technical background

<u>Technical and preparatory bodies</u>

In the present organizational system of Paks NPP, technical support is basically divided according to professions. The safety function and responsibility of technical support is ensured through the following items:

- System analysis, condition monitoring, establishment and execution of technical tasks for safe and economical operation of the nuclear power plant based on the assessment of operational and maintenance events.
- Provisions ensuring that the units meet the actual technical and safety requirements by utilizing international nuclear energy industry results.
- Technical justification, planning and execution of safety improvement measures, modifications and investments.
- Condition monitoring, trend analysis, ageing management and lifetime management tasks in the technical engineering, electrical, instrumentation and control engineering, architecture and chemical engineering areas, and execution of tasks and assessments serving for preserving the qualified state of equipment.
- Execution of technical and closely related safety and economical calculations, analyses and reviews.
- Technical design, preparation of technical applications to the HAEA, maintenance of respective technical documentation.
- Preparation for archiving of technical documentation, and delivery of archive material to storage.
- Justification and preparation of technical developments (e.g. technical optimization, technical changes, increase of efficiency, decommissioning).
- Investment optimization using value analysis methodology
- Preparation and licensing of operation beyond design lifetime, as a primary strategic objective of the company, company-level management and coordination of associated tasks.
- Operation of the company technical documentation system, technical documentation management, operation of document archives.
- Provision of key-data management activity for technical databases.

- Maintenance-technological justification, preparation, planning, licensing of maintenance and repair works, provision of their documentation, elaboration and licensing of maintenance, repair, assembly technologies and programmes.
- Work scheduling of planned preventive and periodic maintenance and repair activities.
- Recording, evaluation and feedback of maintenance experience, design and licensing of execution plans needed for maintenance, repair and trouble-shooting work.
- Development of medium- and long-term fuel consumption strategies.
- Planning of nuclear fuelling, fuel supply, stocking, and coordination of associated tasks. Supervision of safe operation of fuel.
- Development of medium, long-term and annual maintenance programmes of the company.
- Updating the cyclic maintenance plan of plant equipment.
- Draw up of company-level development and investment programme.

The technical background for performing the tasks above is available in each area of operation and construction relevant from safety of the nuclear facility. Accident situations are to be managed by the Emergency Response Organization that has the necessary technical resources. The technical means are available in the property of the company to manage the design basis incidents, severe accidents and the situations identified during the TSR.

Technical support for other activities is available from the technical support organizations, e.g. the Hungarian Academy of Sciences Centre for Energy Research, NUBIKI, VEIKI Energia+.

<u>Decision support committees</u>

Permanent or ad hoc committees may be set up to make recommendations concerning emerging tasks. The tasks and operation of such committees are specified by the entity establishing them. The most important committees are the Technical Forum and the Maintenance Working Committee.

<u>Domestic and foreign support organisations</u>

The MVM Paks Nuclear Power Plant Ltd maintains close relations with all Hungarian companies performing technical support for the plant. The MVM Paks Nuclear Power Plant Ltd maintains relations with those foreign companies (or their successors) that have contributed to the design and construction of the plant or in the manufacturing of its equipment, e.g. TVEL, ATEP, Skoda and Hidropress.

Close relations are maintained with foreign companies with considerable experience in nuclear industry. Some significant companies with which the MVM Paks Nuclear

Power Plant Ltd maintains working relation: *Westinghouse, EdF, Nuclear Electric, Rosenergoatom.*

Based on contracts currently in force, the general design services are provided by MVM ERBE ENERGETIKA Engineering Ltd; while principal consultants are jointly the Hungarian Academy of Sciences Institute for Energy Research and NUBIKI Nuclear Safety Research Institute.

19.6 Reports to the HAEA

According to requirements concerning the Licensee's reporting obligation, two categories are to be distinguished:

19.6.1 Regular reports

- quarterly report: notifying the HAEA of the operational history, current issues of operation and most important factors affecting operation;
- annual report: based on the quarterly reports, but upon the more information being available due to longer periods of time elapsed, a more comprehensive description, evaluation and analysis is available;
- annual safety report: the final safety analysis report should be updated by the Licensee according to the changes relating to nuclear safety taken place in the installation;
- quarterly and annual reports on activities related to maintenance effectiveness monitoring: performance monitoring of systems and components fulfilling active functions, evaluation of their reliability and inoperability;
- report on activities related to maintenance effectiveness monitoring;
- reports on refuelling outage and repair activities: concerning repair activities affecting safety and refuelling outage accompanied by refuelling;
- other information: providing the HAEA with up-to-date information.

19.6.2 Event reports

- Events under the obligation of immediate reporting are required to be notified of within two hours following their occurrence; the INES classification of all events subject to reporting shall be performed, and the provisional rating shall be submitted to the HAEA within 16 hours following the occurrence;
- all occurrences subject to reporting are to be submitted to the HAEA also in writing within 24 hours of their occurrence;

- an event-investigation report should be submitted to the HAEA within 30 days of the occurrence of any event.

19.7 Feedback

19.7.1 Own operating experience

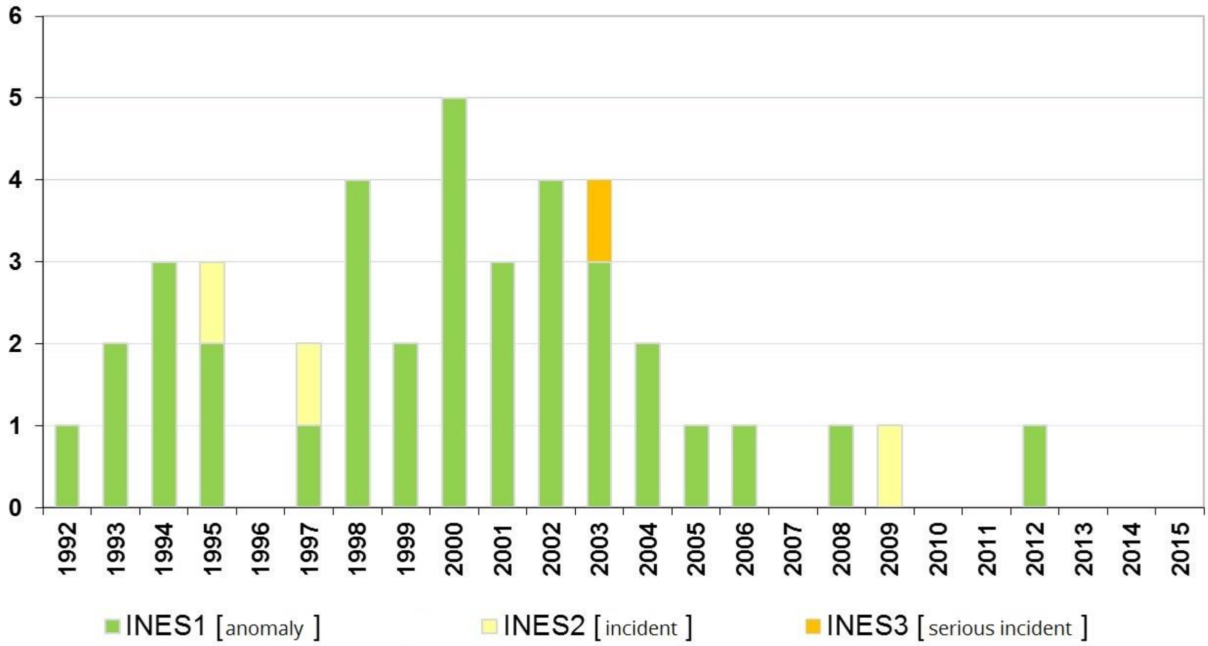
Data acquisition and processing became profession-specific as far as equipment and activities are concerned within the mechanical, instrumentation and control and electric engineering areas. As a result of this, monitoring and the utilization of data received also differ in depth and complexity. A joint database from different areas has been developed in order to ensure a uniform system of data acquisition and processing.

Analysis of reliability and availability indicators should be the basis of replacement, modernization or modification of components or equipment. These data are used in safety analyses as well. The power plant shows good indicators regarding safety systems even by international comparison. In order to achieve a unified and uniform system of data acquisition within the power plant, a plant-level regulation framework has been prepared.

Safety-related events occurring at the nuclear power plant are investigated with the involvement of the concerned technical staff. Events are investigated at different levels, which are intrinsically determined by the severity of the event. Events reported to the HAEA are investigated at plant level, while other events are investigated at area level. From 1992 onwards, events are classified according to the INES scale introduced by the IAEA, and previous events were also classified retrospectively. Since 2000, several events have also been analysed by probabilistic methods.

During the period of 1992-2015 the safety related events that occurred at Paks Nuclear Power Plant were classified to INES as seen in figure 19.7.1. No INES-1 or higher event took place in the subject reporting period.

__Figure 19.7.1:__ Number of INES 1, 2 and 3 events from 1992



The results of investigations and the corrective measures are widely presented. Responsible personnel and deadlines related to corrective measures are always defined and as such are always traceable. Not only single events but also trends are monitored, including the reliability of safety systems. Should any trends be revealed, modifications or other technical or administrative measures are carried out if needed. Experience gained from every event is used for educational purposes via simulator training. The permanent and regular revision of operating instructions and the Technical Specifications offers evidence of the feedback of operating experience.

Once every quarter, the Operation Control Committee reviews the safety indicators, the lessons learned from event investigations, and the status of accomplishment of all measures taken. The Operation Control Committee is an organization operated by the Safety Directorate; it places disputed issues on the agenda for consideration. The head of the Safety Directorate has the right of decision in this forum.

19.7.2 Feedback of experience of other power plants

It is of vital interest to Paks NPP to learn and make use of operating and other experience imparted by other installations and international information sources. MVM Paks Nuclear Power Plant Ltd takes part in the work of significant international nuclear organizations (e.g. International Atomic Energy Agency, OECD Nuclear Energy Agency). Closer co-operation exists by way of participating in the professional work of various groups comprising operators of nuclear power plants, such as the World Association of Nuclear Operators (WANO) and the Club of VVER-440 Operators. The closest cooperation may take place between the partner plants. Links such as these enable many kinds of mutually advantageous occasional or long-term activities to be identified, including joint projects, exchange of experiences, and data supply.

19.7.3 Reviews by external entities

The following table shows international reviews that were carried out at Paks Nuclear Power Plant.

Table 19.7.3. International safety reviews carried out at Paks Nuclear Power Plant

Year	Subject of the review	Review performed by
1984-1987 annually	Operation, maintenance	Experts invited by the Soviet supplier
1988	OSART (full scope)	IAEA
1990	Operation, maintenance	Experts from 4 countries invited by the power plant
1991	Design for safety	IVO
1991	Post-OSART review	IAEA
1992	1st Peer Review	WANO
1992	ASSET	IAEA
1993-1996	Site seismicity - 6 occasions; seismic safety programme – 2 occasions	IAEA
1995	Post-ASSET review	IAEA
1995	1st Peer Review follow-up	WANO
1996	Assessment of the accomplishment of safety improvement measures	IAEA
1997	Nuclear Liability Insurance Engineering Inspection	International experts of the insurance pool
1997	Quality assurance audit	Blayais Nuclear Power Plant
1999	PSA analysis of low power states (IPERS) (VEIKI-Paks NPP joint studies)	IAEA
2000	Pre-OSART mission	IAEA, Paks NPP
2001	OSART mission	IAEA
2001	Nuclear Liability Insurance Engineering Inspection	International experts of the insurance pool
2003	Review of Unit 2 event	IAEA
2003	Review of Unit 2 event	WANO
2003	Expert mission concerning the development of organizational operation	IAEA
2004	Expert mission on organizational development	IAEA
2004	Follow-up mission of the serious incident that took place at Unit 2	WANO

2005	Follow-up missions of OSART and expert missions	IAEA
2005	2nd Peer review	WANO
2008	2nd Follow-up of peer review	WANO
2012	3rd Peer Review	WANO
2014	*3rd Follow-up of peer review*	*WANO*
2014	*OSART mission*	*IAEA*
2014	*Corporate level peer review*	*WANO*

In 2014 there were two international reviews to assess the safety performance of the nuclear power plant. The follow-up of the 3rd WANO peer review took place in February 2014, while the OSART mission was conducted at the end of November and beginning of October.

The WANO follow-up review, out of the 18 part areas suggested to further develop, found in six cases an appropriate improvement of the performance, while in 12 cases identified improvement by acknowledging that the plant had taken steps towards the elimination by determining the improvement actions.

The OSART mission visited the plant only eight months after the WANO follow-up review. The mission identified 24 areas to improve and 6 good practices. Among the issues identified by the mission the areas designated as improving but not fully resolved by the WANO follow-up mission also appeared.

It also worth mentioning that at the end of November the WANO held a corporate level peer-review at the MVM Hungarian Electricity Ltd (the holding that Paks NPP belongs to), part of which also took place in the plant. In the focus of the review was the interface between the corporate level and the nuclear power plant and concentrating on seven areas it sought the answer if the mother company effectively provides the conditions for nuclear safety and efficient operation of the nuclear power plant.

In conclusion it can be established that all of the safety reviews were terminated with positive general evaluation, however the experts gave several recommendations based on the international experience to further improve the safety performance. Implementation of action plans developed for the resolution of the issues plays a major role in increasing the level of safety.

As part of its post-Fukushima renewing process the WANO performs peer reviews every four years at its members. Taking into account also the follow-up reviews the plant receives international reviews at least every two years.

19.8 Radioactive wastes

On September 29, 1997 Hungary signed the Joint Convention established under the auspices of the IAEA on the safety spent fuel and the safety of radioactive waste management, which was promulgated by Act LXXVI of 2001. A detailed discussion of the issues related to radioactive wastes and spent fuels can be found in the report submitted within the framework of the Convention; below only the most important characteristics are cited.

The classification of radioactive wastes takes place in accordance with Decree 47/2003. (VIII. 8.) ESZCSM of the minister responsible for health on certain issues of interim storage and final repository of radioactive wastes and radiation health issues of naturally occurring radioactive materials concentrating during industrial activities.

The safe management of radioactive wastes of the nuclear power plant is the responsibility of the entity generating the waste, i.e. MVM Paks Nuclear Power Plant Ltd. The collection, processing and interim storage of wastes is part of the operating tasks; *preparations for safe final disposal of long-lived, high activity wastes are being made according to the Parliament Resolution on the national policy on spent fuel and radioactive waste and the national programme meant to govern its implementation, both developed in line with the Council Directive 2011/70/Euratom of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste.*

According to the Act on Atomic Energy and its implementing decrees the responsible organization for final disposal of radioactive wastes and for interim storage and final disposal of spent fuel, closing of the nuclear fuel cycle together with the de-commissioning of nuclear facilities is the Public Limited Company for Radioactive Waste Management. Legally, waste generating entities are obliged to create financial resources for waste disposal and decommissioning by payments into the Central Nuclear Financial Fund. This Fund also serves to cover the activities aimed at the final disposal of radioactive wastes, namely preparatory works and assessments. The administrator of the Central Nuclear *Financial Fund is the minister (currently the minister of national development) designated by the Prime Minister to oversee the atomic energy oversight organization (HAEA).*

Activities aimed at supporting the final disposal of low and medium level radioactive waste from the nuclear power plant

From 1983 to 1997 low level solid wastes generated by the nuclear power plant were transported to the Radioactive Waste Treatment and Disposal Facility located at Püspökszilágy (30 km away from Budapest). Since 1997, solid radioactive wastes from the power plant have not been transported to the above-mentioned site. *By end of 2004 the original capacity of the storage facility had been exhausted. Based on the safety analysis performed in 2002 a comprehensive safety improvement programme was launched to improve the long term safety and to provide the appropriate post-closure safety of the facility. In the framework of that the waste packages placed in the storage vaults in the past are to be lifted and sorted. Except for the long lived wastes, which are stored in an interim storage area constructed within the operation building, the repacked wastes will be placed back to the final storage vaults. By the implementation of the programme, beyond safety improvement, an extra capacity* *sufficient for further decades will be released in the final storage vaults, making it possible to receive additional radioactive wastes of non-nuclear power plant origin.*

The demonstration part of the safety improvement programme was successfully completed in 2010, during which removal, selection, processing and re-disposal of the wastes of 4 storage pools took place. Based upon the experience, the detailed plan of continuation of the safety improvement programme was developed. *In 2015, the investment related to the physical protection system modernization and renewal of the laboratory building launched in 2013 were also completed.*

Relying on the results of surveys and safety analyses of several years to select the subsurface repository site for low and medium level radioactive wastes of nuclear power plant origin, the vicinity of Bátaapáti was selected. Based on the resolution in principle of the Parliament and the positive result of the local referendum the establishment of the Radioactive Waste Treatment and Disposal Facility commenced in 2006.

In the first phase of the establishment, by the autumn of 2008, the most important surface facilities of the Radioactive Waste Treatment and Disposal Facility were completed, and the commissioning license was granted by the competent authority on September 25, 2008.

The tunnels surrounding the underground repository chambers were completed by the beginning of 2010. Construction work of the surface of the tunnels was finished during 2011 and the first two chambers became ready to accept the waste (*I-K1, I-K2*) in a depth of 200-250m. The competent authority *of that time* granted the operation license for the surface facility and the first chamber *(I-K1)* of the NRWR, which came into force on September 21, 2012. The first reinforced concrete container containing 9 waste barrels was placed in the facility in December, 2012. *By December 31, 2015 altogether 6280 barrels were transported to the NRWR, out of which 2221 barrels are stored in the technology building, while the rest 4059 barrels (451 containers) were finally disposed in the I-K1 chamber.*

In parallel to put into operation of the first disposal chamber, preparation for further construction of the NRWR also started, and with the participation of experts from the Paks Nuclear Power Plant Ltd an optimization of the disposal system to more effectively use the place of the disposal chambers also started. According to the conception above the construction of two additional storage vaults having large segment size (i.e. I-K3 and I-K4) was completed in 2015.

Preparatory work for the final disposal of high level radioactive waste

The Boda aleurolit formation in the Western Mecsek Mountains seems to be potentially suitable for the disposal of long lived radioactive wastes of high activity level and the spent fuel assemblies (not regarded as radioactive waste according to the present regulation) generated in Hungarian nuclear facilities.

A research programme aiming at the site selection for high level radioactive waste started in 2003. The implementation, however, slowed down in 2005 having given priority to the construction of the NRWR for low and medium level radioactive wastes. In 2010, by way of the completion of a final report, the first part of the surface research was completed, although with a reduced scope as compared to the original plans.

After the professional and methodological review of the results obtained to date, the geological research plan for the next part of surface research lasting till 2017 was developed in 2012, which was approved by the competent authority in May, 2013. In 2014, in addition to the continuous operation of the environmental and geodynamics monitoring system of the impact area, two deep survey holes (474.6 m and 913.6 m) were bored, where the corresponding examinations were completed. In 2015 the construction of a new geological research pit started.

Amount of waste stored on December 31, 2015

The amount of low and medium level solid radioactive waste in the nuclear power plant is altogether 8,876 barrels of 200 litres.

The amount of liquid waste stored in the plant in the radioactive waste storage barrels is 8,051 m^3, which consists of evaporation residue, decontamination solution, ion exchanger resin and evaporator acidifying solution.

Up to December 31, 2015 48.1 m^3 of high level radioactive waste was generated altogether, the required disposal volume of which is 101.6 m^3.

20. Plans on safety improvement

As a consequence of the Fukushima nuclear accident on March 11, 2011, Paks Nuclear Power Plant carried out a TSR. The HAEA approved the report resulted from the reassessment and, at the end of 2012, required the Licensee to implement the safety improvement actions decided by the plant. The implementation of the safety improvement plan is to be completed until 2018. The safety improvement actions decided upon the Targeted Safety Reassessment makes the management of severe accidents affecting more units (or spent fuel pools) at the same time possible. (See in details in Annex 7). *The most important actions of the TSR that have not yet been completed are as follows:*

a) *purchase of high power accident diesel generators protected against beyond design basis external hazards;*
b) *implementation of containment overpressure protection occurring during severe accident;*

c) construction of alternate cooling of the spent fuel pools;
d) construction of a Protected Command Centre and a Backup Command Centre protected against beyond design basis external hazards.

ANNEX 1: DETAILED DESCRIPTION OF IN-SERVICE INSPECTIONS

Types of operational tests

The preparation, scheduling, performance, evaluation and documentation of tests and inspections performed regularly or in an ad hoc manner on systems, sub-systems and components of the nuclear power plant are regulated by the instruction of MVM Paks Nuclear Power Plant Ltd.

An inspection programme has to be implemented in order to demonstrate that the plant systems and components continuously, throughout the service life of the plant are capable to perform their intended functions according to their design. The inspection programme is realized by means of technology tests. The tests are performed at Paks Nuclear Power Plant on the basis of testing instructions. These can be unified, paper based instructions or electronic format instructions installed on the unit computer.

On the basis of the instruction, the processes and activities related to tests are regulated in the following classification:

- *in-service technological test – this is a function for testing systems in standby and readiness state of operation to check the main function of the equipment or systems while by the minimum possible power decrease and the lowest risk possible;*
- *unit shutdown technological test – checks of the operability of equipment and systems taking part in the shutdown, checks of system of conditions of change of operation mode during unit shutdown, and obtaining of information for maintenance work;*
- *refuelling outage technological test – check of the operability and function of the equipment and systems that are to be operated after the maintenance during the overhaul;*
- *unit start-up technological test – this is a full-scope test of the systems and equipment following the refuelling outage in the scope required for unit start-up by utilizing the opportunity provided by the operation mode to screen out the possibility of failures increased because of the maintenance, inspection works that entailed dismantling;*
- *non-scheduled technological test – this is a test of failed systems and equipment and their backups according to the prescriptions or checking of the main functions of the systems and equipment for any other reason by the lowest possible risk, according to the conditions of the Technical Specifications in such cases (e.g. post-maintenance, or when a deviation is detected during an inspection) when it is necessary.*

Scheduling of in-service tests

The in-service tests have to be scheduled considering the requirements of the Operational Conditions and Limits. Scheduling of the in-service tests takes place in two steps. The first step is the annual schedule; the second step is the weekly operative schedule. The schedule is prepared for the period of the refuelling outages, separately for each unit determined with the accuracy of shifts. Concerning systems consisting of redundant systems, components or sets the in-service tests of the particular systems, equipment are scheduled so that the tests are shifted to equal periods from each other. It is allowed to modify the time of execution of the tests determined in the schedule of the fuel cycle to be performed either earlier or later depending on the cycle time.

