Republic of Hungary

NATIONAL REPORT

Document prepared in the frame of the
Convention on Nuclear Safety

fifth report, 2010

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1. Declaration

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

The Republic of Hungary states that nuclear safety is paramount in all aspects and thus Hungary completely fulfils the conditions stipulated in the Convention and included in 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, September 2010

Director General
Hungarian Atomic Energy Authority

2. Introduction

National energy policy

The Hungarian energy policy that was approved in 1993 by Parliament and described in the previous reports was in force in the first part of the period discussed in this present report.

On June 17, 2008 Parliament concluded a resolution on the energy policy for the period of 2008-2010. The most significant aspect of the resolution is that of realizing the primary objectives: i.e. security of supply, competitiveness and sustainability, the supply of the energy needs of the economy and the public by taking into account safety, economic, and environmental protection aspects, the strengthening of the competition in the energy market, as well as facilitating the common objectives specified in the framework of the European Union. The resolution emphasizes the importance of the harmony between the establishment and maintenance of a balanced energy source structure, and between energy policy and climate policy. The resolution determines that the energy policy should contribute to sustainable development through a decrease in energy consumption, and an increase in the ratio of renewable energy sources and energy produced from waste. These factors should be in harmony with the natural character of Hungary and with the load-bearing ability of the public, and through the gradual introduction of environment and nature-friendly technologies.

The resolution, in its second part, requests the Government to take the necessary governmental steps in order to realize the stated energy policy. Of the twenty tasks listed, two deal with the use of atomic energy. Accordingly, the Government:

- *"shall commence the preparatory work for the decision on new nuclear capacities. In due course, the Government shall submit, after thorough professional, environmental protection and public debate, its proposal on the need and condition of the construction, type and establishment of the new nuclear power plant to Parliament";*
- *"shall ensure appropriate execution of programmes dealing with the final disposal of nuclear wastes, and the provision of the necessary conditions".*

Finally, the closing part of the 2008 resolution repeals the parliamentary resolution of 1993 on energy policy.

The role and contribution of nuclear energy

Paks Nuclear Power Plant, Hungary`s only nuclear power plant, operates as a shareholders' company under the name of Paks Nuclear Power Plant Ltd. The contribution of nuclear energy to the total generation of electric energy *in 2007 and 2008* was *37%, in 2009 it was 43%.*

The report of the OECD International Energy Agency (IEA) reviewing the energy policy of Hungary, with special considerations on the role of nuclear energy, was published in 2007. The report made by an expert group declares that from the viewpoint of security of supply the role of Paks Nuclear Power Plant in the Hungarian electricity system is essential.

Significance of safety

Act CXVI of 1996 on Atomic Energy [I.2] (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". This is 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 power plant, 34 international reviews have taken place since 1984. These include all kinds of reviews organized by the International Atomic Energy Agency.

International relations

Hungary maintains wide-ranging relations with various international and national nuclear organizations, professional bodies, institutes, nuclear power plants abroad, companies involved in the 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 in high esteem internationally is demonstrated by their active role in several committees, with many of them being board members of international organizations or invited as experts.

International bodies of major importance are: the International Atomic Energy Agency (IAEA), the OECD Nuclear Energy Agency (NEA), the European Union and its organizations, the European Atomic Energy Community (EURATOM), the World Association of Nuclear Power Plant Operators (WANO), the WWER-440 operators' club, the WWER users' club, the International Nuclear Safety Program (the so-called Lisbon Initiative), the Nuclear Maintenance Experience Exchange (NUMEX), *the European Safeguards Research and Development Association (ESARDA)* and the European Atomic Energy Society (EAES). The Hungarian Nuclear Society is a member of the European Nuclear Society (ENS), and the Health Physics Section of the Roland Eötvös Physical Society is a member of the International Radiation Protection Association.

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In this current 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 present the reader with a stand-alone report. Important aspects have not been omitted from the current document; the detailed descriptions are placed in the Annexes. Changes carried out in relation to the previous report are indicated *in italics.*

The data presented in this report reflect the situation as at December 31, 2009.

3. Major changes since submission of the previous National Report

Since the submission of the Fourth National Report no change has taken place in the number of nuclear installations.