Evaluation of in-service tests

The records evaluating the tests are the basic documents for verifying acceptability. Evaluation is done by the organization responsible for the performance of the test. As a result of the evaluation the maintenance, reconstruction, quality management concepts and cycle times may be modified.

All records of operational technological tests have been kept by the power plant since 1992 and they have been processed carefully.

Over a period of time the in-service tests performed have verified the adequate availability of components, structures and systems and means of protection. *The supplementary measures due to any unsuccessful test are always carried out without delay according to the valid procedures.*

Tests related to refuelling outages

During refuelling outages three groups of tests are performed:

- before shutting down the unit, tests are scheduled to verify the systems necessary for shutdown and cooling down;
- during the refuelling outage of the unit, upon completion of the maintenance of safety systems, the adequacy of these are tested before handing over the next system for maintenance;
- after the refuelling outage of the unit, the systems necessary for start-up and operation of the unit are thoroughly tested.

Tests are scheduled depending on technological conditions. The sequence of tests and the conditions for establishing further operational states are regulated.

Among the above listed groups the one performed after the unit refuelling outage contains the most tests. These are the following:

- functional and interlock tests of individual components;
- tightness and pressure testing of systems;
- full logical and real functional testing of protection systems;
- hydraulic pressure test of the main cooling circuit and of steam generators, depending on cycle times;
- integral tightness test of the hermetic zone;
- criticality tests on the reactor, in order to verify the physical calculations;
- unit start up tests performed at different power levels.

The scope of tests to be performed after unplanned maintenance is decided after special consideration, when the nature of interventions and the time elapsed are already known.

Introduction of electronic testing instructions in relation to extension of service lifetime means a significant change in the system of tests. The essence of the method is that the testing process is supervised by the unit computer, thus information occurring during the test is recorded, and the subjectivity about measuring of valve running times is eliminated. The application of the method means important contribution also to the frequency test of rotating machines. Data of electronic testing instruction may be processed within the system of origin and can be uploaded to the central database where, as lifecycle data, may be analysed further. Data obtained from the system forms the basis of development for a symptom-based maintenance strategy.

System of requirements relating to material testing

In Paks NPP, the unified programme and criteria for periodic material testing were elaborated simultaneously with the commissioning of the units and on the basis of Soviet requirements and standards, pre-commissioning tests and international experience, and with the involvement of domestic research institutes.

These requirements were approved by the former National Energetics and Energy Safety Engineering Inspectorate, competent at that time, and any modification requires the permission of the HAEA. During the preparation for the service life extension of the units these documents were revised according to modern requirements. The documents are revised regularly and necessary changes are made.

The Nuclear Safety Code issued as Annex to Govt. Decree 118/2011. (VII. 11.) Korm. on the nuclear safety requirements for nuclear facilities and on the corresponding regulatory activities requires the in-service inspection of nuclear power plant components. It stipulates that the Licensee shall develop and implement a documented in-service inspection programme in relation to systems, structures and components important to nuclear safety to demonstrate the integrity of the aforementioned systems, structures and components and determine the actions necessary to maintain the safe conditions.

In-service inspections

The scope of in-service inspection is defined by material testing programmes, which specify the testing area, the method of testing, the scope and frequency of testing, reference to the corresponding item of the acceptance standards, technological conditions needed for the test, engineering safety requirements and the anticipated method of documentation for each component element or group of components. The full-scope periodic and non-destructive material testing of primary and secondary circuit equipment comprises the following units:

- reactor and its sealing units;
- upper chamber;
- reactor internals;
- main circulating pipeline;
- steam generators;
- pressurizer;
- hydro-accumulators;
- primary circuit components and piping;
- local sealing;
- secondary circuit components and piping;
- clamping structures;
- fuel containers.

The criteria for the evaluation of tests – relevant to all inspection methods and types – are contained in the volume entitled "General Methodology and Acceptance Standards for Non-Destructive Material Testing".

ANNEX 2: AGEING MANAGEMENT

Basic concepts of ageing management
The nuclear power plant meets the regulatory requirements related to ageing management, which enables the plant operator to create the safe conditions for operation of the plant even beyond the design lifetime (30 years). This concept is in accordance with

- international and domestic experience related to ageing and lifetime management;
- the aspects of nuclear safety;
- the continuous development of scientific and technical knowledge.

MVM Paks Nuclear Power Plant Ltd. conducts a systematic lifetime management activity for the components of safety classes 1-3, and for those 4, 4T that do not belong to safety class (hereinafter referred to as ABOS 1-3+) but whose failure may jeopardize the operation of components providing a safety function. According to the concept:

- The technical conditions of the required safety level for components fulfilling an active function is ensured by utilizing the maintenance effectiveness monitoring system;
- Environmental qualification is made for electrical and I&C components operating under harsh environments, and the qualified state is continuously maintained;
- Systematic ageing management is conducted for components fulfilling passive function: (1) individually for critical components, (2) in groups for other components (commodity groups).

The systematic ageing management in relation to components fulfilling passive function includes consists of:

- determination of postulated degradation mechanisms and ageing sensitive locations;
- application of measures mitigating and preventing ageing mechanisms;
- determination of parameters to be inspected for ageing monitoring;
- timely detection of ageing effects by operational and in-service condition testing (e.g. technical safety reviews, non-destructive material testing, operational tests.);
- monitoring of aged condition (ageing monitoring system), status evaluation;
- development of acceptance criteria used for status evaluation;
- development and implementation of corrective measures for non-compliances (e.g. repair, replacement, administrative measures);

- improvement of efficiency of component ageing management programme (feedback of condition information into the programme);
- possibility of administrative verification regarding ageing management (quality management, coordination, documentation);
- utilization of operational experience feedback.

These activities are performed in approx. 150 ageing management programmes, the technical aspects and contents of which are in compliance with the Hungarian requirements and, additionally with the international practice (NUREG 1801, International Atomic Energy Agency Safety Guide NS-G-2.12, *IAEA SRS 82 (IGALL)*).

Selection of critical components at ageing management

The components screened for ageing management were selected primarily during the review of equipment. These components play a prominent role in the cooling and safe shutdown of the reactor core, and of structures inhibiting the release of radioactive substances (principle of defence-in-depth). During the selection procedure, the document Technical Report Series 338 of the IAEA entitled "Methodology for the Management of Ageing of Nuclear Power Plant Components Important to Safety" together with the related Hungarian regulations in the Nuclear Safety Code issued as Annex to Govt. Decree 118/2011. (VII. 11.) Korm.

As a consequence of taking the above aspects into account the plant performs systematic ageing management with regard to passive components in safety classes *ABOS1-3+* (about 25,000 items/unit). The components covered by the ageing management programme belong to one of the following groups:
(1) Items listed in the Nuclear Safety Code as critical components. Ageing management of each of these components is performed individually.
(2) Components managed on system component group (commodity group) level. Several components aged similarly belong to the same group.

The set of critical components is the same, the items of which need long term lifetime management activity or the replacement of which would mean serious financial and technical challenge. The critical components are as follows:
- reactor pressure vessel *and its support structures*;
- reactor pressure vessel internals;
- nozzles of main circulating loop and the connected pipelines;
- pressurizer;
- steam generators;
- main gate valves;
- main circulating pumps.

The ageing management programme of each critical component contains the ageing management of its seismic reinforcement.

Regarding the other mechanical components and civil structures, the plant may decide if it performs ageing management in commodity groups or by way of an individual ageing management programme. Regarding electric instrumentation and control components operated in a harsh environment, the plant shall perform equipment qualification.

Procedures

The MVM Paks Nuclear Power Plant Ltd implements comprehensive ageing management as required by the Nuclear Safety Code. Examination of technical issues related to systems, structures and components, determination of ageing management related tasks, implementation of the comprehensive ageing management and operation of specific ageing management programmes are based on the procedures: "Process of comprehensive ageing management" and "Operation of ageing management programmes". The procedures specify and harmonize the tasks of the organizational units involved in the implementation of ageing management.

Current status of ageing management

Taking account of the differences the ageing management in the plant is carried out within the four areas: mechanical, electric, I&C and civil engineering. The systematic and coordinated activity is ensured by the respective procedures.

Component-specific ageing management programmes have been developed by the areas, based on which the implementation of the comprehensive ageing management is performed. Electric area is an exception, where ageing management of cables according to specific programmes are only the supplements of environmental qualification. During the development of specific ageing management programmes the formerly applied condition monitoring programmes and results had been used.

Results of ageing management are of major significance in the licensing process of lifetime extension in the determination of the technical and safety margins of important equipment and in the development and implementation of lifetime management strategy. Ageing management utilizes the domestic and international good practices and results. New, previously not known degradation processes may arise during the work, for the learning of which the targeted research and development might assist.

ANNEX 3: SITE EVALUATION OF PAKS NUCLEAR POWER PLANT

Meteorology

Based on the measurements performed at Paks, the annual mean temperature is slightly increasing. The length of extremely cold periods (25 °C below zero) spans a few days only. Experience shows that the nuclear power plant is able to prevent the freezing of components caused by such cold weather by taking temporary measures. It is often the Paks meteorological station that report the most intensive night cooling in the entire country, as the sandy soil of the region allows strong heat emission, thus the microclimatic layer cools down more easily on clear nights. No specific tendencies can be found regarding maximum temperatures.

Distribution of precipitation shows great variation, and this is obviously caused by the proximity of the River Danube.

The dominant wind direction is north-westerly though surveys have found that north-easterly winds are becoming more predominant during winter. No significant new trends have been found concerning wind speeds.

Other effects (e.g. hurricanes, extraordinary rain or snow) are so rare in the region that they were not even taken into account when the plant was designed. Protection against external natural hazards has been completed. The administrative and technical actions intended to manage the deficiencies have mostly been completed.

Since the installation of the nuclear power plant, weather conditions have proved to be rather capricious within the range of values characteristic for Hungary's climatic zone, but it cannot be shown that the plant has had any effect on the microclimate. For the time being, climatic changes have not affected the safe operation of the nuclear power plant.

Hydrology

In the vicinity of the site the only significant surface water is the River Danube, which is of slightly low-course nature here. The power plant is situated at 1,527 river km from the mouth of the Danube. The Danube is well regulated in the region.

The average yield of the river in the region is 2350 m^3/s, the water speed is 1m/s, the average height of the water is 88 m above Baltic Sea level.

The quantities of warmed cooling water released into the Danube from the nuclear power plant are as significant as the amounts of heat flows that determine the natural heat balance of the river, thus the natural river water may become heat polluted under unfavourable conditions. If all four units are in operation during autumn, some 10 to 11% of the total yield of the river has to be removed for cooling. The plume of hot water returned to the river completely mixes on its way to the border of the country (some 80 km), but no obvious temperature rise can be measured after the midway of this section. According to Decree 15/2001. (VI . 6.) KöM of the minister responsible for environment and the water use license issued jointly for the four units, the warming of the cooling water returned to the river may not exceed 11 °C, or 14 °C if the temperature of the water is below 4 °C. The cooling water temperature is continuously measured by the Licensee; the limit has never been exceeded. The maximum temperature of the hot water stream must not exceed 30 °C at a distance of 500 m from the point of entry. This parameter is randomly checked by the competent authority, the measured values have never exceeded the set limits. To date, the temperature of released water has never consistently reached these limit values.

By comparison with previous data, the water quality has improved. This can be explained by the fact that industrial and agricultural production have fallen back both in Hungary and in certain neighbouring countries where our river waters mostly originate.

Statistical analyses of floods with different probabilities of occurrence have assessed the differences between icy and ice-free conditions of high water levels. The flood level with a probability of 10^{-4}/year (0.01%) is 96.36 mB (above the Baltic Sea) as calculated for icy waters and 95.62 mB as calculated for ice-free waters. Floods usually begin at the 93.3 mB water-level, and the frequency of this does not even reach 1 day/year (0.18 day). The landfill level of the power plant site has been defined at 97.00 mB; this level is 40 cm higher than the formation level of the flood-control dike in the vicinity of the power plant, and 24 cm higher than the highest water-level calculated to occur once every 10,000 years.

Assessment by earth sciences

Geology, tectonics

Geological research has shown that there are three main groups of formations in the geological composition of the region: pleistocene-holocene surface sediments, neogene basin sediments, and the paleozoic-mezozoic basin basement.

Seismic-tectonic characteristics

The final evaluation of the seismicity of the site was elaborated with the help of experts of the IAEA and accepted by the HAEA. The value considered in original design was 6 on the MSK scale based on the catalogue of historical earthquakes in Hungary and on the isoseistic map that can be drawn from this. Seismicity is low in Hungary as a whole, even though stronger vibrations (with epicentre intensities of about 8 on the MSK scale) do occur, they are few in number. These are rather unevenly distributed regionally. Based on the frequency of seismic disturbances in the time period from the middle of the 19th century to the present day, a quake of intensity 4 on the MSK scale can be expected once a year while one of intensity 8 (MSK scale) may occur once every 40 to 50 years. Relations between known tectonic elements and available seismologic data can be shown only in certain cases. The focal depth of quakes in Hungary is usually 9 to 12 km, and the quakes are usually of the strike-slip nature.

The characteristics of an SL-2 earthquake (maximum horizontal acceleration, uniform hazard response spectra) were determined by calculation using probabilistic seismic hazard analysis based on a 10,000 year repetition rate. Calculation of free-field characteristics has taken into account the non-linear transmission of upper loose soil layers. Input for these calculations was taken from the results of the site geo-technical study programme. For maximum free field horizontal acceleration of an SL-2 earthquake a value of 0.25 g has been accepted.

On the seismic profiles taken at the site and its surroundings, several fault lines can be observed in the Pannon layer, which suggest movements 6 million years ago. Based on the data obtained it can be presumed that the fault lines generally follow the W-SW → E-NE direction, while a few of them follow the SW→NE direction. At the same time none of the profiles of the minimum 45,000 year old Quaternary upper layer had fault lines. Detailed geological and geophysical analyses performed at the site and its surroundings show that there is no obvious sign of a Quaternary fault. No Pannon structure can be related to measurable activity. No Quaternary faults can be found in the loess to the west of the site either. Deterministic analyses showed no faults reaching the surface. In spite of this, low-probability activity of structures within the Pannon layers around the Paks site was taken into consideration in the probabilistic risk analysis.

Joint evaluation of data of micro-seismic monitoring put into operation in 1995 and that from the recent neo-tectonical scientific results was performed in 1998. These studies justified that the assumptions taken as the basis for the evaluation of site seismicity and for analysis of the present activities were correct; there is no need for their revision. Microseismic monitoring is being continued by Paks Nuclear Power Plant Ltd and the results are annually published for scientific purposes.

Soil liquefaction

The basis for the assessment of soil liquefaction was a detailed geotechnical analysis of the site, following the recommendations of the IAEA (50-SG-S9). The upper soil layer (about 30 m) at the site is young river-water with sandy, gritty, loose sediment with a shear wave speed of 250 to 355 m/s. This covers the Pannon layer of around a minimum 500 m/s shear wave speed. The quality of the soil meets the requirements for foundations.

Further analysis of building settlement and soil liquefaction is in progress.

ANNEX 4: MAINTENANCE AND INSPECTIONS

The maintenance activity of the nuclear power plant aims at maintaining or returning the technological equipment in or into a state applicable to fulfil its function, to avoid, mitigate or eliminate the consequences of failures with through reasonable expenditure. The most important requirement during maintenance is nuclear safety. The key element of the maintenance system is that of being well planned with optimal realization of preventive maintenance and condition dependent maintenance. Certain components may operate until failure, this is also part of the maintenance strategy.

Refuelling outages consist of the following activities:

- technical-safety reviews implemented within the In-service Inspection Programme;
- periodic and individual maintenance works;
- inspections laid down by material testing frame programmes;
- work from regulatory requirements;
- repairing failures occurred during operation;
- safety improvement measures, modifications, reconstructions.

Periodic maintenance work performed on units in operation is accomplished on equipment with sufficient backup that can thus be handed over during the rated operation of the given unit. This reduces the work to be done at refuelling outages.

Regular maintenance circles serve as means of assessing the condition of operating equipment or those in stand-by mode. Maintenance or repair of equipment is scheduled on the basis of the potentially revealed deficiencies.

Preparation is a key element of maintenance, which is the task of the centralized technical organization. Such a task is, for example, the management of the activities of preventive maintenance programme in the work management system and compilation and updating of the documentation describing the operation history of the equipment.

Refuelling outage strategy

One of the most important factors affecting the availability of the power plant is the time required for refuelling outages. Recently, considerable efforts have been made to optimize or, if possible, decrease this time period.

The long-term strategy is aimed at implementing a series of measures that can reduce the time taken by refuelling outages to an optimal level both from the aspect of economic efficiency and the adequate use of the workforce.

A new element is the “interim refuelling outage” within that unit, where the inspection cycle has been changed to 8 years in relation to mechanical components of safety class 1.

- Short refuelling outage: works to be performed cyclically, and repair of spontaneous failures.
- Interim refuelling outage: fuel loading and unloading, barrel removal, internal inspections of main gate valves and valve revision that can be implemented at low reactor level.
- Long refuelling outage: fuel loading and unloading, inspection of reactor pressure vessel and vessel internals, internal inspections of main gate valves and valve revision that can be implemented at low reactor level, hydrostatic pressure test of steam generators (interim refuelling outage can be implemented if necessary).

The order of executing maintenance activities

The activities of maintenance, as a main process of the plant, are regulated under the production subsystem and the hierarchically subordinated process instructions and procedures. These documents include:

- the systems and components in question and their parts;
- maintenance related preparatory activities;
- the activities to be performed;
- documentation, evaluation and experience feedback of maintenance activities;
- materials used directly or indirectly during the activities.

Corresponding to maintenance, quality supervision activities are performed in accordance with regulating documents of main processes of inspection and industrial safety.

The system of requirements ensures that all activities corresponding to civil, electrical, instrumentation and control and mechanical engineering related maintenance of the power plant are of adequate quality. Several kinds of supervising methods and regulation guarantee were introduced at Paks NPP.

Compliance with quality requirements is inspected during maintenance supervision and quality control activities; in some cases HAEA staff also inspects the activities.

The basic documents of maintenance work are the work instructions, maintenance instructions and the corresponding quality control plan, technical decision sheet, along with the maintenance records, plans, technology descriptions and permits.

The procedure for the scheduling of refuelling outage and minor overhauls includes all tasks related to documentation and specifies the responsible personnel. The management body of the refuelling outage scheduling is the Maintenance Working Committee. Its work is regulated by conference rules. The implementation of the overhaul is determined by the overhaul authorization plan, the overhaul net diagram, and other directives in force.

Separate instructions regulate the planning and accomplishment of planned preventive and periodic maintenance work. The lowest level of maintenance regulation consists of several hundred equipment-specific maintenance technologies.

The method of involving external contractors in maintenance is also regulated in detail. External contractors are involved in order to accomplish individual tasks on the grounds of classical service contracts. The factors ensuring supervised work are: the contract, the authorization of the applied technology, the system of work instructions, the handing-over of the working area, and the obligatory inspection exercised by executives of the given professional area.

ANNEX 5: ACTIVITY AIMED AT EXTENDING PAKS NPP SERVICE LIFE

Preliminaries

The owner of Paks Nuclear Power Plant declared, as a strategic goal in 2001, to extend the original design lifetime of 30 years of the units 1-4 by an additional 20 years, following a study of service life extension and its economic feasibility. This strategic goal, after the specification of necessary tasks and preparatory works, was confirmed by an assembly resolution of the owner, based on which MVM Paks Nuclear Power Plant Ltd launched the project aimed at the founding and licensing of the service life extension. In the framework of the service life extension project, the Licensee performed the two major tasks for licensing: it prepared and founded the environmental license application for service life extension and elaborated and founded the programme with the intention of creating the conditions for the planned service life extension.

The HAEA has verified the programme and its attached documentation, and has not identified any such deficiency which would have excluded the possibility of service life extension. The HAEA supplemented the elements/tasks of the service life extension programme by specifying additional requirements in its resolution and, in a separate resolution, specified additional tasks that were not directly related to the preparation of service life extension but were revealed during the review of the programme.

Project of activities in the lifetime extension (hereinafter referred to as LTE) between 2013 and 2015

Unit 1 LTE licensing

The design service life of Unit 1 of Paks Nuclear Power Plant expired at the end of 2012, so the licensee submitted the license application for lifetime extension on December 5, 2011 to the HAEA. The HAEA granted the operating license on December 17, 2012 for Unit 1 of the MVM Paks Nuclear Power Plant Ltd for the period between January 1, 2013 and December 31, 2032.

Unit 2 LTE licensing

The licensing procedure for Unit 2 service life extension was launched by the submission of the application on October 31, 2013. The HAEA granted the operation license for Unit 2 of Paks Nuclear Power Plant on November 24, 2014 being valid from January 1, 2015 to December 31, 2034.

Unit 3 LTE licensing

The MVM Paks Nuclear Power Plant Ltd wished to transfer to a 15-months operational cycle (C15). It wishes to increase the availability and to decrease the maintenance costs by the introduction of a new fuel cycle, application of new technology solutions and new technical standard system. Consequently the system of conditions taken as basis for the long term operation also changes. This will directly affect the licensing of lifetime extension via the substantiating analyses and review of certain part of the qualifications.

Taking into account all these above, the licensee developed the substantiating documentation of Unit 3 LTE license application and requested the independent expert review of the documentation. The LTE license application for Unit 3 was submitted on December 2, 2015 to the HAEA for assessment.

Unit 4 LTE licensing

According to the respective laws, the latest date to submit the license application for Unit 4 LTE is the end of December, 2016 to the HAEA. The licensee therefore commenced the compilation of the substantiating documentation for Unit 4 service life extension in the first quarter of 2015 to leave sufficient time for the independent expert review and the necessary corrections. The progress of the tasks is according to their schedule.

ANNEX 6: LIST OF LAWS

I. Acts

Act C of 2012.	on Penal Code
Act CXVI 1996	on Atomic Energy
Act I 1997	on the promulgation of the Convention on Nuclear Safety signed in Vienna on the 20th of September in 1994 under the auspices of the International Atomic Energy Authority
Act CXL of 2004	General Rules of Administrative Proceedings and Services
Act LXXXII of 2006	on the promulgation of safeguards agreement and protocol on the implementation of Article III, (1) and (4) of the Treaty on the Non-Proliferation of Nuclear Weapons, and on the Additional Protocol enclosed to the Agreement.
Act LXII of 2008	on the promulgation of Amendments to the Convention on the Physical Protection of Nuclear Material, adopted by the International Atomic Energy Agency (IAEA) in 1979 and promulgated by Legal Decree 8 of 1987, signed on 8 July 2005 at the Diplomatic Conference organised by the IAEA
Act XLIII of 2010	on central state administrative organs and on the legal status of government members and state secretaries
Act CXXVIII of 2011	on disaster management and amendment of certain corresponding acts
Act I of 2013	on Labour Code
Act II of 2014	*on the promulgation of the Intergovernmental Agreement between the Government of Hungary and Government of the Russian Federation in the field of peaceful use of atomic energy*
Act XXIV of 2014	*on the promulgation of the Intergovernmental Agreement between the Government of Hungary and Government of the Russian Federation on granting the state loan provided for financing the construction of the nuclear power plant in Hungary*
Act VII of 2015	*on the investment related to maintaining the capacity of Paks Nuclear Power Plant and the amendment of certain corresponding acts*
Act CXVI of 2015	*on the amendment of certain energy related acts*

II. Government Decrees

Govt. Decree 314/2005. (XII. 25.) Korm.	on the environmental impact study and the licensing procedure of unified environmental use
Govt. Decree 148 /1999. (X. 13.) Korm.	on promulgation of the Espoo Convention on Environmental Impact Assessment in a Transboundary Context signed on February 26, 1991
Govt. Decree 179/2008. (VII. 5.) Korm.	on the promulgation of the Agreement on support and financing of repatriation of spent fuel of the Budapest Research Reactor concluded between the Government of Hungary and the Government of the United States of America
Govt. Decree 204/2008. (VIII.19.) Korm.	on the promulgation of the Agreement on cooperation regarding repatriation of spent fuel of the Budapest Research Reactor concluded between the Government of the Russian Federation and the Government of Hungary
Govt. Decree 34/2009. (II. 20.) Korm.	on licensing of transboundary shipment of radioactive wastes and spent fuels
Govt. Decree 167/2010. (V.11.) Korm.	on the National Nuclear Emergency Response System
Govt. Decree 323/2010. (XII. 27.) Korm.	on the National Public Health and Medical Officer Service, on fulfilment of public health administration tasks, and on the designation of pharmaceutical administration organ
Govt. Decree 112/2011. (VII. 4.) Korm.	on the scope of activities of the HAEA in connection with its international obligations including the European Union, its authority and penalizing rights, the assignments of its co-authorities and on the Scientific Committee assisting the HAEA`s activity.
Govt. Decree 118/2011. (VII. 11.) Korm.	on the nuclear safety requirements for nuclear facilities and the corresponding HAEA regulatory activities
Govt. Decree 190/2011. (IX. 19.) Korm.	on physical protection requirements for various applications of atomic energy and the corresponding system of licensing, reporting and inspection
Govt. Decree 234/2011. (XI. 10.) Korm.	on implementation of Act CXXVIII of 2011 on disaster management and amendment of certain corresponding acts
Govt. Decree 246/2011. (XI. 24.) Korm.	on safety perimeter of nuclear installation and radioactive waste repository
Govt. Decree 247/2011.	on independent technical expert proceeding in

(XI. 25.) Korm.	nuclear energy issues
Govt. Decree 213/2013. (VI. 21.) Korm.	*on the Professional Committee of the Central Nuclear Financial Fund*
Govt. Decree 214/2013. (VI. 21.) Korm.	*on the rule of supports to be provided to the monitoring and information purpose municipal associations from the Central Nuclear Financial Fund*
Govt. Decree 215/2013. (VI. 21.) Korm.	*on the designation of the organization fulfilling certain tasks related to radioactive wastes and spent fuel, its activities and the financial resources thereof*
Govt. Decree 155/2014. (VI. 30.) Korm.	*on the safety requirements for facilities ensuring interim storage or final disposal of radioactive wastes and the corresponding authority activities*
Govt. Decree 180/2014. (VII. 25.) Korm.	*on the promulgation of the Agreement on the early notification in radiation emergency between the Government of Hungary and the Government of the Republic of Serbia*
Govt. Decree *487/2015. (XII. 30.) Korm.*	*on the protection against ionizing radiation and the corresponding licensing, reporting (notification) and inspection system*[7]
Govt. Decree *489/2015. (XII. 30.) Korm.*	*on monitoring radiation conditions relevant for public exposure of natural and artificial origin and on the scope of quantities obligatory to be measured* [8]
Govt. Decree 490/ 2015. (XII.30) Korm.	*on the reports and interventions regarding missing, found or seized nuclear and other radioactive materials and other actions pertaining to radioactive materials following their report*
Govt. Decree 357/2014. (XII. 29.) Korm.	*on the amendment of Govt. Decree 118/2011 (VII.11.) on the nuclear safety requirements for nuclear facilities and the corresponding regulatory activities and Govt. Decree 190/2011 (IX.19.) on physical protection requirements for various applications of atomic energy and the corresponding system of licensing, reporting and inspection*

[7] *The law entered into force on January 1, 2016, so its implementation will be described in the Eighth National Report*

[8] *The law entered into force on January 1, 2016, so its implementation will be described in the Eighth National Report*

III. Ministerial decrees

Decree 16/2000. (VI. 8.) EüM of minister of health	on the execution of certain provisions of the Act CXVI of 1996 on Atomic Energy
Decree 15/2001.(VI. 6) KöM of minister of Environment	on radioactive releases to air and water during the use of atomic energy and its control
Decree 47/2003. (VIII. 8.) ESzCsM decree of minister of health, social affairs and family	on certain issues of interim storage and final disposal of radioactive wastes, and on certain radiohygiene issues of naturally occurring radioactive materials concentrating during industrial activity
Decree 7/2007. (III. 6.) IRM of minister of justice and law enforcement	on the rules of registration for and control of nuclear material
Decree 47/2012. (X. 4.) BM of minister of interior	police tasks corresponding to the use of atomic energy
Decree 55/2012. (IX. 17.) NFM of minister of national development	on special professional and further education of employees of nuclear installations, and on the scope of professionals authorized to perform activities corresponding to use of atomic energy
Decree 5/2015. (II. 27.) BM of minister of interior	*on the fire protection rules specific in the use of atomic energy and the reinforcement methods thereof during the activities of the authorities*

ANNEX 7: NATIONAL ACTION PLAN OF HUNGARY ON THE IMPLEMENTATION ACTIONS DECIDED UPON LESSONS LEARNED FROM THE FUKUSHIMA DAIICHI ACCIDENT

National Action Plan of Hungary

on the implementation actions decided upon the lessons learned from the Fukushima Daiichi accident

Országos Atomenergia Hivatal

Reviewed by the Hungarian Atomic Energy Authority for the CNS 7th National Report

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INTRODUCTION

The accident at the TEPCO Fukushima Daiichi NPP triggered the European Commission to conclude that the safety of all EU nuclear power plants should be reviewed, on the basis of comprehensive and transparent risk and safety assessment [1] - the so called stress tests. The official Hungarian denomination of this assessment was "Targeted Safety Re-assessment" (TSR). The stress tests consisted of three main steps: a self-assessment by licensees, followed by an independent review of the results and preparation of a national report by the national authorities, and by a third phase of international peer reviews. The peer review also consisted of three steps: an initial desktop review of the national reports, three topical reviews in parallel *(namely: external initiating events, loss of electrical supply and of ultimate heat sink, and accident management)* when the reviewers discussed the national reports with the authors of the reports; then visits were conducted by international expert groups at the national authorities and at the site of one nuclear power plant in each of the 17 participating States concerned. This last phase meant the conclusion of the country reports.

In Hungary, the Hungarian Atomic Energy Authority (hereinafter referred to as the HAEA or the Authority) issued the requirements for operator’s re-assessment [2] shortly after the publication of the ENSREG requirements [1]. The nuclear power plant completed the re-assessment and then the Authority prepared and submitted the national report [3] to the European Commission by the deadline.

As the result of the first two steps of the international peer review, a draft country report was drawn up on the basis of the reports of the national authorities and the consultations. The draft country report still contained a "list of open questions" requiring further discussion, which provided basis for the third review phase to be concluded on the scene. The Hungarian party provided the review team with further information regarding the open questions even before the commencement of the third review step. During the visit phase, the review team conducted a site walk-down in addition to discussions with the experts of the authority and the operator. In the course of the site visit the international experts received clarification and explanatory information and visited the locations, reviewed equipment as well as the relevant procedures, which were referred in the National Report [3].

The international peer-review concluded that Hungary submitted a comprehensive National Report [3], which presented the appropriate analyses and their results. Hungary provided further detailed answers and explanations to the questions asked during the presentation of the report. During the national review both the authority and the operator provided appropriate explanations and justifications, as well as they allowed the international experts to observe the relevant documentation. The peer-review team was allowed to visit all relevant locations during the site walk-down.

The general statements of the country report on Hungary [5] on the basis of international peer-review were:

- The nuclear power plant is in compliance with the licensing conditions, able to withstand the loads induced by a design basis earthquake, flood or by extreme weather conditions; additionally, the facility is prepared for those design basis events, which entail the total loss of the electric power supply or the ultimate heat sink.
- The design basis established during the construction of the plant was extended through a series of safety improvement programmes (e.g. free surface acceleration, occurrence frequency of external threats) during the service life of the plant.
- Regulatory requirements were not in existence for events beyond the design basis at the time of the construction of the plant, but they are now established and the plant is in compliance with them thanks to the completed modifications.
- As a condition for the planned service life extension the authority requested the completion of all modifications in connection with the management of severe accidents. (These modifications had already been completed on Unit 1, since the service life extension licensing procedure of this unit finishes in 2012).

In addition to those mentioned above, in the course of the TSR process the operator proposed several corrective actions in order to increase the safety margins [3]. The HAEA overviewed and accepted the proposed actions and, together with a few additional actions, issued a decision [10] on their implementation and the preparation of a detailed implementation action plan.

The actions to be implemented for increasing the margins require detailed analyses and further preparation. Consequently, the authority required the preparation of the above mentioned action plan, which includes the detailed description of each action, the schedules of their planned implementation and the final deadlines thereof. This action plan [11] was submitted by the operator for regulatory review on June 27, 2012. The authority, after careful review, ordered the implementation of the actions in an authority resolution [12] in December 2012. The operator's action plan [11] determined a list of elementary actions in order to complete the actions identified in the National Report [3] and in the authority decision [10], so that each elementary action can be associated with a unique modification or some other activity. Therefore, the number of elementary actions is larger than the number of actions in the authority decision [10], without identifying any new action since. In the current National Action Plan we refer to these elementary actions and also to additional actions to be completed by the authority itself.

After the implementation of all corrective actions, the authority shares the opinion of the operator on the judgment of the safety improvement of the nuclear power plant, as follows:

- The occurrence probability of severe accidents due to the permanent loss of electric power supply and ultimate heat sink is decreased.
- Severe accidents of reactors and spent fuel pools can be prevented or mitigated by the provision of an alternative water supply and electric supply routes.
- Extreme external events may cause damages to the site, but the risk of damage occurrence and the consequences of such events are reduced.
- The capability to prevent and/or mitigate accidents simultaneously affecting more units is enhanced.

- The solutions that can be utilized for emergency response are extended, including accident situations simultaneously affecting more than one unit.

The European Union has not closed the European level review triggered by the accident of Units 1-4 of the TEPCO Fukushima Daiichi Nuclear Power Plant; instead it declared its intention to track the implementation of the actions decided on the results of the "stress tests" in the Member States. Accordingly, the ENSREG (European Nuclear Safety Regulators Group) as the advisory body of the European Commission made a decision at its meeting held on September 4-5, 2012 that the EU Member States operating nuclear power plants should elaborate a National Action Plan (hereinafter referred to as NAcP) and then submit it to the European Commission by December 31, 2012. The NAcP should include the corrective actions identified during the stress tests and the subsequent international review, together with the deadlines for their implementation. Additionally, the NAcP should include the actions determined in the scope of those issues, which were identified in the 2nd Extraordinary Review Meeting of the Convention on Nuclear Safety (CNS) held in August, 2012.

The ENSREG provided guidance for the format and content of the NAcP (i.e., "Compilation of recommendations and suggestions, Peer review of stress tests performed on European nuclear power plants" [9] and "National Action Plan (NAcP) Guidance as directed within the ENSREG Stress test Action Plan" [8]). The current Hungarian NAcP has been prepared in accordance with these recommendations in the following structure and with the following content:

The introduction describes in general the preliminaries, the structure of the NAcP and the authority tasks in connection with the implementation of the corrective actions.

Part I, in line with the ENSREG recommendations [9] in its Topics 1-3, discusses the actions determined in relation to:

- External events,
- Design issues,
- Severe Accident Management and Recovery.

The document includes a short description of the actions, but their detailed justification is excluded, since such information can be found in the publicly available TSR National Report [3].

Part II includes those statements and potentially required actions, which came to the floor only at the Extraordinary Review Meeting of the Convention on Nuclear Safety held in Vienna, on August 27-31, 2012. Hungary, pursuant to the expectations, submitted an Extraordinary National Report [6] to the Convention by the requested deadline. The main areas discussed during the extraordinary review meeting, in addition to the scope defined by ENSREG, were:

- National organizations,
- Off-site Emergency Preparedness and Response,
- International Cooperation.

Part III would list those actions, which were not discussed above and did not belong to any areas listed above. Such actions were not identified based on the review; so Part III remained blank.

Part IV presents the actions discussed in Parts I-III in a table format, together with the deadlines for their implementation. In order to facilitate the identification of the listed actions, the table, if appropriate, provides references to the identifiers used in the ENSREG recommendations [8, 9], to the related chapters in the TSR National Report [3], as well as in the authority resolution [12] ordering their implementation. These references are meant to facilitate the work of those reviewing the NAcP, since the corrective actions can be clearly associated with the previously identified lessons and issue areas to be assessed.

This Hungarian NAcP was thus prepared based on the authority resolution [12] issued on the action plan proposed by the licensee of the nuclear power plant [11] (in relation to the scope and deadlines of tasks to be performed by the licensee) that was complemented by the actions to be performed by the authority.

Review at the end of 2014

The Hungarian Atomic Energy Authority published the Hungarian National Action Plan on its website in Hungarian language and on the ENSREG website in English. The plan of Hungary, together with similar plans of other EU member states, underwent a peer review process, which consisted of two stages: (1) a preliminary commenting period, where the experts of other member states, the designated rapporteurs and the public could take comments and questions to the plan, and (2) a peer review meeting. The member states presented their plans in a meeting, answered the questions, then the rapporteurs designated per countries prepared evaluation reports of the national action plans. A summary report was approved by the ENSREG about the meeting [13].

The report on the Hungarian National Action Plan [14] contained the following conclusions:

- *The structure of the Hungarian National Action Plan (NAcP) is compliant with the provided ENSREG guidance. The content of the Hungarian NAcP follows the ENSREG guidance, contains the necessary references.*
- *It reflects the items of the ENSREG Action Plan, contains the schedule of the actions and the Hungarian authority published the plan according to the expectations.*
- *The Hungarian authority built the supervision activities concerning the nuclear safety related actions into its annual oversight programme.*
- *The Hungarian authority inspects the completion of the particular actions or manages them during the related licensing procedures.*
- *Hungary has fully integrated the IAEA nuclear safety fundamentals and standards as well as WENRA reference levels into its nuclear safety legislation.*
- *The action concerning the prevention of long term containment overpressurization (development of external active cooling) was highlighted by the report. It drew the attention to the fact that this action means the most important challenge in terms of authority supervision.*

The Hungarian Atomic Energy Authority has taken into account these aspects during the oversight of the implementation of the plan. Based on the ENSREG decision the national action plans should be reviewed until December 31, 2014, and a peer review workshop should take place in 2015 very similarly to the previous workshop in 2013. The ENSREG provided guidance on how to carry out the review, in which the following aspects were specified:

- *Response/clarification on any issues identified in the rapporteur's report from the 2013 workshop.*
- *Progress on implementation and update of the NAcP.*
- *Main changes in the NAcP with justification, including: additional measures, measures removed or modified, changes in the schedule.*
- *Technical basis leading to the main changes identified in the NAcPs.*
- *Relevant outcomes of studies and analyses identified in the NAcPs.*
- *Nationally identified good practices and challenges during implementation so far.*

Beyond that the WENRA reference levels revised in the light of the lessons learned from Fukushima should be taken into account to the extent possible.

The HAEA has taken into account the above aspects when carried out the review of the plan.

The National Action Plan has been supplemented with a new part (Part V), in which a new, simplified table describes the progress of the tasks. There have been no tasks removed or added to the plan, and for the time being there has been no official deadline modification. Many tasks have been completed before or in some cases well before the deadline, however there are such tasks as well, concerning which delays cannot be avoided. Regarding them the determination of new deadlines will take place at the beginning of 2015, when the second half-year report of the licensee for 2014 will be completed and reviewed.

2016 April review for the CNS report

The HAEA reviewed the action plan again in 2016 April. The intention was to describe the status of the actions at the end of 2015 in the CNS report. For this purpose Annex V of the plan describing the status of the actions was updated. As a summary, out of the 51 tasks:

- *28 tasks have been implemented within deadline,*
- *further 9 tasks was reported complete by Paks NPP, but have not yet been closed by the HAEA,*
- *in the case of 10 tasks the deadline has not yet expired and can be met,*
- *delay is anticipated in relation to 4 tasks,*
- *according to the present situation all tasks will be closed until the end of 2018.*

Authority tasks

The authority, during the implementation of actions decided based on the lessons learned from the Fukushima accident, performed and performs the following tasks:

a) Review of the TSR action plan prepared by the licensee [11], its extension and harmonization, as well as ordering its execution.
b) Authority supervision of the execution of the ordered action plan; oversight of the fulfilment of the action plan.
c) Revision of the nuclear safety legal requirements, with the consideration of the compulsory requirements of the EU directive and of the reviewed WENRA reference levels and also of the reviewed IAEA safety standards, as well as the results of the national review process of the legal background.
d) Participation in the international processing and utilization of operational experience feed-back (IAEA and ENSREG Action Plan, OECD NEA).
e) Public information.

a) Review of the action plan of the licensee

The authority evaluated the action plan submitted by the licensee [11]. A working group was established to carry out the evaluation, which prepared a work plan including the major milestones and viewpoints of the review. The review was carried out by at least two experts in each professional area and task, based on whether:

- the harmony with the TSR [3] report is adequate,
- all findings identified in the TSR report are managed,
- the actions are adequate and effective to eliminate the findings,
- the actions established are clear and can be performed,
- the schedule of actions is justified, and the safety risk of the period until the implementation is acceptable,
- the tasks have any relationship to Service Life Extension or Periodic Safety Review results (in order to establish agreement among action plans).

In the course of the review described above, the HAEA requested the licensee to supplement the action plan in order to comprehensively evaluate the safety risks of the periods remaining until the execution of each action. After the review of the additional information provided by the licensee, a unified and synthetic plan was concluded, the implementation of which was ordered by the authority to be carried out by the operator [12].

b) Supervision of the implementation of the licensee's action plan

The execution of tasks listed in the action plan, even if the shortest possible deadlines are considered, is a long-lasting process, which needs several years. Consequently, the authority should be prepared for a long-term supervisory activity, which may include difficulties that are usual in the case of actions requiring such prolonged implementation periods (e.g. replacement of persons, difficulties in traceability).

The supervision over the execution of actions can be divided into two basic groups:

A.) The supervisory activities for (nuclear safety related) modifications requiring authority approval are to be performed in line with Govt. decree 118/2011. (VII.11) Korm.; i.e. licensing procedure, inspection and evaluation in connection with the given modification, and if appropriate, enforcement. The modifications not requiring authority approval are also inspected and evaluated by the authority according to the rules of the above mentioned government decree. The oversight can be performed by a site inspection during the construction phase or via evaluation of the relevant documentation.

B.) Supervisory activities of actions not related to any modification (e.g. study, analysis, assessment, concept planning) are performed through evaluation of the individual documents in order to ensure that the necessary interventions will be accomplished in compliance with the nuclear safety requirements. If additional actions are to be established based on the regulatory evaluation (e.g. further modifications are needed), then the supervisory activities are realized as in Para A.

The progress of the implementation of the licensee's action plan is supervised by the authority in the frame of comprehensive and targeted inspections. These inspections are integrated to the yearly inspection plan of the authority.

In order to facilitate the tracking process of the implementation of the action plan, the authority obliged [12] the licensee to prepare periodic (due every six months) reports. This regulatory tool was successfully applied by the authority also for tracking the action plan that was established as a result of the latest Periodic Safety Review. The TSR action progress report should present the progress in the implementation of each action individually, including the difficulties, decision points, any change in the schedule, as well as any such issue that may have effect on implementation. The report should also identify the reference documents prepared for each action.