Throughout their work, both the Authority 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:

- *The works dealing with the removal of the fuel assemblies damaged during the incident that occurred on April 11, 2003 at Paks Nuclear Power Plant (in the revision shaft of Unit 2) was finished. ; Full recovery from the consequences of the incident was reported and conditions for normal use of the revision shaft were reached at the end of April 2007.*
- *Thanks to the power uprating project of Paks Nuclear Power Plant Ltd, all four units have been operating at increased power (500 MW each) since November 2009; thus the nominal electric power of Paks Nuclear Power Plant has reached 2000 MW. All four units are now operating safely and reliably at increased power: Unit 4 since September 2006, Unit 1 since July 2007, Unit 2 since December 2008, and Unit 3 since November 2009.*
- *The proceedings for licensing the units of Paks Nuclear Power Plant enabling them to operate until the end of the designed service life of 30 years were completed in 2008.*
- *In 2008, Paks Nuclear Power Plant Ltd submitted its programme for substantiating the operation of Unit 1 with an additional 20 years beyond its design lifetime. After evaluating the programme the nuclear safety authority determined that given the accomplishment of the programme it may provide a basis for the lifetime extension.*
- *Act LXII of 2008 [I.10] in harmony with the amendment of the international convention on physical protection of nuclear materials has modified certain provisions of the Act on Atomic Energy. The amendment to the convention and the more rigorous regulations for physical protection of nuclear material was made necessary by the increasing threats related to the illicit trafficking of nuclear material and nuclear terrorism, and the ongoing development of security techniques.*
- *In 2008, the spent high enriched fuel assemblies of the KFKI Atomic Energy Research Institute were repatriated to the Russian Federation in the framework of the Global Threat Reduction Initiative (GTRI) during the execution of the programme initiated under the coordination of the International Atomic Energy Agency.*
- *Based on the outcome of the revision of the National Nuclear Emergency Response Plan, the Governmental Coordination Committee issued the new National Nuclear Emergency Response Plan in May 2008. The content of the new plan is in accordance with the recommendations in the technical documents of the International Atomic Energy Agency.*
- *On March 30, 2009 the Hungarian Parliament granted the license in principle needed to commence the preparation activities for the new nuclear power plant unit(s) to be*

established at the site of the Paks Nuclear Power Plant with 300 "yes" votes, 6 no's, and 10 abstentions.

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.

The Republic of Hungary was one of the first nations to sign the Convention on Nuclear Safety (hereinafter referred to as the Convention) concluded in Vienna on September 20, 1994 within the framework of the International Atomic Energy Agency. Promulgation of the Convention took place in Hungary by Act I of 1997 [I.3].

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 *fifth* National Report has been compiled in accordance with the requirements of the Convention and those of the related documents entitled "Guidelines Regarding National Reports under the Convention on Nuclear Safety" together with the recommendations based on the conclusions of the Fourth Review Meeting (Vienna, 2007).

The National Report, in 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 Authority;
- general issues of safety (including the state of financial and human resources, quality assurance, radiation protection, and emergency preparedness);
- overview of the Safety Analysis Report 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 all four units of Paks NPP. The units were commissioned between 1983 and 1987 and are currently in good technical condition.

Paks Nuclear Power Plant Ltd is a state owned economic entity. More than 99% of the shares are held by the Hungarian Electricity Board Ltd (with authority granted by the state) while the remaining part is held by local governments.

6.1.1 Main technical attributes

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: V-213
Thermal power of each unit	*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
Enrichment of the fuel	2.4-3.82%,
Fuel quantity per unit	42 tons of uranium in 349 fuel assemblies
Number of turbines per unit	2
Pressure of secondary circuit main steam line	43.15 bar

Paks Nuclear Power Plant Ltd operates four pressurized-water nuclear units of type WWER-440/V-213; both the moderator and the coolant of the reactors is light water. (On the basis of its safety philosophy, the power plant belongs to the group of second-generation WWER-440 nuclear power plants.) The reactor has six 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 accidents 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 pressure suppression containment for the reactors.

Each unit is installed with three active safety trains, and in case of abnormal events their electrical supply is backed up 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 output of each of the four units was 440 MW. *As a result of the second power uprating programme realized between 2006 and 2009, the thermal power of each unit has been 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 two 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 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 nuclear safety authority, viz. the Hungarian Atomic Energy Authority, requires submission of safety reports for licensing of the installation, and always orders the application of a quality assurance system. In the course of their operative work, nuclear safety inspectors are obliged to take decisions in a conservative manner biased towards safety should any not-clearly-assessable situation arise.

In Hungary a decree stipulates the performance of periodic safety reviews and submission of safety reports containing results of such assessments. *The operating licences granted on the basis of the evaluation of the Periodic Safety Reviews are valid until the end of the design lifetime of each unit (Unit 1 - 2012, Unit 2 - 2014, Unit 3 - 2016, Unit 4 - 2017).*

National and international reviews have always been important and promoting elements of constant endeavours aimed at assessing and increasing the safety of the nuclear power plant. The measures aimed at eliminating deficiencies discovered through assessments or found to be necessary by outside experts greatly contribute towards improving power plant processes. A list of international safety reviews performed at Paks NPP is given in Table 19.7.3.

6.1.3 Safety improvement measures

The relevant safety improvement measures that were realized between 2007 and 2009 at Paks Nuclear Power Plant are as follows:

- *qualification or reinforcements of the majority of relays and cabinets that had not previously been qualified to withstand earthquakes;*
- *substitution of the chain cables on Units 1 and 3, termination of maintenance connections in order to prevent false actuations.*

The several-year-long Organizational and Operational Development Programme came to an end in the reported period. The self-assessment based programme had been launched subsequent to the 2003 incident. The programme specified the specific short- and long-term tasks in five sub-programmes (i.e. Values and Strategy, Management Development, Human Development, Operation Optimization, Information Technology Development). A start was made on these tasks and some have already been successfully finalized and their outcomes already deployed.

By virtue of the measures and modifications implemented during the power uprating programme the safety of the units has been further enhanced.

The core damage probability due to internal initiating events (i.e. one of the safety indicators of a nuclear power plant unit) has decreased by a magnitude compared with the first assessment, both for the operating state and shut-down state (shut down for either maintenance or refuelling) of the reactor. It is now reasonable that the further enhancement of safety should primarily focus on protection against seismic events.

Taking account of all the operating states, the average probability of core damage calculated for a year due to accident processes that can be postulated as a consequence of internally caused system and component failures and inadequate human interventions, for any unit operating at increased power is:
- $4.7x10^{-6}$ *for operation at nominal power;*
- $5.1x10^{-6}$ *for operating states under shut- down for refuelling or overhaul;*
- $1.0x10^{-5}$ *for internal fires and floods.*

Figure 6.1.3 shows how the core damage frequency caused by internal events decreased between 1995 and 2009.

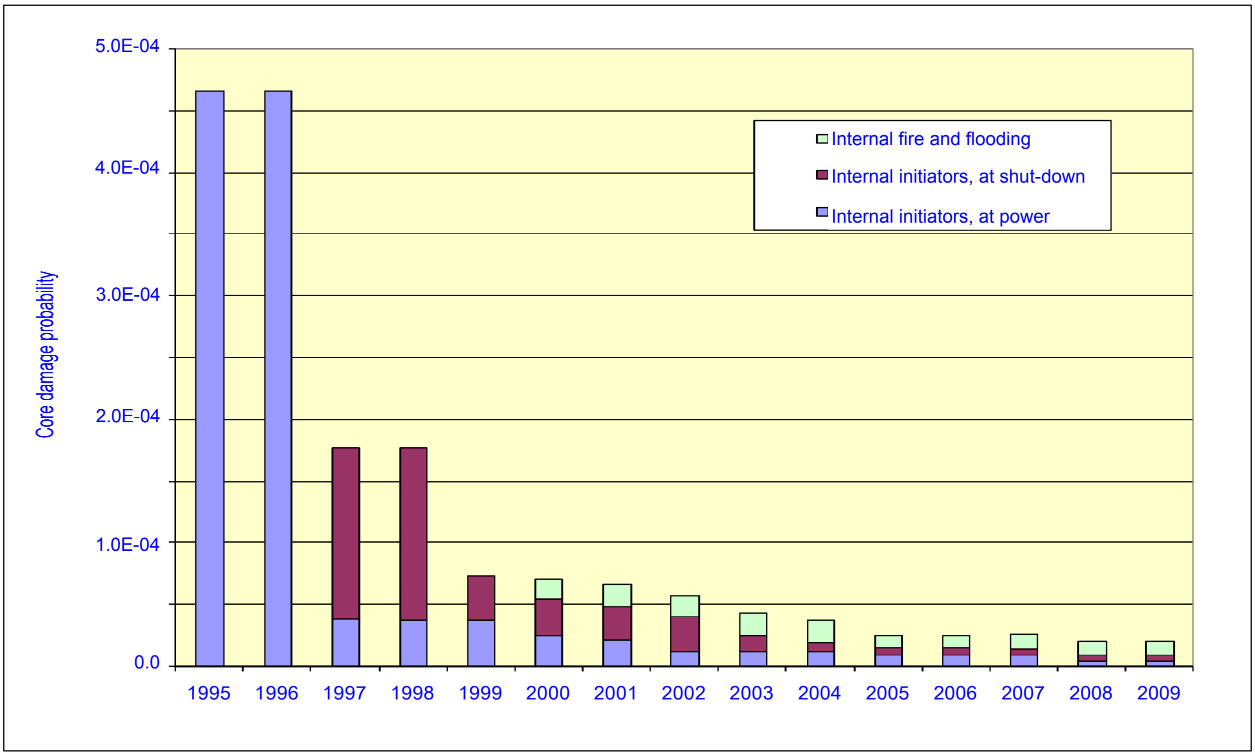

Figure 6.1.3: Overview of core damage frequency due to internal events

Paks NPP Ltd has performed seismic assessment of a given reference unit and determined the value of anticipated core damage frequency. By virtue of the similarity and architectural identity of the units, this value is valid for the other units as well. Subsequent to the reinforcement work carried out after the first assessment *and technical qualifications elaborated between 2006 and 2009*, the calculated average value of core damage frequency of any unit of the nuclear power plant originating from an accident scenario postulated as a consequence of an earthquake is $6.4x10^{-5}$ per year.