The HAEA, in addition to the oversight activity of the individual modifications (the particular method is described at the given action), reviewed the bi-annual reports submitted by the Licensee and overviewed the status of each action during two inspections:

- Until the time of the review Paks NPP submitted reports on the activities performed in the first and second half of 2013 and in the first half of 2014.
- The HAEA conducted two inspections on Match 8, 2013 and on September 18, 2014 to confirm the status of the actions in the action plan. The results were recorded in inspections protocols in both cases.
- **Additionally, until the end of 2015, Paks NPP submitted the status reports on the activities performed in the second half of 2014 and in the first half of 2015.**

  In addition to the inspections conducted in relation to the modifications meant to implement the particular actions, the HAEA conducted one more inspection on September 24, 2015 to confirm the status of the actions. An inspection protocol was again prepared on the results.

c) Review of nuclear safety laws

The nuclear safety requirements for nuclear facilities should be reviewed based on the lessons learned from the Fukushima accident, as discussed in detail in Topic 4 of Part II.

The HAEA reviewed the nuclear safety regulations and proposed amendments to them. The proposal is being considered by the Government at the time of the review.

d) Participation in the international experience feedback

Several international organizations are committed to process the experience gained from the Fukushima accident. HAEA has an active role in the work of these organizations, what gives opportunity to exchange and utilize the lessons learned (see Topic 6 of Part II).

In summary, the most important task in the field of international cooperation is the preparation and execution of the National Action Plan (NAcP).

e) Public information

It is important to inform the public about the results and consequences of the Hungarian and European stress tests. The HAEA puts special emphasis on providing appropriate and correct information to the public, as further discussed in Part II.

PART I: REVIEW AREAS DERIVED FROM THE POST-FUKUSHIMA STRESS TESTS OF THE EUROPEAN UNION

Part I contains the Action Plan concluded in the three main topics (1: External events, 2: Design issues, 3: Severe Accident Management and Recovery) of the Targeted Safety Re-assessment (the Hungarian stress test), which has been structured according to the expectations of the four following documents:

1. ENSREG "Compilation of Recommendations and Suggestions" [9],
2. Stress Test Peer Review, Country Report about Hungary [5],
3. Recommendations of the 2nd Extraordinary Meeting of the Contracting Parties to the Convention of Nuclear Safety held in 2012 August [7], and
4. additional tasks revealed during the Hungarian Stress Test [3].

According to the three main topics Part I is divided into three chapters, in which four sub-chapters appear.

TOPIC 1: EXTERNAL EVENTS

The accident of Fukushima Daiichi NPP has made it obvious that it is essential to consider the *appropriate* level of natural hazard factors in the design basis of nuclear power plants and that in addition to direct impacts the indirect consequences should also be taken into account.

1.1 Tasks derived based on the ENSREG "Compilation of Recommendations and Suggestions" document [9]

Document [9] highlights eight topics in relation to external natural hazards in Sections 3.1.1. through 3.1.8., which should be covered in the National Action Plans (NAcPs). Those issue groups regarding these topics together with the respective tasks are described below in which corrective actions were decided to improve the situation:

1.1.1 Recurrence frequency taken into account in the design basis

According to the recommendation: *in the safety reviews and back-fitting of nuclear power plants a return frequency of 10^{-4} per annum (0.1g minimum peak ground acceleration for earthquakes) with respect to external hazards should be considered*. The Hungarian regulation requires to consider natural hazards of 10 thousand year recurring frequency. As described in Section 2.1.1. of the Hungarian Stress Test Report [3] this requirement had been satisfied for earthquakes before the Periodic Safety Review terminated in 2008, due to the completion of the seismic safety reinforcements. The respective analyses demonstrated (See [3] 3.1) that the requirement for flooding, or for low water level, of the Danube is also met. ([3] 4.1.). Systematic assessment of these impacts had not yet been accomplished at the time of the Periodic Safety Review, but later, by 2011 December the analyses were successfully completed. [<1>][9]. So no open task exists in this relation.

1.1.2 Secondary effects of earthquakes

The assessments described in Section 2.3.3. and 3.1.1 of [3] showed that flooding occurring as a consequence of an earthquake on the site, or far from it (dam break in

[9] The form [<x>] will be used hereinafter to make reference to individual serial number of tasks listed in Part IV.

upstream direction or narrowing of runway of the Danube), cannot endanger the site. Possible secondary effects of design basis earthquakes are discussed in Section 2.1.2. of [3]. However, occurrence of a fire on the site cannot be excluded, which may necessitate the deployment of the plant fire brigade. Some intervention is necessary therefore to protect the personnel and equipment in the fire brigade headquarters, which are made of reinforced concrete, but are not yet seismically qualified. [<2>].

The demineralised water tanks at Installation II (Units 2 and 3) – that play an important role in ensuring demineralised water stocks – are located in the direct vicinity of the service building. The walls of the building shall be seismically qualified and, if necessary, reinforced or provide appropriate protection of the tanks by other means. [<3>].

According to the current conservative analyses, soil liquefaction might occur in the acceleration ranges slightly exceeding the design basis, which may cause uneven settlement of the buildings (discussed in Section 2.2.1.1. of [3]). As a consequence, the underground lines and connections (pipelines, cables) at risk due to potential settlement of the main building shall be re-qualified and, if necessary, modified to allow for a relative displacement [<4>]. In addition, a state-of-the-art analysis shall be performed for the proper assessment of the existing margins of earthquake-initiated building settlement and soil liquefaction phenomenon [<5>].

1.1.3 Protected volume approach

There are certain wall penetrations in the machine room of the essential service water pumps above the level Bf 95.12 m (Section 3.1.2. of [3]). The penetrations are not provided with water sealing, so flooding of the machine room may occur if a flood exceeding this level takes place. The water penetrating through the walls would accumulate in a sump and a permanently installed sump pump can remove it. Modification of the wall penetrations to a sealed design shall be carried out [<6>].

According to Section 2.1.2. of the report [3], automatic shutdown of the main condenser coolant pumps shall be provided when the condenser pipeline is damaged due to earthquake or other reason. It shall be ensured that the pipeline trenches are applicable to receive and drain the discharged water. If necessary, the dike shall be elevated or additional dam shall be constructed to avoid the flooding of the turbine hall or the cable tunnels [<7>].

1.1.4 Early warning notifications for extraordinary natural impacts

Besides the fact that Paks NPP operates its own meteorological station, it is in daily touch with the Hungarian Meteorological Services. A similar relationship is maintained with the water authorities. Taking into account the relatively small size and geographical situation of Hungary, the current practice is satisfactory from every aspect and no task has been identified.

1.1.5 Seismic monitoring system

The Paks NPP control rooms are equipped with seismic monitoring systems, which provide an alarm signal if a pre-defined acceleration level is exceeded. However, currently no such system exists which would initiate an automatic shutdown of the reactors for a given acceleration level ([3] 2.1.2). In the frame of the reconstruction project of the seismic instrumentation, which is in preparatory phase, the question of automatic shutdown shall be revisited [<9>].

1.1.6 On-site inspections, qualified walkdowns

The licensee performed a large number of walkdowns during the TSR process, and deployed external experts when and where it was necessary. Records were taken about the walkdowns. The authority supervised the stress test assessments of the licensee in an inspection process. During the course of implementation of safety improvement measures, with special regard to those where the implementation of which was ordered by it, the authority shall apply regulatory inspections. If specific international standards, requirements become available for such inspections and qualified walkdowns, both the authority and the licensee shall adopt and apply them. Currently it was not justified to set up any additional task in this field.

1.1.7 Flooding margin assessments

Section 3.2. of [3] determined that the site of Paks NPP is not prone to flooding, since the formation level of the embankment both on the opposite side of the Danube and upstream on the right bank is lower than the level of the site. Consequently, should an extreme high water level occur, the opposite bank and areas far from of the plant site will be flooded. No open task exists.

1.1.8 Assessment of external hazard margins

Section 1.1.2. discussed task [<5>] in relation to earthquakes. Apart from that, the seismic resistance margins of buildings and equipment have been recently reviewed using the most advanced techniques and appropriate margins have been observed (see: [3] 2.2.). Section 4.2.2. of the report [3] describes that one of the statements of the latest Periodic Safety Review dated to 2008, that evaluation of loads caused by weather impacts is not in compliance with modern expectations. Accordingly, the assessment scheduled a new, supplementary analysis. The deadline for that is the end of 2012. Following the submittal of the results of those, the authority will review these assessments.

1.2 Tasks from the stress test peer review report of Hungary [5]

The report [5] contains recommendations for the authority in relation to earthquakes, to closely supervise and inspect the implementation of those actions, which the licensee plans to implement to make certain structures (underground lines and connections) of the plant more resistive against the effects of a potential uneven building settlement occurring due to the effect of a possible soil liquefaction. Similarly, it recommends revision of the database containing the seismic classification of certain systems, structures and components. This revised database was completed by April 30, 2012 and its regulatory supervision was also performed. Also the ENSREG peer review [5] recommended the oversight of modification of the wall penetrations of the essential service water system to a sealed design and of the activities for necessary reinforcements against extreme weather conditions. It is true for all these activities that the authority oversees and reviews the process and results of the tasks accomplished by the licenses according to the normal regulatory procedures. The recommendations of document [5] therefore did not necessitate identification of additional tasks.

1.3 Tasks from the recommendations of the 2nd Extraordinary Review Meeting of the CNS

In Topic 1 of the 2nd Extraordinary Review Meeting of the CNS held in August, 2012, which addressed external natural hazards, five thematic recommendations were formulated. It is expected from the member states of the Convention to report during the next, 2014 ordinary review meeting about:

1) Results of reassessments of external hazards with emphasis on changes to licensing basis.
2) Peer reviews of assessments and their results.
3) Additional improvements taken, or planned, based on the reassessments.
4) Activities taken, or planned, to improve safety culture based on lessons learned from the Fukushima accident.
5) Regulatory changes concerning external events that are already expected to be reported.

These five themes are discussed below:

1.3.1 Reassessments of external hazards

This action was accomplished by Paks NPP during the last Periodic Safety Review completed in 2008. The results were reassessed in the frame of the EU Stress Test [3] and presented in Sections 1.1 and 1.2.

1.3.2 Peer review of reassessment

The reassessment took place during the peer review phase of the EU Stress Test, the results of which were discussed in section 1.2.

1.3.3 Additional improvements taken or planned based on the reassessments.

Details were discussed in Section 1.1.

1.3.4 Safety culture

Within the topic of external natural hazards, during the course of the stress test, it was revealed corresponding to safety culture (Sections 2.1.2. and 2.2.4. of [3]) that seismic-proof fixing of temporary, non-process equipment in the outage periods and recovery of fixings dismantled for maintenance purposes are not duly regulated. Paks NPP defined a corrective action in relation to that: “Extraordinary attention shall be paid to seismic-safety related housekeeping and full recovery of fixings after main outages. Fixing of the non-process equipment and maintenance tools that could adversely impact process equipment during outages shall be provided.” [<8>]. The authority inspects the implementation of the action during post-outage start-up process of the reactors.

1.3.5 Review of regulatory requirements

The full revision of the regulatory requirements started in 2009 and terminated at the beginning of 2012. A further revision has been taking place with the involvement of external experts. The result of this revision will be the identification of the necessary amendments of the system of requirements [<50>]. Additional amendments of the requirements will be planned and scheduled when such modified international standards are issued (e.g. IAEA, WENRA, NEA), which go beyond the current domestic norms (see also Part II Section 5).

1.4 Tasks additional to the above expectations

Primary circuit damage for the effect of design basis earthquakes was excluded by the seismic-reinforcement projects implemented earlier. However, due to implications from the Fukushima Daiichi accident, such improbable, complex cases shall also be taken into account as extension of the design bases (See: Section 2.1.2. of [3]). Accordingly, the existing symptom-based emergency operating procedures shall be reassessed as to whether they support an optimal recovery in such a combined situation [<10>].

Section 2.2.1.2 of [3] concludes that the 400 kV and 120 kV substations are not safety systems and therefore they are not seismically reinforced. These substations however, might provide many alternative electric supply opportunities, if they are not damaged. The earthquake protection of the substations and the gears for automatic switching the plant to isolated operation shall be re-evaluated and reinforced if necessary [<11>].

According to Section 5.2.2. of [3] maintenance and inspection procedures to be applied in the situation of the extreme low level of Danube were not satisfactory. Therefore, the periodic inspection, maintenance and operational testing regarding the equipment to be applied in case of low water level shall be supplemented. The inspection, testing and maintenance instructions, which are still missing, shall be developed [<12>].

During the stress test the authority required [10] that a “list of such system components important to safety, which are endangered by electromagnetic effects (including the effects induced by lightning) and thereby need to be classified accordingly, shall be compiled to display whether or not a given component is adequately qualified” [<13>]. Based on the list the authority and the licensee can specify reinforcements and corrective actions.

Also the authority resolution terminating the stress test assessments [10] ordered that “it shall be analyzed if the lack of seismic qualification of the machine racks and travelling water band screens of the essential service water system jeopardizes the ultimate heat sink function and, if necessary, the adequate exclusion measures shall be implemented” [<14>].

TOPIC 2: LOSS OF SAFETY SYSTEMS

2.1 Tasks derived based on the ENSREG “Compilation of Recommendations and Suggestions” document [9]

2.1.1 Application of means providing alternate cooling and heat sink

Corrective actions planned in Section 5.2.5. of report [3]: the operator shall maximize the available inventory of the stored demineralised water in all operation states [<15>]. The access to the connection point of the auxiliary emergency feedwater system in accident conditions shall be improved. Connection points shall be established on the demineralised water tanks to allow the water supply, through the auxiliary emergency feedwater system, by mobile equipment. Arrangements shall be laid down in instructions for additional external supply opportunities from the Danube and the fishing lakes. [<16>]. The potential setting of the boron concentration of water inventories from external sources, and its storage, shall be solved and supply mode of borated water inventories to the containment shall be regulated in an operating instruction [<17>]. By provision of an appropriate electrical power supply it shall be established that the bank filtered well plant, which can be used irrespective of the water level of the river, be able to supply water to the essential service water system via the existing connections in accident situations [<18>]. The accessibility of the water reserve available in the closed segment of the discharge water canal for the earthquake resistant fire water pump station of Installation II that is equipped with an individual diesel power supply shall be solved [<19>]. Similar to the connection existing on Installation I, the water supply shall also be solved for Installation II from the fire water system to the essential service water system through the technology cooling water system [<20>]. The equipment necessary for the cooling water supply to at least one diesel generator of each unit from the fire water system shall be provided and the operating instruction shall be completed with the measures to be implemented [<21>]. Topic 3 deals with the equipment to be deployed from external organizations that should be applied in case of severe accidents. See actions [<32>, <33>].

2.1.2 Enhancement opportunities of on-site and off-site AC power supply

The following corrective actions were decided based upon Sections 5.1.1.3., 5.1.5., 5.2.5. and 5.3.1. of report [3]: utilizing the fuel storage capacity of the tanks of the safety diesel generators, the amount of stored diesel fuel shall be increased, and this shall be incorporated in the procedures [<22>]. Protection of the 400 kV and 120 kV substations, which are not of safety category and therefore are not seismically reinforced and the automatic switching of the plant to isolated operation against earthquakes shall be evaluated and reinforced if necessary [<11>]. Power supply from the safety trains of - filters of the essential service water system shall be established [<23>]. Appropriately protected independent severe accident diesel generator(s) shall be installed after assessment of the necessary capacity and determination of the design requirements including beyond design basis hazards [<24>]. Out of the two power plants being able to supply external electric power via dedicated lines, the black-start capability (start-up from own diesel generator) shall be established for the Litér gas turbine plant [<25>]. Actions discussed in the previous section can also be mentioned here: actions [<18>] and [<21>]. Procedures shall be developed for the use of the possible, but currently not applied, cross-links of the safety power trains across the units. The procedures shall cover the normal operational trains, as well as the backup and safety buses. [<26>]. Possible cross-links shall be studied and the concluding modifications shall be carried out for providing safety electrical power supply from any operable emergency diesel generator in any unit to the safety consumers of any other unit [<27>]. Topic 3 addresses the provision of electric power supply equipment of external organizations to be applied in severe accidents in the plant, see action [<33>].

2.1.3 Enhancement opportunities of DC power supply

Paks NPP assessed the battery stations during the stress test. The conclusion was that if the reliability and amount of AC power supply is available then there cannot be a problem with the DC power supply, since the battery stations can be charged from any of the AC power supplies. After considering the corrective actions related to AC power supply described above, no additional corrective actions were identified for DC power supply, see sections 5.1.1.2. and 5.1.2.1. of report [3].

2.1.4 Operational and preparatory actions

Actions [<8>], [<10>] and [<6>] in Topic 1, and actions [<22>, <15>, <16>, <17>,<21> and <26>] described above, along with actions [<33>, <34>, <35>, <37>, <38>, <42>, <43>, <41>] described below in this topic and in Topic 3, address the development and enhancement of operational and other application procedures. Action [<12>] of Topic 1 should also be mentioned here, which foresees the practical training of the personnel.

2.1.5 Instrumentation and monitoring

Although the task according to corrective action [<9>] of Topic 1 itself is not related to instrumentation, but builds on the results of seismic instrumentation reconstruction decided prior to the stress test. Beyond that, action [<36>] of Topic 3 address the instrumentation of the Protected Command Centre, while action [<46>] required by the authority schedules the revision of the adequacy of the emergency related on-site and off-site radiation monitoring devices for earthquakes and loss of power supply.

2.1.6 Shutdown improvements

Corrective actions are only indirectly assigned to shutdown state, in relation to two analyses actions. Section 2.1.17. will describe them. Based on section 2.2.1., 5.2.4. and 5.2.5. of the stress test report [3] action [<28>] will clarify the necessity of a time limit for the state of shutdown but not for a cold reactor, while action [<41>] connected to Topic 3 includes 3-dimensional hydrogen distribution calculations for the simultaneous accident state of one open reactor in refuelling state, one operating reactor and two spent fuel pools (considering that two units have a common atmosphere reactor hall).

2.1.7 Reactor coolant pumps seals

Seals of the main coolant pumps of Paks NPP do not degrade during shutdown; therefore the issue in Hungary is not relevant, which has been satisfactorily clarified during the course of the peer review (last Para. of Section 3.2.2.2 of [5]).

2.1.8 Improvement of ventilation capacity in total loss of power supply

Section 2.1.2. of [3] dealt with the provision of AC power supply. If this is available, then ventilation connected to safety supply, required for the operation of the process equipment and compartments for personnel to stay is ensured. No separate action was necessary except for the Protected Command Centre. Action (PCC) [<48>] of Topic 3 plans the re-assessment of air conditioning for the PCC and installation of operable equipment that can be operated from an adequate power diesel generator.

2.1.9 Improvement of main and backup control rooms for long term habitability after a total loss of power

Taking into account Section 4.2.1. of [3], after the improvement of safety supply according to Section 2.1.2. the habitability of the unit control room will be appropriate (also taking into account the DC power supply according to Section 2.1.3). The situation is different in the case of the command centres designed for managing emergency response: both the Protected Command Centre and the Backup Command Centre corrective actions had to be decided ([<48>] and [<49>]). These are described in Topic 3.

2.1.10 Improvement of robustness of spent fuel pools for various events

Further actions, going beyond the contents of Section 1.2.2. and 2.1.2. of the Stress Test report [3] have also been identified: [<32>, <34>, <35>]; they appear in the field of emergency preparedness (see Topic 3).

2.1.11 Improvement of separation and independence of safety systems

One improvement action was decided in relation to separation (see: Section 2.1.2. and 2.2.4. of [3]). The intention is to timely shut down the large diameter and large flow-rate condenser cooling water systems, if damaged, and to allow for the whole water volume discharged [<7>]. In another respect, the stress test actions are rather meant to increase diversity than to improve separation and independence.

2.1.12 Flow path and access availability

Instead of maintenance of routes with special tools, actions rather meant to ensure parallel, diverse water and electric power supply routes were decided. Actions [<11>, <16>, <20>, <21>, <25>, <26>, <27>] were already mentioned in Sections 2.1.1. and 2.1.2., and actions [<32>, <33>, <42>] described in Topic 3. The latter is related to routes of liquid releases during severe accidents. Action [<16>] relates to ensuring accessibility and the tasks [<43>, <44>, <45>] also for accident conditions.

2.1.13 Provision of mobile devices and their adequate storage

Actions [<8>] and [<12>] described in Topic 1 and tasks [<34>] and [<18>] in Topic 3 are connected to mobile devices and appropriate storage.

2.1.14 Bunkered/hardened systems

Action [<24>], which also belongs to Topic 3, was concluded based on the considerations in Section 5.1.3 of the national regulatory stress test [3]. The placement of these diesels is regarded as hardened. Action [<32>] aimed at establishing a new, hardened coolant supply route to the spent fuel pool was discussed in Section 5.2.3. of the same report. The Protected Command Centre and the Backup Command Centre shall be reinforced according to actions [<47>] and [<48>]. These actions also belong to Topic 3. Action [<2>] discussed in Topic 1 on the hardened placement of fire brigade and personal protective equipment.

2.1.15 Improvement of response capability to multiple accidents on the site

The following actions of Topic 3 address the potential multiple accidents of the units on the site: [<24>, <36>, <37>, <41>].

2.1.16 Equipment inspection and training programmes

The necessity for a more elaborated formal control of NPP staff activity by procedures in relation to supplementary actions to be taken when an extreme low level of the Danube occurs was determined based on Section 5.2. of [3] that also included a more frequent training and exercise of the staff for these activities [<12>]. This belongs to the issues discussed in Topic 1.

2.1.17 Further studies to address uncertainties

Performance of further assessments was decided in concert with Sections 2.1.2., 2.2.1., 2.2.4., 6. and 7.3. of report [3]. Additional actions [<5>, <9>, <10>, <11> and <14>] discussed in Topic 1 can also be mentioned here. Action [<28>] which foresees a probabilistic assessment for closed reactor states under 150 °C primary circuit temperature can also appear in this part. Some actions of Topic 3 are also relevant to this issue: [<30>, <38>, <41>, <46>].