6.2 Spent Fuel Interim Storage Facility

In order to store the spent fuel assemblies removed from the plant's reactors for a period of 50 years, a modular type dry storage (MVDS) facility operates adjacent to the site of the plant.

The facility's modules are capable of storing 450 fuel assemblies, and can be extended if so required. The positioning of modules in a row allows the use of a common reception building and loading equipment. Spent fuel assemblies are held 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 enclosed within 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 capacity of the first and second stages of the spent fuel interim storage facility (16 modules) provides storage for 7200 fuel assemblies. This capacity corresponds to the number of fuel assemblies spent during 16 years of operation of all 4 units of Paks NPP. The capacity of the facility can be increased for interim storage of all irradiated fuel generated during 30 years of operation. In accordance with *the licence for establishment, the construction of the 3rd phase of the facility has commenced; the facility will be extended with 4 more modules in this stage. By the end of 2009, a total of 6067 fuel assemblies had been loaded into the storage facility.*

The holder of the operating license of the Interim Spent Fuel Storage Facility is the Public Limited Company for Radioactive Waste Management.

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

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

The Budapest Research Reactor operated by KFKI Atomic Energy Research Institute was built in 1959 and its full reconstruction was carried out between 1986 and 1993. In 2003 based on the results of a safety review, the Authority issued a licence for further operation and for performing activities described in the Final Safety Analysis Report. The operating licence se is valid until revocation.

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, high enriched (HEU) spent fuel assemblies (154.5 kg) of the Budapest Research Reactor were repatriated to the Russian Federation in the frame of the Global Threat Reduction Initiative that is financed by the United State of America.

The preparation for the application of low enriched (LEU) fuel assemblies (i.e. conversion) started with the repatriation of the HEU fuel assemblies in 2008. The conversion is justified by the international effort to decrease the use of HEU fuel that is potentially capable of producing nuclear weapons and requires international verification. The conversion and the purchase of new fuel assemblies were licensed (i.e. as a modification license in principle and as a purchase license) by the HAEA in 2007. The operator concluded an agreement with the Russian partner for the delivery of the necessary low enriched fuel, which was inspected by the HAEA inspectors at the manufacturer. The KFKI Atomic Energy Research Institute, as the operator of the research reactor, submitted its application for a modification license to the HAEA. The technical background of the application was justified by the document demonstrating the nuclear safety of the execution of fuel conversion. Conversion is being carried out gradually; cores containing both HEU and LEU fuel assemblies will be used through four campaigns by gradually increasing the quantity of new fuel elements. In the fifth campaign *(to be considered as a test campaign) the core will be built only from LEU fuel assemblies. Conversion commenced in 2009 and is due to l last for some three years.*

The reactor operated by the Institute of Nuclear Techniques at the Budapest University of Technology and Economics was built in 1972 for training and research purposes. In that the *previous operating license of the Training Reactor was valid until June 30, 2007, the operator requested that a new operating license be granted. The application was based on the Periodic Safety Review Report of the Training Reactor. Taking into account the evaluation of the Report and the required corrective measures, the Authority - bearing in mind the conditions specified by the co-authorities - issued the new operating licence valid for ten years, i.e. until June 30, 2017.*

Main technical data of the reactor:

- pool-type reactor;
- coolant and moderator: light water;
- fuel: EK-10, 10% enrichment;
- nominal thermal power: 100 kW.

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 current 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 considers all legislative, regulatory-related and operational experience gained during the construction and operation of Paks NPP, it considers the technological development achieved since the issue of the previous Act on Atomic Energy, 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 International Atomic Energy Agency and the OECD Nuclear Energy Agency (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 supervising procedures;
- entrusting the facility-level licensing authority of nuclear installations to the Hungarian Atomic Energy Authority;
- declaration of the organizational and financial independence of the Authority;
- 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 Authority 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 regulations have been and are issued to implement the requirements of the Act on Atomic Energy. *During the period 2007-2009 the following relevant laws were promulgated:*

Acts

- *Act LXII of 2008 [I.10] on the promulgation of the Amendment to the Convention on Physical Protection of Nuclear Material that was signed in the frame of the diplomatic conference organized by the International Atomic Energy Agency on July 8, 2005. The Act, according to the Amendment, has amended the Act on Atomic Energy as well.*
- *Act CVI of 2008 [I.9], by amending the Act on Atomic Energy , requires that a service fee shall be paid for regulatory proceedings and administrative services, initiated on request of the health regulator, in connection with the use of atomic energy, with regard to licensing of transport of radioactive material on public roads, facilities, equipment, activities, radioactive waste storage and disposal, radiation protection qualification of protective tools against radiation, radiation protection training, personal dosimetry as well as with regard to the determination of internal doses.*
- *Act XLVII of 2009 that re-defined the system of criminal records and amended Article 11 of the Act on Atomic Energy.*

Governmental decrees

- *Govt. decree 34/2009. (II. 20.) Korm. [II.13] regulates the licensing of transboundary transport of radioactive wastes and spent fuels.*
- *The agreements concluded and cooperation realized on the basis of Govt. decree 179/2008. (VII. 5.) Korm. [II.11], and Govt. decree 204/2008. (VIII.19.) Korm. [II.10] have made it possible to repatriate the Soviet-made high enriched spent fuel assemblies that were previously used in the Budapest Research Reactor and to terminate their storage in Hungary.*
- *Govt. decree 136/2008. (V. 16.) Korm. [II.9] on the promulgation of the amendments to the Espoo agreement on the assessment of transboundary environmental effects, which amendments affect, besides other activities and facilities, the nuclear power plants, nuclear reactors, the final disposal of spent nuclear fuel and radioactive waste and their planned storage for a period longer than 10 years, as well as the nuclear fuel reprocessing facilities.*
- *Govt. decree 362/2006. (XII. 28.) Korm. [II.12] defines the co-authorities to be involved in certain regulatory proceedings, inter alia in the nuclear facility related regulatory proceedings of the HAEA. Govt. decree 182/2009 Korm. [II.14] specifies further special authority tasks dating from October 2009.*

Ministerial decrees

- *Ministerial decree 7/2007. (III. 6.) IRM [III.4] was issued as implementation of Act LXXXII of 2006 [I.8] to fulfil the international obligations undertaken in the safeguards agreement concluded after the accession of the Republic of Hungary to the European Union.*

- *Ministerial decree 19/2007. (VIII. 29.) ÖTM [III.5] specifies fire protection regulations for nuclear facilities, the requirements for the prevention of fires, the means for the fulfilment of fire fighting tasks, the measures to be taken for investigating fires, as well as for the provision of the necessary conditions, and the rules of inspections.*
- *Ministerial decree 45/2008. (XII. 31.) KHEM [III.6] has updated the regulations for professional qualification and necessary experience of employees working in nuclear power plants, and in research and training reactors.*

Nuclear Safety Code

The nuclear safety requirements for the use of atomic energy are regulated by the Nuclear Safety Code issued as appendices of Govt. decree 89/2005. (V. 5.) Korm [II.7].
The following code volumes were issued:
1. Regulatory procedures related to the nuclear power plant
2. Quality management requirements for the nuclear power plant
3. Requirements for nuclear power plant design
4. Requirements for nuclear power plant operation
5. Nuclear safety requirements for research reactors
6. Nuclear safety requirements for the spent fuel interim storage facility

The Nuclear Safety Code entitles the HAEA's Director-General to issue guidelines as to how the requirements should be implemented by a licensee. Further detailed regulation of tasks originating from the implementation of legal requirements is provided by the internal rules and procedures developed and operated by the Authority and by the Licensee.

Pursuant to the regulations of the governmental decree, the Nuclear Safety Code, in order to enhance nuclear safety, shall be revised and updated at least every five years. The management of the HAEA decided on the revision of the Code in 2008. During the revision the following factors were taken into account: the legal changes, the regulation-related outcomes of international reviews, the experience gained from the application of the regulations, the new results of science and technology, international good practice and the lessons learnt from recent regulatory proceedings. Updating of the regulations has been justified, inter alia, by the requirements to be specified due to the lifetime extension of the Paks NPP units, as well as by the adaptation of the requirements (reference levels) determined by the Western European Nuclear Regulators' Association - WENRA.

As an outcome of the revision, the HAEA has formulated a draft of the updated regulations covering the supervisory procedures of modifications and including the new requirements. The modifications have moved the focus of regulatory activities from licensing to supervisory/control actions. The introduction of the new regulations increases both the freedom and accountability of the licensee and the importance of its decisions, and in addition makes the supervisory activities of the Authority more flexible.

The harmonization of the Nuclear Safety Code started in 2009 through expert bodies and the administration. The next amendment of the Act on Atomic Energy requires the elaboration and harmonization of further modifications due to the implementation of the EU Nuclear Safety Directive [Council Directive 2009/71/EURATOM (June 25, 2009) on *establishing a Community framework for the nuclear safety of nuclear installations], the Amendment to the CPPNM with regard to the physical protection of nuclear installations, as well as due to the administrative aspects of the construction of the new unit(s). Consequently, the HAEA, at the end of 2009, initiated the development and administrative procedure for commenting on such a version of the Code whose promulgation does not require amendment to the Act on Atomic Energy.*

7.2.2 Licensing procedure

The basic licensing principles for the establishment of a new nuclear power plant and for the authorities taking part in the licensing proceedings are regulated by Chapter III of the Act on Atomic Energy.