2.2 Tasks from the stress test peer review report of Hungary [5]

The report of the peer review team contains one recommendation in relation to this topic: *"The possibilities of interconnection of existing equipment are beneficial. However might also lead to loss of separation. Such improvements or modifications should be prepared carefully. Before the implementation, separation issues should be investigated.* (See Section 3.3 of [5]). No corrective action is required in relation to this recommendation. If the interconnections are established as part of emergency/accident management, when it is necessary anyway to consider the pros and cons of the action in the given situation, then obviously no corrective action can be formulated as a preparatory action. Notwithstanding that the interconnections are established under normal circumstances as part of preparation for the accident situations, then these are modifications of the systems. The nuclear safety regulations specify the modification process and the requirements for the respective supporting analysis and the modification is subject to authority approval. This is a satisfactory provision to comply with the above recommendation.

2.3 Tasks from the recommendations of the 2nd Extraordinary Review Meeting of the CNS

Connecting topic: 2 – Design Issues

Recommendations based on the final summary report of the 2nd Extraordinary Review Meeting of the CNS [7] and the corresponding thematic rapporteur reports, which are not published, are listed below. Also the reasons are specified why no additional improvement actions are decided.

2.3.1 Increasing plant robustness to face unexpected challenges

The expectation, according to the detailed explanation, is the safety improvement of existing nuclear power plants and the improvement to designs of new reactors by taking account of natural hazards more severe than the ones considered in the design basis.

During the stress test [3] the beyond design basis effects were examined for Paks NPP and the necessary improvement actions were determined (see Topic 3). Additionally, the relevant regulation for new reactors, in harmony with international recommendations, contains the requirements for the extension of design basis and severe accidents.

2.3.2 Safety objective for new NPPs

The safety objective for new nuclear power plants is defined through the introduction of the approach of “design extension conditions”: long term off-site radioactive contamination due to severe accident shall be prevented.

The recent update of the Hungarian Nuclear Safety Codes contains this requirement.

2.3.3 Safety requirements for equipment used in design extension conditions

Requirements for the equipment designed to apply in design basis extension state are included in the nuclear safety regulations both regarding fixed (installed) and mobile equipment and their storage location, in full compliance with the current international practices.

It should be noted in relation to each of the above themes that the HAEA follows, and the Hungarian regulations incorporate regularly the enhancements of the international safety standards and recommendations.

TOPIC 3: ON-SITE EMERGENCY RESPONSE, ACCIDENT MANAGEMENT AND RECOVERY

3.1 Tasks derived based on the ENSREG "Compilation of Recommendations and Suggestions" document [9]

The ENSREG document [9] details the expectations regarding on-site emergency preparedness and severe accident management, so the tasks in this issue are only described according to this document and recommendations of the CNS Extraordinary Review Meeting. Recommendations of the Stress Test Peer Review to Hungary [5] are referred to within the issues described.

3.1.1 Compliance with WENRA reference levels

3.1.1.1 Hydrogen mitigation in the containment

This issue is in relation to Theme 2.2. of Topic 3 of the 2nd Extraordinary Review Meeting of the CNS

Paks NPP had decided to introduce the Severe Accident Management Guidelines before the accident of Fukushima-Daiichi NPP as one of the conclusions of the earlier Periodic Safety Reviews, as well as the implementation of the respective technical modifications. One of the technical modifications was the installation of hydrogen recombiners in the containments designed to cope with severe accidents, which was accelerated as a response action to the accident in Japan and carried out before the end of 2011 for each of the units.

Section 6.3.2. of the Hungarian Stress Test report [3] and Section 4.2.1.3. of report [5] address this issue. No further action is necessary.

3.1.1.2 Hydrogen monitoring system

This issue is in relation to Theme 2.2. of Topic 3 of the 2nd Extraordinary Review Meeting of the CNS.

Installation of the severe accident instrumentation has been taking place for Paks NPP unit also in the frame of the above described technical modifications that had been decided before the accident of Fukushima Daiichi NPP. This involves the construction of the hydrogen monitoring system, which may be powered from the severe accident diesel generators. The modification has already taken place in unit 1 and unit 2, while it will be implemented in 2013 in unit 3 and in 2014 in unit 4 [<29>].

Section 6.3.7. of the Hungarian TSR report [3] and the Section 4.2.1.3. of report [5] address this issue. No further action is necessary.

3.1.1.3 Reliable depressurization of the reactor coolant system

This issue is in relation to Theme 2.2. of Topic 3 of the 2nd Extraordinary Review Meeting of the CNS.

Installation of the severe accident diesel generators have also taken place for Paks NPP in the frame of the above described technical modifications decided before the accident of Fukushima Daiichi NPP. This modification is accomplished for all 4 units of the plant. As a means of primary circuit depressurization, the system of overpressure protection valves connected to the pressurizer vessel was modified to ensure its power supply from the severe accident diesel generator, which means a significant safety gain from the aspect of implementation of depressurization.

Section 6.1.2.1. of report [3] described the modification, report [5] did not specifically address this issue. No further action is necessary.

3.1.1.4 Containment overpressure protection

This issue is in relation to Theme 1.4. and 2.2. of Topic 3 of the 2nd Extraordinary Review Meeting of the CNS.

Section 6.3.3. of report [3] described the technical solutions available in Paks NPP in order to prevent over-pressurization of the containment. The report decided the following action for the severe accident pressure conditions to prevent unfiltered release [<30>]:
An analysis of the long-term (beyond 1 week) progression of severe accidents shall be carried out. Based on the analysis results, a system that is able to prevent the long-term, slow over-pressurisation of the containment shall be developed and implemented.
Section 4.2.2.2. of section [5] confirmed the necessity of such an action. Paks NPP prepared the concept for the implementation, which recommends the installation of an active cooling system.

3.1.1.5 Molten corium stabilization

This issue is in relation to Theme 2.2. of Topic 3 of the 2nd Extraordinary Review Meeting of the CNS.

Among the severe accident management measures decided by Paks NPP before the accident of Fukushima-Daiichi NPP the licensee of Paks NPP selected the strategy of in-vessel maintenance of the molten core. According to that, the molten core can be stabilized within the reactor pressure vessel by flooding the reactor cavity and external cooling of the vessel. The respective modification has already been implemented for unit 1 and unit 2, while it will take place in 2013 and 2014 during the refuelling outages of unit 3 and unit 4 respectively.
Section 6.3.5. of report [3] described the modification and Section 4.2.1.3. of report [5] addressed the issue [<31>]. No further action is necessary.

3.1.2 Severe accident management hardware provisions

This issue is in relation to Theme 2.1. and 5.5. of Topic 3 of the 2nd Extraordinary Review Meeting of the CNS.

The design basis for severe accident management modifications decided before the accident of Fukushima Daiichi NPP had been the provision of operability under the specified severe accident circumstances. In addition to that the following actions have been decided:
According to Section 5.1.5. of report [3] in addition to the existing severe accident diesel generators supplying electrical power to measurement and control systems described in accident management procedures, it is justified to install a diverse accident diesel generator, which can supply electrical power to safety consumers having roles in severe accident prevention and long term accident management. The capacity of the diverse accident support diesel generator shall be determined in such a way that it shall be capable of supplying electrical power to the required consumers, pumps and valves. The number and capacity of the independent accident diesel generators shall be determined with the consideration of the safety principles. Simultaneous loss of power of more, even all, units shall be assumed and

the cooling needs of the reactors and the spent fuel pools shall be considered. The independent severe accident diesel generators shall have appropriate protection against beyond design basis external hazards (earthquake, natural hazards, flooding) of the installed emergency diesel generators and they shall be totally independent of other systems (such as the cooling or electric supply systems) of the plant. The design basis for the independent severe accident diesel generators shall be determined in such a way that the accident diesel generators would be available even if the design basis loads of the installed safety diesel generators were exceeded. The concept document prepared for the action contains the installation of 1-1 diesel generator both for Installation I and II, the capacity of which is enough to supply one safety train [<24>].

According to Section 5.2.5. of report [3] the nuclear power plant has 9 wells, each having a large diameter and a depth of 30 m that are bored in the pebble bed of the Danube; these wells are permanent water sources providing an unlimited quantity of water independently of the water level of the Danube. A connection system is installed from the well plant to the essential service water system. Electric power supply shall be provided from a duly protected fixed or mobile diesel generator to supply, in emergency, the submersible pumps of the wells drilled into the pebble bed of the Danube bank [<18>].

According to Section 5.2.5. of report [3] a new water supply route connected in the courtyard by flexible means shall be constructed that is protected from external hazards (such as earthquake). The spent fuel pool shall be filled from the borated water reserve specified above via this line. The required operations shall be specified in procedures [<32>].

According to Section 6.1.5. of report [3] corresponding to management of severe accidents, for the construction of an external water supply route to the auxiliary emergency feedwater system, the equipment necessary for the connection of external origin mobile diesel generators and pumps to the systems shall be purchased [<33>].

3.1.3 Review of Severe Accident Management Provisions Following Severe External Events

This issue is in relation to Theme 1.2. and 5. of Topic 3 of the 2nd Extraordinary Review Meeting of the CNS.

Development of severe accident management guidelines was one of the severe accident management actions decided by Paks NPP before the accident of Fukushima Daiichi NPP. One of the design aspects of the guidelines was the provision for their implementation under the assumed severe accident circumstances. The guidelines enter into force in the various units, when the respective technical modifications are completed: until the end of 2012 regarding unit 1 and unit 2, while in 2013 and 2014 in unit 3 and unit 4, respectively. In the course of the stress test the following action has been decided to supplement the guidelines:
A severe accident situation simultaneously taking place in the reactor and the spent fuel pool shall be managed by the development of a severe accident management guideline. Technical modifications, generated by the implementation of other actions, shall be implemented in the concerned Severe Accident Management Guidelines (SAMG), and the method of the use of external supply opportunity shall be described in procedures [<34>, <35>].

Section 6.1.1.2. of report [3] described the SAMGs and Section 4.1.5. of report [5] confirmed that they conform to the international expectations and it did not identify any need for additional actions.

3.1.4 Enhancement of Severe Accident Management Guidelines

This issue is in relation to Theme 1.2, 4 and 6 of Topic 3 of the 2^{nd} Extraordinary Review Meeting of the CNS.

In addition to that which has been described in Section 3.3.3., Section 6.3.8. of report [3] dealt with further improvement of severe accident guidelines for multi unit accidents. According to the conclusion the guidelines themselves can be applied independently for each unit respectively, but the resources are not sufficient to carry out the guidelines in parallel. So the following action has been determined:
The physical arrangement and instrumentation of the Technical Support Centre, established at the Protected Command Centre, shall be extended to provide sufficient resources for simultaneous management of severe accidents occurring on more than one (even all 4) units [<36>]. The structure of the organization responding to accidents affecting multiple units and the number of staff shall be determined; procedures shall be developed for personnel and equipment provisions, as well as for shift changes [<37>].

The issue was discussed in Section 4.2.1. of report [5], while its Section 4.3. confirmed the decided action.

A further action that increases the tools of the guidelines are that Paks NPP is to initiate the provision of black-start capability (start-up from its own diesel generator) for the Litér gas turbine, such action has also been discussed in Section 2.1.2 [<25>]. The action was grounded in Section 5.1.1.2. of report [3] and discussed by Section 3.2.2.1. of report [5].

3.1.5 Validation of enhanced severe accident management guidelines

The issue corresponds to Theme 1.2 of Topic 3 of the 2^{nd} Extraordinary Review Meeting of the CNS.

In the course of regulatory licensing of severe accident management guidelines, the authority obliged the operator to verify the guidelines in the frame of an emergency response exercise. This has taken place with a regulatory inspection. As the result of the verification the guidelines have been introduced for unit 1. A similar verification would take place after any supplementation or enhancement of the guidelines. Report [3] did not discuss this verification, but in the course of country peer review the international peers received information on the content of that. Report [5] did not foresee any action in this field.

3.1.6 Severe accident exercises

The area of emergency response exercises has been shortly discussed in Section 6.1.1.5. of report [3]. According to the Hungarian legislation the emergency response organization of the NPP is required to carry out a full-scale nuclear emergency exercise every year that involves the whole personnel of the organization. Off-site emergency response organizations shall be invited to take part in the exercise. The scenario of the exercise shall make it possible to practice the implementation of on-site organizational and technical measures in severe accident situations. No action was determined in this area.

3.1.7 Training of severe accident management

This issue is in relation to Theme 1.2. and 4. of Topic 3 of the 2^{nd} Extraordinary Review Meeting of the CNS.

By the introduction and implementation of severe accident management guidelines and modifications the operator also introduced the training of severe accident situations (see 3.3.5.) and proposed its connection with emergency response exercises. Consequently, the emergency response exercises provide an opportunity to practice the tools and procedures of severe accident management. In order to prepare for multiunit accidents, the action described in Section 3.3.4. was determined. The training and exercise of multiunit emergencies can take place after the implementation of that action.

A software-based severe accident training simulator shall be developed [<38>]. In the first stage of the two-stage development the current simulator will be extended for the education of the staff of Technical Support Centre, while later it will be applicable to train a wider scope of the potential users.

Section 6.1.6. of report [3] and Section 4.2.4.2. of report [5] discussed the issue related to severe accident management. No further action is necessary.

3.1.8 Extension of severe accident management guidelines to all plant states

This issue is in relation to Theme 1.2. of Topic 3 of the 2nd Extraordinary Review Meeting of the CNS.

In the frame of severe accident management guidelines elaborated in the frame of severe accident management measures decided before the accident of Fukushima-Daiichi, NPP cover the low power and shutdown mode of the reactor, as well as the severe accident situation of the spent fuel pool. Section 6.2. of report [3] and Section 4.2.1.2. of report [5] discussed the guidelines. No further action is necessary in this area.

3.1.9 Improvement of communication

This issue is in relation to Theme 2.2. of Topic 3 of the 2nd Extraordinary Review Meeting of the CNS.

Section 6.1.2.4. of report [3] discussed emergency communication and the improvement action below has been determined based on the considerations:

The methods to guarantee the conditions for radio communication shall be assessed in the case of permanent loss of electric power and earthquakes and the necessary actions shall be performed [<39>].

Informatics mirror storage computers shall be installed, both at the Protected Command Centre and the Backup Command Centre, containing the necessary scope of data (i.e. technical documentation, personal data, etc.) [<40>].

Section 4.2.2.2. of report [5] confirmed the actions.

3.1.10 Presence of hydrogen in unexpected places

This issue is in relation to Theme 5. of Topic 3 of the 2nd Extraordinary Review Meeting of the CNS.

During the stress test (Section 6.3.8. of [3]) it was determined by conservative, lumped-parameter codes what amount of hydrogen is generated in the accident of two spent fuel pools, one reactor in shutdown and the other reactor in operation and what hydrogen concentration occurs in the reactor hall. According to the calculation results inflammable concentrations may occur, which can lead to turbulent burning. An action was therefore decided in order to determine the distributions using less conservative, three-dimensional analyses beyond the use of the lumped-parameter models [<41>].

The action was confirmed in Section 4.3. of report [5]. Need for further action will be the result of the analysis.

3.1.11 Large volumes of contaminated water

This issue is in relation to Theme 1.4. of Topic 3 of the 2nd Extraordinary Review Meeting of the CNS.

Section 6.1.3.3. of report [3] determined that the plant is not fully prepared to manage liquid radioactive wastes generated in large quantities during a severe accident. The following action was therefore decided:
Procedures shall be developed for the management of liquid radioactive wastes during severe accidents. The risk, potential routes and possible monitoring tools and methods of liquid form release of radioactive materials shall be examined and the measures necessary, and possible to respond to in such a situation, shall be specified [<42>].

3.1.12 Radiation protection

This issue is in relation to Theme 1.4. and 6 of Topic 3 of the 2nd Extraordinary Review Meeting of the CNS.

Report [3] determined (6.1.3.5.) that the following actions are necessary in order to improve the access in severe accident conditions impaired by the adverse radiation conditions:

Procedures for collecting and transporting emergency response personnel shall be developed and the necessary means and rules of their provision shall be determined [<43>]. A shielded transport vehicle deployable at significant radiation levels shall be procured [<44>]. The rules for exemptions from the air ban around the plant shall be modified to manage airborne support [<45>].

According to authority resolution [10] the applicability of fixed radiation monitoring devices installed on, and in the vicinity of the site to support emergency response activities after an earthquake and total loss of power shall be assessed [<46>].

The actions were addressed in Section 4.2.1.5. of [5].

3.1.13 On-site emergency centre

This issue is in relation to Theme 3 of Topic 3 of the 2nd Extraordinary Review Meeting of the CNS.

The NPP has an appropriate on-site emergency centre, the so called Protected Command Centre and shelters suitable for the stay of response personnel. In order to further improve the situation, the following actions have been decided:

Seismic qualification of the on-site shelters not yet qualified shall be performed and non-earthquake resistant equipment in the shelters shall be improved. A nuclear emergency response centre resistant to earthquakes of peak ground acceleration higher than design basis earthquake shall be established [<47>].

Air-conditioning of the Protected Command Centre shall be re-assessed and an appropriate piece of power equipment shall be installed that can also be supplied by diesel generator [<48>].

A Backup Command Centre that complies with protection requirements and is equivalent with the Protected Command Centre in terms of management and communication shall be established [<49>].

The actions were discussed in Section 4.2.1.5. and 4.3. of report [5].

3.1.14 Support to local operators

According to Section 6.1.4 (and 6.1.3.1. and 6.1.3.9.) of report [3] the plant is duly prepared for getting support from external forces in severe accident situation. No further action is necessary. The area was discussed in Section 4.2.1.1. of report [5].

3.1.15 Level 2 Probabilistic Safety Assessments (PSA)

This issue is in relation to Theme 1.3. of Topic 3 of the 2nd Extraordinary Review Meeting of the CNS.

Paks NPP has Level 1 and Level 2 PSA assessment for each operating mode of the reactors and the spent fuel pools. Since the Severe Accident Management Guidelines are not event based, but symptom based, low probability event sequences are not excluded from the scope based on PSA results. No action is necessary.

The area is addressed in Section 3.1.3. of report [5].

3.1.16 Severe accident analyses

No additional actions have been determined for further enhancement of severe accident analyses of Paks NPP beyond those that have been described above.

3.2 CNS themes not, or not fully, addressed above

Theme 1.1: review of regulatory framework

Requirements for beyond design basis accidents and severe accidents appear in the regulatory requirements after being revised in 2011 and 2012. A new revision of the regulations is planned after the revision of IAEA safety standards and WENRA reference levels are completed and published. See Topic 4 in Part II.

Theme 1.4: others (including alternative water sources, recovery from SA, radiological analysis)

Section 2.1.1. discusses the alternative and new diverse coolant supply possibilities. Section 1.1.8. addressed the robustness of essential systems against extreme conditions. Certain aspects of long term severe accident management were covered in Sections 3.1.1.4. and 3.1.4.

Theme 4: multi-unit aspects

Section 2.1.2. discusses sharing of systems and establishment of cross-links between units.

Theme 5: spent fuel pool aspects

Actions for further enhancement of spent fuel pool cooling are included in Sections 2.1.14. and 3.1.2.

Theme 6

Decision-making process of the emergency response organization and its relation to severe accident management are described in Section 6.1.1.2. of report [3].

PART II: ADDITIONAL TOPICS FROM THE 2ND EXTRAORDINARY REVIEW MEETING OF THE CNS

TOPIC 4: NATIONAL ORGANIZATIONS

4.1 Review of nuclear safety and/or radiation protection laws, requirements and recommendations

This issue is in relation to Theme 1 of Topic 4 of the 2nd Extraordinary Review Meeting of the CNS.

As quoted from Act CXVI of 1996 on atomic energy (hereinafter referred to as Atomic Act), Article 8 (4) states that:

"*The organization supervising the use of atomic energy shall*
...
b) in the field of application of atomic energy
ba) follow the general directions of international development, especially the international development of regulations, and make proposals on the necessary national measures and the establishment of laws;
bb) follow the technical development results, international experience and expectations; and
bc) follow the compliance with the laws under its competence; initiate actions based on its conclusions, make proposals on the necessary amendment to laws or establishment of new laws;"

In accordance with Article 3 (7) of Govt. decree 118/2011 on the nuclear safety requirements for nuclear facilities and the related regulatory activities:

"*The Nuclear Safety Code, with the consideration of scientific results, national and international experience, shall be reviewed and if necessary updated at least every five years. The guidelines shall be reviewed periodically based on the decision of the nuclear safety authority or upon the request of the licensees.*"

As an outcome of the latest revision of the Hungarian nuclear safety regulations, the Govt. decree 118/2011. (VII. 11.) Korm. and its annexes (the so called Nuclear Safety Codes) were issued, which establish the national nuclear safety requirements. The fundamental objective of the revision was to utilize the new international expectations and the national experiences gained in the meantime. Govt. decree 37/2012. (III. 9.) Korm. supplemented and amended these regulations in order to establish requirements for a new nuclear power plant unit to be constructed in Hungary. As an outcome of the revision the new regulations include the WENRA (Western European Regulatory Association) Reference Levels (i.e., the expected safety levels generally approved by the European authorities) and the latest safety standards of the International Atomic Energy Agency. The revision, because of its schedule, did not aim at utilizing the experience gained from the Fukushima accident. The lessons to be learned regarding regulations can only be identified after the comprehensive assessment of the accident; the preliminary results have not required any immediate amendment to the legislation.

Hungary undertakes the utilization of the lessons learned from the Fukushima Daiichi accident during the next revision of the nuclear safety legislation. The review should be conducted taking into consideration the following:

- information available regarding emergency response at Fukushima,
- international experience and identified corrective actions,
- statements of the CNS review conference and the stress test on external threats, low probability events, performance of safety functions, emergency response, requirements for severe accident management and on the effective design basis.

The rules of regulatory activities, the independence of the authority, as well as the availability of the resources, needed for the supervisory activity should be reviewed.