To establish a new nuclear power plant or a new nuclear power plant unit the preliminary consent in principle of Parliament is required for starting preparatory work, whereas to establish 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 concordance with regulations in force, licences shall be obtained from the authorities for all phases of operation (site selection, construction, commissioning, operation, decommissioning) during the lifetime of a nuclear power plant. Moreover, a separate licence shall be obtained for all plant level or safety related equipment level modifications. Within the licensing proceedings, technical aspects are enforced by legally delegated co-authorities, the opinions of which shall be taken into account by the Authority.

When the installation of a new nuclear power plant is being considered, the precondition for launching the licensing procedure is the existence of an environmental protection license. During the licensing procedure the Licensee prepares a preliminary environmental impact study. The competent environmental protection authority then sends the preliminary impact study to the local governments of potentially affected areas who – in turn – expose it to public view.

The environmental protection authority, if it does not reject the detailed environmental impact study that has been submitted, shall subsequently hold a public hearing. Based on the detailed environmental impact study and on any responses received, the environmental protection authority may issue an environmental protection license for the construction and operation of the plant.

If transboundary environmental impact is likely then each partner-state should be notified by sending them the preliminary impact study. Any comments provided by the partner-states are to be taken into account by the environmental authority during the licensing process conducted on the detailed environmental impact study.

The nuclear safety related licensing of a nuclear installation takes place after the environmental licensing. The environmental protection authority plays the role of a special authority in the course of licensing a nuclear installation.

During the licensing of installations and equipment, and the nuclear safety licensing of their modifications, the contributing procedure of the environmental protection authority provides the possibility for the interested civil organizations to act as clients. The decisions of the nuclear safety authority are made public.

Licences are valid for fixed periods; on request and provided that the necessary requirements are fulfilled, they may be extended. *In accordance with Act CIX of 2006 [I.7] only by means of a court procedure can appeals be heard concerning the decisions and orders of the Authority.*

Every ten years a periodic review of the safety of the nuclear power plant is performed on the basis of a comprehensive, predefined programme known as the Periodic Safety Review. Any decisions on the further validity and conditions of the operating licence are made within the framework of this review.

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 with regular inspections and assessments by the authorities. The licensing authority is liable to check compliance with all legal stipulations, and the safety of the application of nuclear energy.

The Authority is entitled to perform inspections either with or without advance notice, should it be justified. Such inspections may be performed regularly in order to continuously assess the safety of the nuclear power plant based on a comprehensive predefined programme or specifically related to a particular event or activity. Inspections performed by the Authority are defined as observing an activity carried out on site and comparing it with the relevant documentation. The Authority prepares a programme for planned inspections, and notifies those involved in due time. Subsequent to the on-site accomplishment of the comprehensive or specific inspections, the Authority evaluates the lessons learned. Inspections or the evaluation of such inspections may also be performed by outside experts or expert bodies upon the written commission of the Authority.

In addition to the Authority'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 Authority 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 nuclear power plant. Any event affecting nuclear safety is required to be reported by the Licensee to the Authority 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 Authority analyses and evaluates the event and initiates further actions if necessary.

The Authority makes use of the results originating from various sources for evaluating the safety performance of the licensees. As a means of extending the assessment tools, the Authority introduced and applies the system of safety indicators for Paks NPP, the Spent Fuel Interim Storage Facility, the Training Reactor, and for the Budapest Research Reactor. The term "safety indicators" means such measurable parameters which measure the performance of the organization and the human factor.

The safety indicators are specified on the basis of IAEA recommendations. They can be categorized to three major groups:

- *attributes of smooth operation,*
- *safety characters of operation,*
- *attributes of commitment to safety.*

The accumulated statistical set of indicators provides the possibility both for comprehensive evaluation and highlighting various issues. The Authority annually evaluates the safety performance of the licensees based on their regular reports. The lessons learned from evaluations are helpful during the organization of regulatory proceedings, e.g. during the compilation of the annual inspection plan.

7.2.4 Enforcement of legal mandates of the Authority

The conditions for enforcing legal mandates of the authorities are included in Act CXL of 2004 on general rules of administrative proceedings and services [I.5], the Act on Atomic Energy, Act IV of 1978 concerning the Penal Code [I.4], Govt. Decree 114/2003. (VII. 29.) Korm. [II/6], in Govt. decree 85/2005. (V.5.) Korm. [II.7], and in Ministerial Decree 47/1997. (VIII.26) BM [III.7].

Should there be any deviation from the regulations in force, the Authority may initiate administrative proceedings to enforce the requirements of the regulation and within the framework of this may oblige the licensee to eliminate such deviation.

The Act on Atomic Energy enables the Authority to revoke the licence of the nuclear power plant, or to restrict the period of its validity.

The Authority can oblige the Licensee to pay a fine for infringing any regulation or safety standard, for failing to meet any of the stipulations of any individual regulatory licence issued on the basis of the above, or failing to meet an obligatory standard. If the licensee infringes the requirements contained in the approval of the special authority involved in the licensing procedure, the Authority, at the request of the special authority, handles the fining procedure. Fining may also be used independently as an instrument of sanctioning, but it may also be accompanied by other sanctions.

The regulations in force contain the possibility to impose sanctions not only against Paks NPP Ltd as an establishment, but also against individuals employed in the area of the application of nuclear energy.

Those principles and objectives formulated during the periodic revisions of the Nuclear Safety Code required by law every five years serve to enforce the power of the Authority.

Revision of the guidelines as a means of helping to fulfil the requirements of the Nuclear Safety Code is an ongoing process.

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 Hungarian Atomic Energy Authority

In the case of nuclear installations as defined by Article 2 of the Convention, the competent authority in Hungary is the Hungarian Atomic Energy Authority. The Hungarian Atomic Energy Authority (the Authority) is an organizationally and financially independent, public administration body operating in the field of peaceful use of nuclear energy, under the supervision of the Government. *As of May 15, 2008 the Minister of Transport, Telecommunication and Energy acting on behalf of the Government supervises the HAEA independently of his portfolio. The HAEA cannot be directed in its scope of authority as defined in law.*

The Authority's scope of competence comprises nuclear safety licensing (at the levels of the facility, systems and components) and supervision of nuclear installations, 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 authority-specific tasks related to nuclear emergency preparedness, the approval of the emergency response plans of nuclear installations, and maintenance of international relations. It is also the duty of the Authority to perform the tasks generated by the treaty on the non-proliferation of nuclear weapons, along with the accountancy for and control of nuclear materials.

On two occasions the activities of the Authority were surveyed by IRRT (International Regulatory Review Team) missions of the International Atomic Energy Agency.

The departments of the Nuclear Safety Directorate are as follows:

- the Department of NPP Supervision, which performs licensing and inspection procedures for Paks NPP in nuclear safety related regulatory matters as specified by law, also performs special authority tasks in the safety area of the NPP, and contributes to law-making through its experience gained during its procedures;
- the Department of Nuclear Technology and Safety Assessment, which performs licensing and inspection procedures for the spent fuel interim storage facility and the research reactors in nuclear safety related regulatory cases as specified by law, performs special authority tasks in the first instance in those cases pertaining to the scope of competence of other public administration bodies that concerns the licensing of facilities for radioactive waste disposal, assesses the regular and event reports, and carries out the cause analysis of incidents and safety evaluation of the operators' activities;
- the Department of Technical Support, which is responsible for analysis, training and emergency preparedness;
- the Department of Strategy, which is responsible for enforcement, review and maintenance of the laws, regulations and guidelines, long-term planning and preparations, and for maintaining contact with the various co-operating authorities;
- the Site Office at Paks deals with NPP- related tasks on the site.

These departments operate under the direct control of the Deputy Director General heading the Nuclear Safety Directorate of the Authority.

Other official duties of the Hungarian Atomic Energy Authority, such as tasks deriving from the safeguards agreement, 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 Authority, the General Nuclear Directorate.

The principal tasks of the three departments of the General Nuclear Directorate are:

- to perform the tasks imposed on Hungary by the Safeguards Agreement and Additional Protocol concerning the non-proliferation of nuclear weapons (Department of Nuclear and Radioactive Materials);
- to represent Hungary in the European Union, to elaborate the standpoints for discussions, to co-ordinate duties in connection with the law harmonization process including the analysis of regulations on radiation protection (Department of EU Co-ordination and Theoretical Radiation Protection);
- to maintain external relations and to perform tasks relating to public information (Department of External Relations).

The Section of Legal Affairs, the Section of Informatics, and the Department of Economy as well as the quality control officer operate under the direct control of the Director General.

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

In accordance with Subsection (5) of Article 8 of the Act on Atomic Energy, the work of the Authority is supported by a Scientific Council made up of nationally recognized individual experts.