Another important source of amending the legislations is the supplementation of the WENRA reference levels, which is expected to be completed by the end of 2013. Additionally, amendments to the nuclear safety legislation could be required after the review of the IAEA recommendations and the European nuclear safety directive; however, they will be realized in a longer term.

4.2 Changes in the functions and responsibilities of the authority

This issue is in relation to Theme 2 of Topic 4 of the 2nd Extraordinary Review Meeting of the CNS.

The role, competence and tasks of the HAEA were presented in the CNS report. The analyses of the Fukushima accident have not yet revealed such a deficiency which requires any change in the functioning of the HAEA. At the request of the Hungarian Government, the IAEA IRRS mission evaluated the performance of the authority in 2015. If the IRRS mission or the reviews discussed in Section 4.1 reveal any deficiency in the Hungarian regulatory system, then Hungary is committed to make the necessary modifications.

4.3 Review and improvements to aspects of emergency preparedness and response

This issue is in relation to Theme 3 of Topic 4 of the 2nd Extraordinary Review Meeting of the CNS.

The training and exercise programmes for the central, sectorial, regional and local organizations of the Hungarian Nuclear Emergency Response System, as well as for the on-site emergency response organizations are discussed in detail in Section 5.7.

The integration of external forces to fire fighting and technical rescue is discussed in Section 5.4.

The emergency planning zones were established based on the relevant IAEA recommendations; the re-sizing of the emergency planning zones is not a need based on the lessons learned from the Fukushima Daiichi accident.

In line with the international convention on early notification, Hungary maintains bilateral cooperation agreements with each neighbouring country. According to these bilateral agreements, Hungarian experts visit the emergency exercises of the neighbouring countries as observers, as well as Hungary invites the experts of these countries to participate in major Hungarian exercises as observers.

No action is needed based on the experience gained from the Fukushima Daiichi accident.

Nevertheless, the Fukushima Daiichi accident revealed certain areas, where the level of preparation should be verified in the frame of an emergency exercise. The main objectives of the national exercise planned to be held in the first half of 2013 are to practice communication with the media and to practice the implementation of certain protective actions with the involvement of invited members of the public. [<51>].

4.4 Openness, transparency and communication improvements

This issue is in relation to Theme 4 of Topic 4 of the 2nd Extraordinary Review Meeting of the CNS.

In accordance with Article 8 (4) d) of the Atomic Act

”*The organization supervising the use of atomic energy ... shall inform the public on the safety of the use of atomic energy, nuclear security, its own activities, its major decisions and their substantiation, as well as on the applied safety, security and safeguards requirements via publishing the relevant information on its website;”*

The HAEA, on its website, continuously informed the public on the situation evolved in Japan and its consequences. The authority made available all relevant information on the preparation for, and execution of, the TSR as well as on the extraordinary review made by the IAEA.

The public information on the implementation of TSR actions does not require daily information provision; however, information could be provided regarding certain major events (e.g. when the implementation of the TSR action plan was ordered or during the annual press conferences). The interested parties can continuously follow the events on the website of the HAEA, since the major news is released thereon by the authority. Additionally, a "Bulletin" is published every six months, which includes information that may satisfy professional needs as well; Bulletins are sent in printed format to a wider scope of people and organizations. The HAEA newsletters should also be mentioned as a communication channel, through which the authority provides information on the major events every three months; its part targeted at the general public is available at the HAEA website. The HAEA, according to law, annually reports its activity to the Hungarian Parliament. This report is discussed within the professional committees of the Parliament, who finally endorse it.

The outcomes of the analyses of the Fukushima Daiichi accident have not revealed such deficiency, which requires any change in the area of openness, transparency and communication.

4.5 Post Fukushima safety re-assessments and action plans

This issue is in relation to Theme 5 of Topic 4 of the 2nd Extraordinary Review Meeting of the CNS.

Based on the expert review, the action plan prepared by the licensee and on the regulatory review (see Introduction), the HAEA ordered the scheduled execution of the required safety improvement measures. The authority continuously monitors, inspects and evaluates the progress in the implementation of the planned actions.

4.6 Human and organizational factors

This issue is in relation to Theme 6 of Topic 4 of the 2nd Extraordinary Review Meeting of the CNS.

The outcomes of the analyses of the Fukushima Daiichi accident have not revealed any such deficiency, which requires any change in this area. If the international reviews, or the review presented in Section 4.1, reveal the need for changes in the field of human and organizational factors, then Hungary is committed to implement the necessary changes.

TOPIC 5: OFF-SITE EMERGENCY RESPONSE[10]

This issue is in relation to Topic 5 of the 2nd Extraordinary Review Meeting of the CNS.

5.1 Legal background

The organizational structure of the national disaster management system, the tasks of ministers and governmental bodies concerned in disaster management regarding prevention, preparation and response, and the tasks of the disaster management organization are regulated by Act CXXVIII of 2011 on disaster management and the amendment of certain relating acts, as well as by the Govt. decree 234/2011. (XI. 10.) implementing the Act CXXVIII of 2011 on disaster management.

The organizational structure and tasks of the Hungarian Nuclear Emergency Response System (HNERS) are regulated by Govt. decree 167/2010. (V. 11.) Korm. The Disaster Management Coordination Inter-ministerial Committee, and its organizational and operational rules are established by Govt. resolution 1150/2012. (V. 15.) Korm.

The comprehensive review of, and amendment to, the legal background completed in the last two years provided the basis for the establishment of a modern and effective national disaster management system. In harmony with the renewal of disaster management and with the consideration of the practical experience gained during the last decade, an implementing decree regulates the tasks of the organizations participating in the response as along with the general rules of international disaster management support and assistance request.

5.2 Hungarian Nuclear Emergency Response System (HNERS)

The preparation for the response to radiological or nuclear events occurring during the peaceful application of atomic energy, as well as the mitigation and elimination of the consequences, are the tasks of the HNERS. The HNERS consists of those central, sectorial, regional and local organizations, which are concerned in the prevention of events entailing non-planned exposure to the public, as well as the mitigation and elimination of the consequences of such events.

The Disaster Management Coordination Interministerial Committee is responsible for supporting the disaster management related decisions of the Government and for the harmonization of disaster management related tasks of the various ministries.

[10] Topic 5, in accordance with the authorizations established in the Atomic Act, was prepared by the Ministry of Interior - National Directorate General of Disaster Management

The Hungarian Nuclear Emergency Response Plan (HNERP) is maintained and regularly updated by the Higher Level Working Group consisting of the representatives of the relevant central, sectorial and regional organizations. As outcomes of these reviews, several guidelines and technical guidance documents were prepared during the recent years. The last version of the HNERP was published in November, 2011; currently, the HNERP is under review.

The county defence committees and their working bodies operate on regional and local levels. The disaster management and nuclear emergency response working committees are chaired by the chairpersons of County Defence Committees. Their tasks are the development of defence plans, county level direction of preparation, response and recovery, providing professional recommendations on response and recovery in the case of a potential or real emergency, submitting proposals, planning and organization of rescues from any aspect, as well as the direction of rescue works. The work of the chairperson is supported, as an assistant chair-person, by a disaster management expert.

In normal operating state the HNERS performs the following tasks: continuous monitoring of the nation-wide radiological situation; collection, verification, analysis of radiological data, and alarming; operation and maintenance of the HNERS alerting system; updating of nuclear emergency response plans; preparation and exercising of organizations concerned in nuclear emergency response; provision of material and technical resources required for the performance of nuclear emergency response tasks.

Tasks to be fulfilled, in addition to those listed above, in alert operating state are: strengthened monitoring; forecasting of unplanned radiation exposure to the population; provision of reliable and timely information to the public on the event occurred and the nation-wide radiological situation; preparation for the commencement of the emergency operation, should it become necessary.

In emergency operating state, the HNERS performs: the assessment, mitigation and termination of the consequences of the extraordinary event inducing the nuclear emergency; forecasting of the radiological consequences of nuclear accident occurring outside the borders of the country and in space, or of a national situation induced by an event entailing radiation hazard; the determination and implementation of the tasks required by the situation. Amendment to the legislation should not be initiated.

The HNERS was established in compliance with the relevant international standards; thus it is at an internationally recognized level.

5.3 Radiation protection

The National Radiation Monitoring and Alarming System (NRMAS) is operated to provide decision making support to the governmental coordination body. The operation of the NRMAS and the direction of its professional work are performed by the minister responsible for disaster management.

The leading organ of the NRMAS is the Nuclear Accident Information and Evaluation Centre, which performs the central tasks of early forecasting in the case of a nuclear emergency and of the international radiological monitoring data exchange system; additionally it provides contribution to public information, support to decisions made by the governmental coordination organization; forecasts the expected dispersion route of radioactive materials discharged from an event having adverse safety influences; operates the international real-time on-line nuclear emergency decision support system.

A sub-system of the NRMAS consists of the installed automatic remote measurement stations of the Radiological Remote Measurement Network, which is the early warning system in the case of a nuclear emergency; the system continuously monitors the radiation dose-rate in the county and the more important meteorological parameters. Currently, gamma dose rate measurement data from 132 measuring stations of six sectors are collected in the national radiological monitoring centre. The network of mobile radiological laboratories means the other sub-system of the NRMAS, which identifies and analyses the radiation contamination in the case of a nuclear emergency. The third sub-system of the NRMAS is the network of fixed laboratories, which measure the radioactivity of the collected samples (i.e. food, milk, soil, water, etc.). These measurements provide basis for the implementation of long-term protective measures (i.e. grazing ban, limitation of food and water consumption, etc).

The operation of the radiation protection monitoring systems under the direction of the Minister of the Interior is regulated by Ministerial decree 7/2012. (III. 7.) BM. No justification for further amendment to the legislation is revealed.

5.4 External resources and tools that can be utilized for on-site emergency response

The chairperson of the Emergency Response Organization of the nuclear power plant, if needed, can request external resources for the response. At the same time, the chairperson of the organization leading the national level emergency response can send forces to support on-site emergency management, if he/she judges that the nuclear power plant is not able to manage the situation with its own resources.

External forces are involved in firefighting and technical rescue, depending on the severity of the occurred situation.

Detailed data, on mobile equipment available at the administrative and national economy organizations for the provision of the electric supply and internal energy supply to the Paks NPP, is included in the survey conducted by the Directorate General for National Disaster Management in the frame of the Targeted Safety Re-assessment. This data primarily refers to the capacity, number, location and activation time (i.e. taking them to transportable condition, their transportation and putting into service) of the available Diesel generators, pumps and fuel transportation vehicle. The vehicles for the transportation or hauling of the generators are selected by the competent disaster management organizations. Operators are available for the generators and pumps requiring special operatory knowledge.

The equipment can be air transported by helicopters of the Hungarian Defence Forces; however air transportation requires the lifting of the air ban around the plant.

5.5 Protective actions

The three counties within the Urgent Protection Action Zone (i.e., the area within the 30 km radius around Paks NPP) are: Bács-Kiskun, Fejér and Tolna Counties. They fulfil their response tasks according to their regional and local emergency response plans.

5.5.1 Iodine prophylaxis

The necessary stock of iodine tablets for the citizens of the settlements within 30 km radius of Paks NPP are provided and maintained by the Medical Stock Management Institute. The tablets are stored in the offices of the local governments concerned, at the family doctors and the duty services of first responder organizations. Following the receipt of the decision on it, the distribution of iodine tablets is performed according to the HNERP.

5.5.2 Evacuation of the workers of Paks Nuclear Power Plant

The evacuation plan of the workers of Paks NPP is included in the General Emergency Response Plan of the plant. According to the plan, the employees should use their own vehicles, the train owned by Paks NPP and the buses put at the disposal of the plant by the regionally competent bus company.

5.5.3 Evacuation and reception

As a part of the emergency response plan, the disaster management organizations established evacuation and reception plans for the public. The reception of the affected population can be arranged, should the evacuation be ordered.

5.5.4 Provision of the public with protection tools

The protection breathing tools (protective hoods) required for the rescue and evacuation are available for those living in settlements located in the dispersion route of the radioactive plume; the protective hoods are distributed at the meeting points.

The protective hoods are stored in the settlements' warehouses for those living within a 9 km radius of the plant; the rest of the stock is stored in the county warehouses (outside of the 30 km zone); the latter are distributed based upon the local effects of the nuclear emergency situation.

5.6 Alerting the public, public information

5.6.1 Alerting the public

Within the 30 km radius of Paks NPP, the technical tool of alerting is the installed public information and alerting system. Altogether 227 modern public information and alerting devices alert about 225,000 people living in 74 settlements on 2,800 square kilometres.

The acoustic terminals are powered by uninterruptible power supplies, thus the public can be alerted and informed in the case of loss of the electrical power supply. The high capacity loud speakers, in addition to traditional siren signals, are appropriate to transmit voice messages, thus the population can be provided with the essential information by way of live broadcasts.

The control centres of the system are installed at the Protected Command Centre, Plant Control Centre and at the Tolna County Disaster Management Directorate; additionally, a mobile control unit is available.

The operability of the sirens is tested by humming signals (i.e. at reduced volume) on the first Monday of each month, and by transmitting a full loud emergency hazard along with end of emergency signals twice a year.

5.6.2 Public information

As required by Govt. decree 165/2003. (X.18.) Korm. on the rules of public information in the case of a nuclear or radiological emergency, public information plan shall be prepared at national, sectorial, county and facility levels by the central bodies and organizations of the HNERS, as well as by those bodies and organizations that are obliged to prepare Emergency Response Plans. The public information plans are to be prepared for providing timely and reliable information to the public; the plans include those available information principles, methods and tools, which can be applied for effective communication.

5.7 Preparation, training and exercising of organizations participating in emergency response

The training and exercising of those having roles in national level emergency response are organized in line with Govt. decree 167/2010. (V.11.) Korm. on the Hungarian nuclear emergency response system. The Training and Exercise Working Committee prepares the annual Training and Exercise Plan, which is then endorsed by the Disaster Management Coordination Interministerial Committee (DMCIC). This annual Plan establishes the major training and exercise programmes for the subject year and the major directions for the subsequent year. It includes the minimum required training and exercise activity, with the consideration of the Long-Term Training and Exercise Plan. The DMCIC, by endorsing the plan, identifies the expectations for the central, sectorial, regional and local organizations of the HNERS. The tasks included in the plan shall then be integrated into the individual Training and Exercise Plans of the HNERS organizations.

A conduct and evaluation plan is prepared for each exercise. The exercises shall be evaluated in line with the viewpoints defined in advance in the conduct and evaluation plan. Based on the evaluation of an exercise, an action plan is established in order to eliminate the identified non-compliances and deficiencies; the progress of the implementation of the actions shall be monitored by the organizations concerned.

5.8 Summary

The experience gained from the TSR and the Fukushima accident has not revealed any such deficiency in the field of off-site emergency preparedness and response, which requires the modification of the Hungarian disaster management system or that of the Hungarian nuclear emergency response system. Following the completion of the international review, based on its outcomes, Hungary will re-assess the need for modifications and, if appropriate, take the necessary steps.

TOPIC 6: INTERNATIONAL COOPERATION

6.1 Strengthening the peer review process of CNS and of missions (IAEA, WANO and Industry)

This issue is in relation to Theme a) of Topic 6 of the 2^{nd} Extraordinary Review Meeting of the CNS.

Hungary will provide information in the CNS national reports on the results of the review missions conducted in the field of nuclear safety, and will offer monitoring of the progress of the implementation of their recommendations.

Hungary, with its own resources, supports the development of the effectiveness and scope of the international nuclear safety expert missions, as well as the enhancement of the coordination between different missions.

Hungary takes part in the improvement of the processes and effectiveness of the CNS, and in the improvement of the reviews conducted in the frame of the CNS.

After the Chernobyl accident, Hungary participated in the safety re-assessment of the Russian design nuclear power plants built based on Russian design, the lessons learned were integrated into the legislation and the safety improvement programme of the nuclear power plant.

6.2 Optimization of the global safety regime

This issue is in relation to Theme b) of Topic 6 of the 2^{nd} Extraordinary Review Meeting of the CNS.

Hungary, with its own resources, supports the rationalization of the responsibility and task sharing between certain international organizations and welcomes those initiatives, which aim at limiting the duplication and optimizing the.tasks in connection with international cooperation

Hungary studies the potential participation in the establishment of a regional crisis centre.

6.3 Strengthening communication mechanisms through regional and bilateral cooperation

This issue is in relation to Theme c) of Topic 6 of the 2^{nd} Extraordinary Review Meeting of the CNS.

Hungary, with its own resources, supports the enhancement of nuclear safety and the nuclear safety regulatory system in countries opting for nuclear energy; Hungary participates in the related activities of the international organizations.

In the field of nuclear safety, Hungary maintains bilateral cooperation with the neighbouring countries. In meetings organized in the frame of these cooperation agreements, Hungary provides information on nuclear safety related information and events.

Hungary is a member of the WENRA Mutual Assistance Working Group, which aims at enhancing the cooperation between nuclear safety authorities in the case of a nuclear accident.

6.4 Effectiveness of experience feedback mechanisms

This issue is in relation to Theme d) of Topic 6 of the 2^{nd} Extraordinary Review Meeting of the CNS.

Hungary takes part in all fora serving for the exchange of experiences in the field of nuclear safety (i.e., IRS, INES, WANO, EU Clearinghouse, VVER Forum) and strives to utilize the experience gained from other sources as well.

The HAEA participates in the working groups aiming at utilizing the lessons learned from the Fukushima Daiichi accident, as follows:

- ENSREG (HAEA is represented at high management level),
- ENSREG nuclear safety working group (WG1),
- WENRA reactor harmonization working group,
- WENRA mutual assistance working group,
- WENRA accident management working group,
- EU nuclear security ad-hoc working group,
- IAEA Action Plan – occasionally, participation in regular IAEA working groups and activities,
- IAEA CNS – Hungarian delegation participates in the extraordinary and regular review conferences,
- OECD NEA WGOE working group.

The tasks set by the above working groups are performed by the designated members, who can live with the possibility to involve other professionals.

Hungary supports striving for emphasizing the experience feedback during expert review mission.

6.5 Strengthening and expanded use of IAEA Safety Standards

This issue is in relation to Theme e) of Topic 6 of the 2nd Extraordinary Review Meeting of the CNS.

Hungary fully integrates the IAEA nuclear safety fundamentals and standards into its nuclear safety legislation (see Section 4.1); Hungary constantly supports the development of these standards in order to continuously enhance nuclear safety. Hungary agrees that the prevention and consequence mitigation should be more reasonably represented among the requirements.

PART III

In line with Reference [8] Part III would list those actions that are identified in such areas that have not been discussed in the previous topics, i.e., which cannot be grouped under previous topics (under Part I and Part II). The review has not identified the need of such actions.

PART IV: SUMMARY TABLE OF ACTIONS

Task[11]		Topic	Action	Comment	Identifier in the HA5589 resolution [12]	Final deadline	TSR national report [3] reference	ENSREG report [9] reference
	1.	**Natural hazards**						
1.	1.1.	Recurrence frequency taken into account in the design basis	Considering natural hazards of 10 thousand year recurring frequency. For earthquake, flooding and low water level of Danube.	Successful termination of assessments in December, 2011. No open task in this area.		Task completed.	2.1.1	3.1.1
2.	1.2.	Secondary effects of earthquakes	1 - Interventions to protect the personnel and equipment in the fire brigade barrack, which is made of reinforced concrete, but has not yet been seismically qualified.		1.2.	15.12.2015.	2.3.3, 3.1.1	3.1.2
3.			2 - The demineralised water tanks in Installation II that play an important role in ensuring demineralised water stocks are located in the direct vicinity of the		1.9.	15.12.2015.	2.1.2	3.1.2

[11] All references to these serial numbers are in [<xx>] form

Task[11]		Topic	Action	Comment	Identifier in the HA5589 resolution [12]	Final deadline	TSR national report [3] reference	ENSREG report [9] reference
			medical and laboratory building. The walls of the building shall be seismically qualified and, if necessary, reinforced or provide appropriate protection of the tanks by other means.					
4.			3 - The underground lines and connections (pipelines, cables) at risk due to potential settlement of the main building shall be re-qualified and, if necessary, modified to allow for a relative displacement.	According to the current conservative analyses, soil liquefaction might occur in the acceleration ranges slightly exceeding the design basis, which can cause an uneven settlement of the buildings.	1.11.	15.12.2017.	2.2.1.1	3.1.2
5.			4 - A state-of-the-art analysis shall be performed for the proper assessment of the existing margins of earthquake-initiated building settlement and soil liquefaction phenomenon.		1.45.	15.12.2018.	2.2, 2.2.1.1.	3.1.2
6.	1.3.	Protected volume approach	1 - The water penetration through the walls would	Certain wall penetrations in the machine room of	1.4.	15.12.2015.	3.1.2	3.1.3

Task[11]		Topic	Action	Comment	Identifier in the HA5589 resolution [12]	Final deadline	TSR national report [3] reference	ENSREG report [9] reference
			accumulate in a sump and a permanently installed sump pump can remove it. Modification of the wall penetrations to a sealed design shall be carried out.	essential service water pumps are not provided with water sealing, so flooding of the machine room may occur if a beyond design basis flood takes place.				
7.			2 - Automatic shutdown of the main condenser coolant pumps shall be provided when the condenser pipeline is damaged due to earthquake or other reason. It shall be ensured that the pipeline trenches are applicable to receive and drain the discharged water. If necessary, the slope shall be elevated or a protective dam shall be constructed to avoid the flooding of the turbine hall or the cable tunnels.		1.10.	15.12.2015.	2.1.2	3.1.3
8.		Safety culture	Fixing of the non-process equipment and tools that		1.3.	15.12.2014.	2.1.2. and 2.2.4.	

Task[11]		Topic	Action	Comment	Identifier in the HA5589 resolution [12]	Final deadline	TSR national report [3] reference	ENSREG report [9] reference
			could adversely impact process equipment during outages shall be provided.					
-	1.4.	Early warning notifications for extraordinary natural impacts	No action necessary.	Taking into account the relatively small size and geographical situation of Hungary, the current practice is satisfactory from every aspect and no task has been identified.		-		3.1.4
9.	1.5.	Seismic monitoring system	In the frame of the reconstruction project of seismic instrumentation, which is in the preparatory phase, the question of automatic shutdown shall be revisited.	Currently no such system exists, which would initiate an automatic shutdown of the reactors for a given acceleration level.	1.1.	31.12.2012.	2.1.2; 2.1.2., 2.2.1., 2.2.4., 6. and 7.3.	3.1.5
-	1.6.	On-scene inspections, qualified walkdowns	A regular activity is going on, it is not necessary to modify the current practice.	If specific international standards, requirements become available for such inspections and walkdowns, both the authority and the licensee shall adopt and apply them.		-		3.1.6

Task[11]		Topic	Action	Comment	Identifier in the HA5589 resolution [12]	Final deadline	TSR national report [3] reference	ENSREG report [9] reference
-	1.7.	Flooding margin assessments	No action necessary.	The stress test assessment determined that the site of Paks NPP is not prone to flooding.		-		3.1.7
-	1.8.	Assessment of external hazard margins	The latest Periodic Safety Review dated to 2008 required new, supplementary analyses.	Evaluation of loads caused by weather impacts is not in compliance with the modern expectations.		31.12.2012.		3.1.8
10.		Further tasks independent of the above expectations	1- The existing symptom-based emergency operating procedures shall be reassessed as to whether they support an optimal recovery in such combined situation.	Due to implications from Fukushima Daiichi accident, such improbable, complex cases shall also be taken into account as extension of the design bases.	1.21.	15.12.2013.	2.1.2.	
11.			2 - Protection of the not seismically reinforced 400 kV and 120 kV substations and the automatisms switching the plant to isolated operation against earthquakes shall be evaluated and increased if necessary.	The 400 kV and 120 kV substations though not safety systems and not seismically reinforced, might provide many alternative electric supply opportunities, if they are not damaged.	1.6.	15.12.2014.	2.2.1.2, 5.1.1.3, 5.1.5, 5.2.5 and 5.3.1, 2.1.2., 2.2.1., 2.2.4., 6. and 7.3.	

Task[11]		Topic	Action	Comment	Identifier in the HA5589 resolution [12]	Final deadline	TSR national report [3] reference	ENSREG report [9] reference
12.			3 – Periodic inspection, maintenance and operational testing of the equipment to be applied in case of low water level of the Danube shall be supplemented. The respective, missing inspection, testing and maintenance instructions shall be developed.	During the stress test the plant identified that the maintenance and inspection procedures to be applied in the situation of extreme low level of the Danube were not satisfactory	1.24.	15.12.2013.	5.2.2; 5.2	
13.			4 – A list of such system components important to safety, which are endangered by electromagnetic effects (including the effects induced by lightning) shall be compiled and display whether a given component is adequately qualified.	Based on the list the authority and the licensee can specify reinforcements and corrective actions. HA5444-1.2.3	1.42.	15.12.2015.		
14.			5 - It shall be analyzed if the lack of seismic qualification of the machine racks and travelling water band screens of the essential service water		1.41.	15.12.2015.	2.1.2., 2.2.1., 2.2.4., 6. and 7.3.	

Task[11]		Topic	Action	Comment	Identifier in the HA5589 resolution [12]	Final deadline	TSR national report [3] reference	ENSREG report [9] reference
			system jeopardizes the ultimate heat sink function and, if necessary, the adequate exclusion measures shall be implemented.					
	2.	**Design issues**						
15.	2.1.1.	Application of means providing alternate cooling and heat sink	1- The operator shall maximize the available inventory of the stored demineralised water in all operation states.		1.7.	15.03.2014.	5.2.5	
16.			2- Access to the connection point of the auxiliary emergency feedwater system in accident conditions shall be improved, new connection points shall be established on the demineralised water tanks.		1.14.	15.12.2015.	5.2.5	
17.			3- The potential setting of the boron concentration of water inventories from external sources and its storage shall be solved and supply mode of borated		1.15.	15.12.2018.	5.2.5	

Task[11]		Topic	Action	Comment	Identifier in the HA5589 resolution [12]	Final deadline	TSR national report [3] reference	ENSREG report [9] reference
			water inventories to the containment shall be regulated in an operating instruction.					
18.			4- By provision of appropriate electrical power supply it shall be established that the bank filtered well plant, which can be used irrespective of the water level of the river, be able to supply water to the essential service water system via the existing connections in accident situations.		1.17.	15.12.2015.	5.2.5, 5.1.1.3, 5.1.5, 5.2.5 and 5.3.1.	
19.			5- The accessibility of the water reserve available in the closed segment of the discharge water canal for the earthquake resistant fire water pump station of Installation II that is equipped with individual diesel power supply shall be solved.		1.18.	15.12.2018.	5.2.5	

Task[11]		Topic	Action	Comment	Identifier in the HA5589 resolution [12]	Final deadline	TSR national report [3] reference	ENSREG report [9] reference
20.			6- Similar to the connection existing on Installation I, the water supply shall be solved also for Installation II from the fire water system to the essential service water system through the technology cooling water system.		1.19.	15.12.2015.	5.2.5	
21.			7- The equipment necessary for the cooling water supply to at least one diesel generator of each unit from the fire water system shall be provided and the operating instruction shall be completed with the measures to be implemented.		1.20.	15.12.2015.	5.2.5, 5.1.1.3, 5.1.5, 5.2.5 and 5.3.1.	
22.	2.1.2.	Enhancement opportunities of on-site and off-site AC power supply	1- Utilizing the fuel storage capacity of the safety diesel generators the amount of diesel fuel to be stored shall be increased and this shall be incorporated in an administrative procedure.		1.5.	15.03.2014.	5.1.1.3, 5.1.5, 5.2.5 and 5.3.1.	

Task[11]		Topic	Action	Comment	Identifier in the HA5589 resolution [12]	Final deadline	TSR national report [3] reference	ENSREG report [9] reference
-			2- See: [<11>]			30.09.2013.	2.2.1.2, 5.1.1.3, 5.1.5, 5.2.5 and 5.3.1.	
23.			3- Power-operated filters of the essential service water system shall be established.		1.8.	15.12.2015.	5.1.1.3, 5.1.5, 5.2.5 and 5.3.1.	
24.			4- Appropriately protected independent severe accident diesel generator(s) shall be installed after assessment of the necessary number and capacity, and determination of the design requirements including beyond design basis hazards.		1.12.	15.12.2018.	5.1.3; 5.1.1.3, 5.1.5, 5.2.5 and 5.3.1.	
25.			5- Out of the two power plants being able to supply external electric power via dedicated lines, the black-start capability (start-up		1.13.	15.12.2014.	5.1.1.2, 5.1.1.3, 5.1.5, 5.2.5 and 5.3.1.	

Task[11]		Topic	Action	Comment	Identifier in the HA5589 resolution [12]	Final deadline	TSR national report [3] reference	ENSREG report [9] reference
			from own diesel generator) shall be created for the Litér gas turbine.					
26.			6- Procedures shall be developed for the use of the possible, but currently not applied cross-links between the units for normal operation and for the backup and safety buses.		1.22.	31.07.2013.	5.1.1.3, 5.1.5, 5.2.5 and 5.3.1.	
27.			7- Possible cross-links shall be studied and the concluding modifications shall be carried out for providing safety electrical power supply from any operable emergency diesel generator in any unit to the safety consumers of any other unit.		1.23.	15.12.2015.	5.1.1.3, 5.1.5, 5.2.5 and 5.3.1.	
-	2.1.3.	Enhancement opportunities of DC power supply.	No action necessary.					
-	2.1.4	Operational and preparatory	Respective actions are discussed in Topic 1 and/or					

Task[11]		Topic	Action	Comment	Identifier in the HA5589 resolution [12]	Final deadline	TSR national report [3] reference	ENSREG report [9] reference
		actions.	Topic 3.					
-	2.1.5	Instrumentation and monitoring.	Respective actions are discussed in Topic 1 and/or Topic 3.					
-	2.1.6	Shutdown improvements	Discussed in Section 2.1.17 and Topic 3.					
-	2.1.7	Reactor coolant pumps seals	Not relevant for VVER-440/213					
-	2.1.8	Improvement of ventilation capacity in total loss of power supply.	Section 2.1.2. of [3] dealt with the provision of AC power supply. No separate action was necessary except for the Protected Command Centre, which is discussed under Topic 3.	No separate action was necessary except for the Protected Command Centre.				
-	2.1.9	Improvement of main and backup control rooms for long term habitability after a total loss of power	Tasks were only identified for emergency command centres, which are discussed under Topic 3.			15.12.2018.		
-	2.1.10	Improvement of robustness of spent fuel pools for various events.	Respective actions are discussed in Topic 1 and/or Topic 3.					

Task[11]		Topic	Action	Comment	Identifier in the HA5589 resolution [12]	Final deadline	TSR national report [3] reference	ENSREG report [9] reference
-	2.1.11	Improvement of separation and independence of safety systems.	Timely shut down the large diameter and large flow-rate condenser cooling water systems, if damaged, to avoid flooding of safety systems. Identical to [<7>].			15.12.2015.	2.1.2. and 2.2.4.	
-	2.1.12	2.1.12 Flow path and access availability.		Instead of maintenance of routes with special tools, actions rather meant to ensure parallel, diverse water and electric power supply routes were decided during the stress test.				
-	2.1.13	Provision of mobile devices and their adequate storage.	Respective actions are discussed in Topic 1 and/or Topic 3.					
-	2.1.14	Bunkered/hardened systems.	Respective actions are discussed in Topic 1 and/or Topic 3.					
-	2.1.15	Improvement of response capability to multiple accidents on the	Respective actions are discussed in Topic 1 and/or Topic 3.					

Task[11]		Topic	Action	Comment	Identifier in the HA5589 resolution [12]	Final deadline	TSR national report [3] reference	ENSREG report [9] reference
		site.						
-	2.1.16	Equipment inspection and training programmes.	Respective actions are discussed in Topic 1 and/or Topic 3.					
28.	2.1.17	Further studies to address uncertainties.	Probabilistic assessment for closed reactor states under 150 °C primary circuit temperature, whether a time limit considering the balanced distribution of risk is reasonable to be established and introduced and actions [<9>], [<11>], [<10>], [<18>], [<5>].		1.43.	31.12.2012.	2.2.1., 5.2.4. and 5.2.5; 2.1.2., 2.2.1., 2.2.4., 6. and 7.3.	
	3.	**On-site emergency response, accident management and recovery**						
-	3.1.1	Compliance with WENRA reference levels	After completion of amendment of WENRA reference levels the missing requirements will be incorporated in the nuclear			15.12.2018.		3.3.1

Task[11]		Topic	Action	Comment	Identifier in the HA5589 resolution [12]	Final deadline	TSR national report [3] reference	ENSREG report [9] reference
			safety regulations.					
-	3.1.1.1	3.1.1.1 Hydrogen mitigation in the containment	One of the technical modifications was the installation of hydrogen recombiners in the containments designed to cope with severe accidents, which were installed for all of the 4 units before the end of 2011. No action necessary.			31.12.2011.		3.3.1
29.	3.1.1.2	Hydrogen monitoring system	Installation of hydrogen monitoring system as part of the severe accident instrumentation for units 3 and 4.	Installation of a hydrogen monitoring system as part of the severe accident instrumentation has already been completed for units 1 and 2, while it will be completed in 2013 and 2014 for units 3 and 4 respectively.		15.12.2013.	6.3.7	3.3.1
-	3.1.1.3	Reliable depressurization of the reactor coolant system	Installation of the severe accident diesel generators has taken place for Paks NPP in the frame of severe					3.3.1

Task[11]		Topic	Action	Comment	Identifier in the HA5589 resolution [12]	Final deadline	TSR national report [3] reference	ENSREG report [9] reference
			accident management actions for all 4 units of the plant. No action necessary.					
30.	3.1.1.4	Containment overpressure protection	The system that is able to prevent the long-term, slow over-pressurisation of the containment shall be developed and implemented.	Paks NPP prepared the concept for the implementation, which recommends the installation of an active cooling system.	1.25.	15.12.2018.	2.1.2., 2.2.1., 2.2.4., 6. and 7.3.; 6.3.3	3.3.1
31.	3.1.1.5	Molten corium stabilization	Among the severe accident management measures Paks NPP selected the strategy of in-vessel maintenance of the molten core. No further action is necessary.	The molten core can be stabilized within the reactor pressure vessel by flooding the reactor cavity and external cooling of the vessel. The respective modification has already been implemented for unit 1 and unit 2, while it will take place in 2013 and 2014 during the refuelling outages of unit 3 and unit 4 respectively.		31.12.2014.	6.5.3	3.3.1
-	3.1.2.	Severe accident management	1 - Appropriately protected independent severe accident	The concept document prepared for the action		15.12.2018.		3.3.2

Task[11]		Topic	Action	Comment	Identifier in the HA5589 resolution [12]	Final deadline	TSR national report [3] reference	ENSREG report [9] reference
		hardware provisions	diesel generator(s) shall be installed after assessment of the necessary number and capacity and determination of the design requirements including beyond design basis hazards. Identical to [<24>].	contains the installation of 1-1a diesel generator for both Installation I and II, the capacity of which is enough to supply one safety train.				
-			2 - By provision of appropriate electrical power supply it shall be established that the bank filtered well plant, which can be used irrespective of the water level of the river, be able to supply water to the essential service water system via the existing connections in accident situations. Identical to [<18>].	The nuclear power plant has 9 wells each having a large diameter and a depth of 30 m that are bored in the pebble bed of the Danube; these wells are permanent water sources providing an unlimited quantity of water independently of the water level of the Danube.		15.12.2015.		3.3.2
32.			3 - A new water supply route connected in the courtyard by flexible means shall be constructed that is protected from external hazards (such		1.16.	15.12.2018.	1.2.2. and 2.1.2.	3.3.2

Task[11]		Topic	Action	Comment	Identifier in the HA5589 resolution [12]	Final deadline	TSR national report [3] reference	ENSREG report [9] reference
			as earthquake). The spent fuel pool shall be filled from the borated water reserve specified previously via this line. The required operations shall be specified in procedures.					
33.			4 - Corresponding to management of severe accidents, for the construction of an external water supply route to the auxiliary emergency feedwater system, the equipment necessary for the connection of external origin mobile diesel generators and pumps to the systems shall be purchased.		1.35.	15.12.2016.	5.2.5; 5.1.1.3, 5.1.5, 5.2.5	3.3.2
34.	3. 1.3.	Review of SAM Provisions Following Severe External Events	Severe accident situations simultaneously taking place in the reactor and the spent fuel pool shall be managed by the development of a severe accident management	The guidelines enter into force in the various units, when the respective technical modifications are completed: by the end of 2012 regarding	1.26.	15.12.2018.	1.2.2, 2.1.2.	3.3.3

Task[11]		Topic	Action	Comment	Identifier in the HA5589 resolution [12]	Final deadline	TSR national report [3] reference	ENSREG report [9] reference
			guideline. Technical modifications generated by the implementation of other actions shall be implemented in the concerned SAMG.	unit 1 and unit 2, while in 2013 and 2014 in unit 3 and unit 4, respectively.				
35.			The method of usage of external supply opportunity shall be described in instruction documents.		1.36	15.12.2017.	1.2.2, 2.1.2.	3.3.3
36.	3. 1.4.	Enhancement of Severe Accident Management Guidelines	The physical arrangement and instrumentation of the Technical Support Centre established at the Protected Command Centre shall be extended to provide sufficient resources for simultaneous management of severe accidents occurring on more than one (even all 4) units.		1.38.	15.12.2018.	6.3.8	
37.			The structure of the organization responding to accidents affecting multiple units and the number of staff shall be determined;		1.37.	15.12.2017.	6.3.8	

Task[11]		Topic	Action	Comment	Identifier in the HA5589 resolution [12]	Final deadline	TSR national report [3] reference	ENSREG report [9] reference
			procedures shall be developed for personnel and equipment provisions, as well as for shift changes.					
-			Paks NPP initiates the establishment of black-start capability (start-up from its own diesel generator) for the Litér gas turbine. Identical to [<25>]-el.			15.12.2014.	5.1.1.3, 5.1.5, 5.2.5 and 5.3.1.	3.3.4
-	3. 1.5.	Validation of enhanced severe accident management guidelines	No separate task is necessary	As the result of the verification the guidelines have been introduced for unit 1. A similar verification would take place after any supplementation or enhancement of the guidelines.				3.3.5
-	3. 1.6.	Severe accident exercises	The scenario of the exercise shall make it possible to practice the implementation of on-site organizational and technical measures in severe accident situations. No	According to the Hungarian legislation the emergency response organization of the NPP is required to carry out a full-scale nuclear				3.3.6

Task[11]		Topic	Action	Comment	Identifier in the HA5589 resolution [12]	Final deadline	TSR national report [3] reference	ENSREG report [9] reference
			action was determined in this area.	emergency exercise every year that involves the whole personnel of the organization.				
38.	3. 1.7.	Training of severe accident management	The training and exercise of multi unit emergencies can take place after the implementation of that action. A software-based severe accident training simulator shall be developed. In the first stage of the two-stage development the current simulator will be extended for the education of the staff of Technical Support Centre, while later it will be extended to train a wider scope of the users.	By the introduction and implementation of severe accident management guidelines and modifications the operator also introduced the training of severe accident situations to the scope of emergency response exercises.	1.39.	15.12.2017.	6.1.6	3.3.7
-	3. 1.8.	Extension of severe accident management guidelines to all plant states	Already implemented.	The severe accident management guidelines cover the low power and shutdown mode of the reactor, as well as the				3.3.8

Task[11]		Topic	Action	Comment	Identifier in the HA5589 resolution [12]	Final deadline	TSR national report [3] reference	ENSREG report [9] reference
				severe accident situation of the spent fuel pool.				
39.	3. 1.9.	Improvement of communication	1 - Conditions for radio communication shall be assessed in the case of permanent loss of electric power and earthquakes and the necessary actions shall be performed.		1.30.	15.12.2018.	2.1.2., 2.2.1., 2.2.4., 6. and 7.3.	3.3.9
40.			2 - Informatics mirror storage computers shall be installed both at the Protected Command Centre and the Backup Command Centre containing the necessary scope of data.		1.31.	15.12.2016.	6.1.2.4.	3.3.9
41.	3. 1.10	Presence of hydrogen in unexpected places	Distributions using less conservative, three-dimensional analyses beyond the use of the lumped-parameter models shall be performed. Need for further action will be resultant on the analysis.	According to the calculation results inflammable concentrations may occur, which can lead to turbulent burning.	1.46.	31.12.2012.	2.2.1., 5.2.4. and 5.2.5; 2.1.2., 2.2.1., 2.2.4., 6. and 7.3; 6.3.8.	3.3.10

Task[11]		Topic	Action	Comment	Identifier in the HA5589 resolution [12]	Final deadline	TSR national report [3] reference	ENSREG report [9] reference
42.	3. 1.11	Large volumes of contaminated water	Procedures shall be developed for the management of liquid radioactive wastes during severe accidents. The risk, potential routes and possible monitoring tools and methods of liquid form release of radioactive materials shall be examined and the measures necessary and possible to respond to in such a situation shall be specified.	The plant is not fully prepared to manage liquid radioactive wastes generated in large quantities during a severe accident.	1.40.	15.12.2015.	2.1.2., 2.2.1., 2.2.4., 6. and 7.3; 6.1.3.3.	3.3.11
43.	3. 1.12	Radiation protection	1- Procedures for collecting and transporting emergency response personnel shall be developed and the necessary means and rules of their provision shall be determined.	The goal is to improve the access in severe accident conditions impaired by the adverse radiation conditions.	1.32.	15.12.2017.	6.1.3.5.	3.3.12
44.			2- A shielded transport vehicle deployable at significant radiation levels shall be procured.		1.33.	15.12.2018.	6.1.3.5.	3.3.12

Task[11]		Topic	Action	Comment	Identifier in the HA5589 resolution [12]	Final deadline	TSR national report [3] reference	ENSREG report [9] reference
45.			3- The rules for exemptions from the air ban around the plant shall be modified to manage airborne support.		1.34.	15.12.2014.	6.1.3.5.	3.3.12
46.			4- The applicability of fixed radiation monitoring devices installed on, and in the vicinity of, the site to support emergency response activities after an earthquake and total loss of power shall be assessed.		1.44.	15.12.2014.	2.1.2., 2.2.1., 2.2.4., 6. and 7.3; 4.2.1.5	3.3.12
47.	3. 1.13	On-site emergency centre	1- Seismic qualification of the on-site shelters not yet qualified shall be performed and non-earthquake resistant equipment in the shelters shall be improved. A nuclear emergency response centre resistant to earthquakes of a peak ground acceleration higher than design basis earthquake shall be established.		1.27.	15.12.2016.	4.2.1; 5.1.3	3.3.13
48.			2- Air-conditioning of the		1.29.	15.12.2015.	5.1.3. and	3.3.13

Task[11]		Topic	Action	Comment	Identifier in the HA5589 resolution [12]	Final deadline	TSR national report [3] reference	ENSREG report [9] reference
			Protected Command Centre shall be re-assessed and an appropriate power equipment shall be installed that can also be supplied by diesel generator.				4.2.1; 2.1.2.	
49.			3- A Backup Command Centre that complies with protection requirements, and is equivalent with the Protected Command Centre in terms of management and communication, shall be established.		1.28.	15.12.2017.		3.3.13
-	3. 1.14	Support to local operators	The plant is duly prepared for getting support from external forces in severe accident situation. No further action is necessary.					3.3.14
-	3. 1.15	Level 2 probabilistic safety analysis	No action necessary.	Paks NPP has Level 1 and Level 2 PSA assessment for each operating mode of the reactors and the spent fuel pools.				3.3.15

Task[11]		Topic	Action	Comment	Identifier in the HA5589 resolution [12]	Final deadline	TSR national report [3] reference	ENSREG report [9] reference
-	3. 1.16	Severe accident analyses	No action necessary.					3.3.16
	4.	**National organizations**						
50.	4.1.	Review of nuclear and/or radiation protection laws, requirements and recommendations	The laws on regulatory supervisory activity, as well as the independence of the authority and the existence of conditions required for regulatory supervisory activity, should be revised in the mirror of the lessons learned.	Another important source of the amendment to laws can be the supplementation of the WENRA reference levels, which may be established in 2013. Additionally, the amendment to nuclear safety regulations can be required by the revisions of IAEA recommendations and the EU nuclear safety directive; however, their realization is a future issue.		15.12.2016		
-	4.2.	Changes in the role	No action is needed.	At the request of the				

Task[11]		Topic	Action	Comment	Identifier in the HA5589 resolution [12]	Final deadline	TSR national report [3] reference	ENSREG report [9] reference
		and responsibility of the authority		Government of Hungary, the performance of the Authority was reviewed by the IAEA IRRS mission in 2015.				
51.	4.3.	National review of emergency response activity, and developments	One of the main objectives of the national exercise planned to be organized in the first half of 2013 is to practice media communication, as well as to practice the execution of certain protective actions with the participation of the invited representatives of the public.			15.12.2013		
-	4.4.	Steps in the area of openness, transparency and communication	No action is needed.					
-	4.5.	Post-Fukushima safety re-assessment and action plan	No action is needed.	The Authority ordered the scheduled execution of the required safety improvement measures, and continuously verifies				

Task[11]		Topic	Action	Comment	Identifier in the HA5589 resolution [12]	Final deadline	TSR national report [3] reference	ENSREG report [9] reference
				and evaluates the progress of execution.				
-	4.6.	Human and organizational factors	No action is needed.					
-	**5.**	**Off-site emergency preparedness and response**	Currently, no task is needed to be set.	After the conclusion of the international review, based on their results, Hungary will re-assess the need for modifications and be ready to take the necessary actions.				
	6.	**International cooperation**						
-	6.1.	Strengthening the effectiveness of the CNS process and other missions	It is a continuous activity; no additional action is needed.					
-	6.2.	Optimization of the global safety environment	It is a continuous activity; no additional action is needed.					
-	6.3.	Strengthening the communication on a regional and	It is a continuous activity; no additional action is needed.					

Task[11]		Topic	Action	Comment	Identifier in the HA5589 resolution [12]	Final deadline	TSR national report [3] reference	ENSREG report [9] reference
		bilateral basis						
-	6.4.	Improving the effectiveness of experience feedback	It is a continuous activity; no additional action is needed.					
-	6.5.	Development of IAEA safety standards and extension of their application	It is a continuous activity; no additional action is needed.					

PART V: PROGRESS IN THE ACTION PLAN, REVIEW 1, 18.12.2014., REVIEW 2, 11.04.2016 (WITH REFERENCE DATE END OF 2015)

REVIEW 1, 18.12.2014.

REVIEW 2, 11.04.2016 (WITH REFERENCE DATE END OF 2015)

Number of task	Identifier in the HA5589 resolution	Action	Deadline	Description of progress, justification of modifications, technical justification, results
1	-	Considering natural hazards of 10 thousand year recurring frequency. For earthquake, flooding and low water level of Danube.		Completed before the preparation of the action plan.
2	1.2.	Interventions to protect the personnel and equipment in the fire brigade barrack, which is made of reinforced concrete, but has not yet been seismically qualified.	15.12.2015	They will be delayed due to change of technical content. Instead of reinforcement of the old building, a new one will be constructed. The technical plans were completed for a new fire brigade barrack. Construction license was granted to Paks NPP. Construction plan is developed; it is currently under commenting period within the plant. The task can be completed as early as 2017. *At the end of 2015 the task was under tendering.*

3	1.9.	The demineralised water tanks in Installation II that play an important role in ensuring demineralised water stocks are located in the direct vicinity of the medical and laboratory building. The walls of the building shall be seismically qualified and, if necessary, reinforced or provide appropriate protection of the tanks by other means.	15.12.2015	A new analysis changed the technical content. At first the tanks were to be protected, now rather the reinforcement of the building is decided. The new analysis, construction planning, and time needs of public procurement procedure cause delay. A new schedule will be ready by 2015 February. *The proof of completion was submitted to authority approval at the end of 2015.*
4	1.11.	The underground lines and connections (pipelines, cables) at risk due to potential settlement of the main building shall be re-qualified and, if necessary, modified to allow for a relative displacement.	15.12.2017	Seismic input data will be ready by the end of 2015. (Action 5. (1.45.)). The scope of the concerned pipelines was completed. The technical solution is in the planning phase. The concept for management of small diameter (d < 100 mm) pipelines is ready. The completion of the task may undergo delay because the appropriate technical solution for large diameter pipelines should be found; in addition a delay due to the public procurement procedure is also expected. *No modification is necessary based on the assessment performed in Task 1.45.*

5	1.45.	A state-of-the-art analysis shall be performed for the proper assessment of the existing margins of earthquake-initiated building settlement and soil liquefaction phenomenon.	15.12.2018	The work is in progress, determination of settlement parameters will be completed by the end of 2015. Deadline can be met. *The assessment was completed and submitted to authority acceptance at the end of 2015.*
6	1.4.	The water penetration through the walls would accumulate in a sump and a permanently installed sump pump can remove it. Modification of the wall penetrations to a sealed design shall be carried out.	15.12.2015	Completed 29 months before the deadline.
7	1.10.	Automatic shutdown of the main condenser coolant pumps shall be provided when the condenser pipeline is damaged due to earthquake or other reason. It shall be ensured that the pipeline trenches are applicable to receive and drain the discharged water. If necessary, the slope shall be elevated or a protective dam shall be constructed to avoid the flooding of the turbine hall or the cable tunnels.	15.12.2015	The construction plans are finished, the public procurement procedure is in progress. Construction can start in first half of 2015. Deadline can be met. *Implementation has started, completion is anticipated by 2016 August.*
8	1.3.	Fixing of the non-process equipment and tools that could adversely impact process equipment during outages shall be provided.	15.12.2014	Completed by deadline.
9	1.1.	In the frame of the reconstruction project of seismic instrumentation, which is in the preparatory phase, the question of automatic shutdown shall be revisited.	31.12.2012	Completed by deadline.

10	1.21	The existing symptom-based emergency operating procedures shall be reassessed as to whether they support an optimal recovery in such combined situation.	15.12.2013	Completed by deadline.
11.	1.6.	Protection of the not seismically reinforced 400 kV and 120 kV substations and the automatisms switching the plant to isolated operation against earthquakes shall be evaluated and increased if necessary.	15.12.2014	Construction is in progress, at least some parts will be completed by the beginning of 2015. *Completion of the task was approved by the authority in November 2015.*
12.	1.24.	Periodic inspection, maintenance and operational testing of the equipment to be applied in case of low water level of the Danube shall be supplemented. The respective, missing inspection, testing and maintenance instructions shall be developed.	15.12.2013	Completed 17 months before the deadline.
13.	1.42.	A list of such system components important to safety, which are endangered by electromagnetic effects (including the effects induced by lightning) shall be compiled and display whether a given component is adequately qualified.	15.12.2015	Supplementary repair of external lightning protection systems based on the revealed deficiencies is in progress. Modification of cable paths and shielding of relay tables have been commenced. Construction will be completed in 2015. *The licensee submitted the task completion at the end of 2015 for authority acceptance.*
14.	1.41	It shall be analyzed if the lack of seismic qualification of the machine racks and travelling water band screens of the essential service water system jeopardizes the ultimate heat sink function and, if necessary, the adequate exclusion measures shall be implemented.	15.12.2015	The work has commenced. Deadline can be met. *Completion of the task was approved by the authority in November 2015.*

15	1.7	The operator shall maximize the available inventory of the stored demineralised water in all operation states.	13.03.2014	Completed by deadline.
16	1.14	Access to the connection point of the auxiliary emergency feedwater system in accident conditions shall be improved, new connection points shall be established on the demineralised water tanks.	15.12.2015	The plant is prepared for the work, it will be performed during the main overhauls in 2015. *Completion of the task was approved by the authority in November 2015.*
17	1.15	The potential setting of the boron concentration of water inventories from external sources and its storage shall be solved and supply mode of borated water inventories to the containment shall be regulated in an operating instruction.	15.12.2018	The work progresses proportionally, the task will be completed by deadline. *The task will be completed by the deadline.*
18	1.17	By provision of appropriate electrical power supply it shall be established that the bank filtered well plant, which can be used irrespective of the water level of the river, be able to supply water to the essential service water system via the existing connections in accident situations.	15.12.2015	Construction plans have been completed. The task will be completed by deadline. *The licensee submitted the proof of completion for authority acceptance at the end of 2015.*
19.	1.18	The accessibility of the water reserve available in the closed segment of the discharge water canal for the earthquake resistant fire water pump station of Installation II that is equipped with individual diesel power supply shall be solved.	15.12.2018	The work has commenced, deadline can be met. *Licensing of the modification has commenced, the deadline can be met.*
20.	1.19	Similar to the connection existing on Installation I, the water supply shall be solved also for Installation II from the fire water system to the essential service water system through the technology cooling water system.	15.12.2015	The work has been completed. The final technical acceptance takes place in 2014. *Completion of the task was approved by the HAEA in June 2015.*

21.	1.20	The equipment necessary for the cooling water supply to at least one diesel generator of each unit from the fire water system shall be provided and the operating instruction shall be completed with the measures to be implemented.	15.12.2015	Completed 21 months before the deadline.
22.	1.5	Utilizing the fuel storage capacity of the safety diesel generators the amount of diesel fuel to be stored shall be increased and this shall be incorporated in an administrative procedure.	15.03.2014	Completed 6 months before the deadline.
23.	1.8.	Power-operated filters of the essential service water system shall be established.	15.12.2015	Construction plans are ready; they are under licensing. The task can be completed in 2015. *The licensee submitted the proof of completion for authority acceptance at the end of 2015.*
24.	1.12.	Appropriately protected independent severe accident diesel generator(s) shall be installed after assessment of the necessary number and capacity, and determination of the design requirements including beyond design basis hazards.	15.12.2018	2 independent diesel generators protected against external hazards will be provided. They will have accident as well as maintenance functions. Deadline can be met. The technical content has changed, one common Diesel generator will be installed for the 4 units in a building protected against internal and external hazards. The deadline can be kept.

25.	1.13.	Out of the two power plants being able to supply external electric power via dedicated lines, the black-start capability (start-up from own diesel generator) shall be created for the Litér gas turbine.	15.12.2014	Completed 17 months before the deadline.
26.	1.22.	Procedures shall be developed for the use of the possible, but currently not applied cross-links between the units for normal operation and for the backup and safety buses.	31.07.2013	Completed by deadline.
27.	1.23.	Possible cross-links shall be studied and the concluding modifications shall be carried out for providing safety electrical power supply from any operable emergency diesel generator in any unit to the safety consumers of any other unit.	15.12.2015	Major part of the works took place in 2014, it will be completed in 2015. *Completion of the task was approved by the authority in November 2015.*
28.	1.43.	Probabilistic assessment for closed reactor states under 150 °C primary circuit temperature, whether a time limit considering the balanced distribution of risk is reasonable to be established and introduced and actions.	31.12.2012	Completed by deadline.
29.	-	Installation of hydrogen monitoring system as part of the severe accident instrumentation for units 3 and 4.	15.12.2013	Severe accident modifications were completed at all units.
30.	1.25.	The system that is able to prevent the long-term, slow over-pressurisation of the containment shall be developed and implemented.	15.12.2018	A feasibility study was prepared. Technical planning has started. Deadline can be met. License application has not been yet prepared for the modification. *The building license application is under preparation. The deadline can be met.*

31.	-	Among the severe accident management measures Paks NPP selected the strategy of in-vessel maintenance of the molten core. No further action is necessary.	31.12.2014	Severe accident modifications were completed at all units.
32.	1.16.	A new water supply route connected in the courtyard by flexible means shall be constructed that is protected from external hazards (such as earthquake). The spent fuel pool shall be filled from the borated water reserve specified previously via this line. The required operations shall be specified in procedures.	15.12.2018	Prepared for licensing in 2015. The task progresses, the deadline can be met. *The licensing documentation of the modification is under preparation, the work can be completed in 2016.*
33.	1.35.	Corresponding to management of severe accidents, for the construction of an external water supply route to the auxiliary emergency feedwater system, the equipment necessary for the connection of external origin mobile diesel generators and pumps to the systems shall be purchased.	15.12.2016	The task is almost ready. Deadline can be met. *Completion of the task was approved by the authority in June 2015.*
34.	1.26.	Severe accident situations simultaneously taking place in the reactor and the spent fuel pool shall be managed by the development of a severe accident management guideline. Technical modifications generated by the implementation of other actions shall be implemented in the concerned SAMG.	15.12.2018	The task depends on other tasks (1.15, 1.16, 1.35, 1.36). The compliance with the deadline also depends thereon. The incorporation of technology changes into the SAM takes place on a continuous basis, when the particular modifications are completed. *No change, the deadline can be met.*

35.	1.36	The method of usage of external supply opportunity shall be described in instruction documents.	15.12.2017	The task depends on task 1.35. Accordingly it can be completed by deadline. *Completion of the task was approved by the authority in November 2015.*
36.	1.38.	The physical arrangement and instrumentation of the Technical Support Centre established at the Protected Command Centre shall be extended to provide sufficient resources for simultaneous management of severe accidents occurring on more than one (even all 4) units.	15.12.2018	The task progresses, the deadline can be met. *The licensee submitted the proof of completion for authority acceptance at the end of 2015.*
37.	1.37.	The structure of the organization responding to accidents affecting multiple units and the number of staff shall be determined; procedures shall be developed for personnel and equipment provisions, as well as for shift changes.	15.12.2017	The task is in progress, the deadline can be met. *Completion of the task was approved by the authority in June 2015.*
38.	1.39.	The training and exercise of multi unit emergencies can take place after the implementation of that action. A software-based severe accident training simulator shall be developed. In the first stage of the two-stage development the current simulator will be extended for the education of the staff of Technical Support Centre, while later it will be extended to train a wider scope of the users.	15.12.2017	The simulator is in test operation already. *The licensee submitted the proof of completion for authority acceptance at the end of 2015.*
39.	1.30.	Conditions for radio communication shall be assessed in the case of permanent loss of electric power and earthquakes and the necessary actions shall be performed.	15.12.2018	The deadline can be met. *The public procurement process is under preparation, the deadline can be met.*

40.	1.31.	Informatics mirror storage computers shall be installed both at the Protected Command Centre and the Backup Command Centre containing the necessary scope of data.	15.12.2016	The deadline can be met at both locations. *Procurement has started, the deadline can be met.*
41.	1.46.	Distributions using less conservative, three-dimensional analyses beyond the use of the lumped-parameter models shall be performed. Need for further action will be resultant on the analysis.	31.12.2012	The task was completed by deadline.
42.	1.40.	Procedures shall be developed for the management of liquid radioactive wastes during severe accidents. The risk, potential routes and possible monitoring tools and methods of liquid form release of radioactive materials shall be examined and the measures necessary and possible to respond to in such a situation shall be specified.	15.12.2015	The examinations were completed. A separate procedure is being prepared. The task will be completed by deadline. *The licensee submitted the proof of completion for authority acceptance at the end of 2015.*
43.	1.32.	Procedures for collecting and transporting emergency response personnel shall be developed and the necessary means and rules of their provision shall be determined.	15.12.2017	Completed 25 months before the deadline.
44.	1.33.	A shielded transport vehicle deployable at significant radiation levels shall be procured.	15.12.2018	Implementation is in progress, it could be completed in 2015. *Completion of the task was approved by the authority in June 2015.*
45.	1.34.	The rules for exemptions from the air ban around the plant shall be modified to manage airborne support.	15.12.2014	Completed. The related proposal was taken by the plant. However no modification is necessary to exempt from the ban, it can be decided by the government in the case of an emergency.

46.	1.44.	The applicability of fixed radiation monitoring devices installed on, and in the vicinity of, the site to support emergency response activities after an earthquake and total loss of power shall be assessed.	15.12.2014	The examination was completed. The task will be completed by deadline. A plan is being prepared to solve the identified problems. *Completion of the task was approved by the authority in June 2015.*
47.	1.27.	Seismic qualification of the on-site shelters not yet qualified shall be performed and non-earthquake resistant equipment in the shelters shall be improved. A nuclear emergency response centre resistant to earthquakes of a peak ground acceleration higher than design basis earthquake shall be established.	15.12.2018	Qualification is complete. Reinforcement of the equipment at two shelters took place. A slight reinforcement of the protected command centre is necessary for DBE. It can be completed when the new backup command centre will be ready. Deadline can be met.
48	1.29.	Air-conditioning of the Protected Command Centre shall be re-assessed and an appropriate power equipment shall be installed that can also be supplied by diesel generator.	15.12.2015	The task can be carried out after the reinforcement of the PCC (Task 47 (1.27)) or in the frame of that task; so the completion will be significantly delayed. *The task will be completed by the end of 2018, start of implementation must wait for completion of Task 1.28.*
49	1.28.	A Backup Command Centre that complies with protection requirements, and is equivalent with the Protected Command Centre in terms of management and communication, shall be established.	15.12.2016	A delay is probable due to public procurement procedures endangering the deadline of other tasks (1.27, 1.29). *Implementation of the task will commence in 2016, but the deadline cannot be met.*

50	-	The laws on regulatory supervisory activity, as well as the independence of the authority and the existence of conditions required for regulatory supervisory activity, should be revised in the mirror of the lessons learned.	15.12.2016	Modification of the Nuclear Safety Code was proposed by the HAEA for the new units reflecting to the experiences. The proposal is in front of the government. The 5-year regular review of the nuclear safety regulations will take place in 2016, which will take account of the new WENRA RLs and modified IAEA documents also for the existing nuclear facilities. *The modified requirements for the new units were published in the end of 2014. The review of the NSC due every five years is in progress. The deadline can be kept.*
51.	-	One of the main objectives of the national exercise planned to be organized in the first half of 2013 is to practice media communication, as well as to practice the execution of certain protective actions with the participation of the invited representatives of the public.	15.12.2013	Completed. The whole national emergency response system was involved in exercising the public information activities during the ONER-3-2013 exercise. A demonstration exercise took place as part of Phase 2 of the exercise, which contained sheltering, dissemination of iodine pills and evacuation of a certain, preliminary designated and informed part of Paks town.

REFERENCES

[1] Declaration of ENSREG - EU "Stress Tests" specifications, 13 May 2011
http://www.ensreg.eu/node/286

[2] Requirements for the Technical Scope of the Targeted Safety Reassessment (TRS) of Paks Nuclear Power Plant, HAEA, May 24, 2011.
www.haea.gov.hu/web/v2/portal.nsf/att_files/brochur/$File/stress.pdf?OpenElement

[3] National Report of Hungary on the Targeted Safety Re-assessment of Paks Nuclear Power Plant, HAEA, December 29, 2011.
http://www.oah.hu/web/v2/portal.nsf/att_files/cbf/$File/HUN_Nat_Rep_eng_signed.pdf?OpenElement

[4] Post-Fukushima “STRESS TESTS” of European Nuclear Power Plants– Contents and Format of National Reports, HLG_p(2011-16)_85
http://www.ensreg.eu/sites/default/files/HLG_p(2011-16)_85/Post/Fukushima/Stress/Tests/-/Contents/and/Format/of/National/Reports.pdf

[5] Hungary, Peer review country report of Stress tests performed on European nuclear power plants
http://www.ensreg.eu/sites/default/files/Country/Report/HU/Final2.pdf

[6] Extraordinary National Report for the Convention on Nuclear Safety, 2012
http://www.haea.gov.hu/web/v2/portal.nsf/download_en/67EB13B9A529E00DC1257A280023F2FD/$file/CNS_HUN_with_table.pdf

[7] Final Summary Report, 2nd Extraordinary Meeting of the Contracting Parties to the Convention of Nuclear Safety, 27-31 August 2012, Vienna, Austria
http://www.iaea.org/Publications/Documents/Conventions/cns-summaryreport310812.pdf

[8] National Action Plan (NAcP) Guidance as directed within the ENSREG Stress test Action Plan, Working material of the ENSREG WG1 meeting of 4-5 September, 2012, Brussels, Belgium

[9] Compilation of recommendations and suggestions, Peer review of stress tests performed on European nuclear power plants, ENSREG, 26/07/2012
http://www.ensreg.eu/sites/default/files/Compilation/of/Recommendationsl_0.pdf

[10] Authority resolution on the termination of regulatory inspection on the targeted safety reassessment of Paks NPP, HAEA docket number: OAH-01170-0003/2011-EH, Resolution number: HA5444. HAEA, December 29, 2011.

[11] Action plan of Paks NPP on the implementation of tasks identified during the targeted safety reassessment, HAEA docket numbers: OAN-01384-0001/2012, OAH-01384-0003/2012 and OAH-01384-0009/2012.

[12] Authority resolution on the implementation of action plan of Paks NPP, HAEA docket number: OAH-01384-0010/2012-EH, Resolution number: HA5589 HAEA, December 17, 2012.

[13] ENSREG National Action Plans Workshop, Summary Report, ENSREG, 10/06/2013
http://www.ensreg.eu/sites/default/files/HLG_p(2013-24)_120%20Final%20NAcP%20Workshop%20Summary%20Report.pdf

[14] Rapporteur’s report Hungary, National Action Plans Workshop
http://www.ensreg.eu/sites/default/files/HU%20Rapporteurs%20Report.pdf

[15] Action plan, Follow-up of the peer review of the stress tests performed on European nuclear power plants, ENSREG Action Plan
http://www.ensreg.eu/sites/default/files/ENSREG%20Action%20plan_0.pdf