8.1.1 International relations of the Hungarian Atomic Energy Authority

In accordance with the Act on Atomic Energy the HAEA is responsible for the harmonization 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 in contact with the HAEA the most important are the European Union, the IAEA and the Nuclear Energy Agency of the OECD. The Authority is a member of the Regulatory Assistance Management Group that coordinates the realization of European Union PHARE programmes providing support to Central and Eastern European countries in the field of nuclear safety, as well as of the Network of Regulators of Countries with Small Nuclear Programmes that was initiated by Switzerland. The HAEA actively participates in the work of the Western European Nuclear Regulators' Association – WENRA and the cooperation forum of the countries operating VVER type reactors (i.e. VVER Regulators Forum). *The HAEA is a member of the European Safeguards Research and Development Association (ESARDA), and the Global Nuclear Energy Partnership (GNEP).*

In addition to the international organizations with large membership, multilateral international cooperation has been developed with other nuclear safety authorities. In the framework of mutual information exchange, the HAEA cooperates with the authorities of the Czech Republic, Slovakia, the United States of America, Russia and Romania. The execution of the bilateral intergovernmental agreements in the field of safe use of nuclear energy falls under the competence of the HAEA.

The technical support organizations of the Authority 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 Hungarian Atomic Energy Authority

The Authority is constantly striving to present a thorough description of its work. It publishes quarterly newsletters on the most important events relating to the safety of nuclear energy and to its own regulatory activity. *A colourful and richly illustrated information booklet on Hungarian nuclear applications is published annually.* Additionally, the HAEA informs the public by organizing press conferences and issuing press releases dealing with the most important issues concerning the safe application of atomic energy. *Once a year the HAEA keeps an open house, when the public is invited to the office building and may obtain information on the HAEA's activities by means of presentations, demonstrations and posters. As of October 2009 the HAEA regularly provides information on the decisions made in the field of nuclear safety including the date of issuance, the validity, and a concise summary of the subject of each decision.*

An Internet-based service is integrated into the communication policy of the Authority. Apart from a great deal of other information, one can find the National Report on the Authority's home page both in Hungarian and in English.

8.1.3 Scientific technical background

8.1.3.1 Technical support institutes

During the regular technical support programmes of the recent years, the network of institutes supporting the regulatory work of the HAEA has been established. The most significant institutes of the network are: KFKI Atomic Energy Research Institute, Institute of Nuclear Techniques at the Budapest University of Technology and Economics, the Department of Radiochemistry of University of Pannonia, and the Institute of Isotopes of the Hungarian Academy of Sciences. *The ETV-ERŐTERV ZRt joined the network in 2008, while the successor of the nuclear division of the Electrical Power Research Institute (i.e. NUBIKI Nuclear Safety Research Institute Ltd.) in 2009.*

In terms of available expertise, in 2009 the HAEA has reviewed the profile of its technical support organizations (TSOs). Based on the outcomes of this review it is concluded that adequate contractual potential exists in each important field of expertise. The technical support organizations carry out expert and scientific activities not only for the Authority 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 Authority but not for both simultaneously. The relatively comprehensive system of censure, the internal quality assurance system of the support organizations and the careful selection of the reviewers guarantee the appropriate consideration of interest and independent decision-making of the Authority.

8.1.3.2 Technical support activity

The HAEA is responsible for the harmonization of the research and development related to the safety of peaceful applications of nuclear energy, as well as for the financing of the technical activities providing the basis for the regulatory supervision.

The strategic directions of technical activity supporting the regulatory control of safe use of nuclear energy are defined in the technical support policy of the HAEA; while the actual tasks are specified in four-year programmes. *The policy on technical support activities was reviewed by the HAEA in 2008; it was then finalized after a harmonization process with the most important partner institutes for the period 2009-2012. The newly formulated policy defines the following priorities:*

- *direct support for the regulatory activities;*
- *implementation of tasks initiated by the Authority;*
- *support for the tasks connected with the new units;*
- *maintenance of expertise.*

8.1.3.3 Hungarian Nuclear Knowledge Management Database Initiative

In order to effectively manage the problems of screening, using, accessing and storing information, the HAEA initiated the establishment of the Knowledge Management Database for the entire Hungarian nuclear industry. The aim of the Hungarian Nuclear Knowledge Management Database is to collect, 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. Apart from the HAEA, licensees of nuclear installations and the lead institutes of nuclear expertise participate in the development of the project. Currently, as part of the preparatory work for establishing the Database, various legal issues are being clarified and an overview is being elaborated of the potential technical solutions (hardware and software).

8.2 Independence of the Authority

In 2006, the Hungarian Parliament approved Act LVII of 2006 on central public administration bodies. The act defines the concept of governmental office, according to which "a governmental office is a central public administration body established by act under the supervision of the government"…"Supervision of a governmental office is performed by a minister designated by the Prime-Minister" ..."A governmental office shall not be instructed in its legally defined competence". The act referred to classifies the Hungarian Atomic Energy Authority as a governmental office. *The new laws on governmental restructuring further strengthen the independence of the HAEA. Act CIX of 2006 [I.7] amended several paragraphs of the Act on Atomic Energy as from January 1, 2007.*

As required by the Act on Atomic Energy, the HAEA annually submits its report on the safety of Hungarian nuclear applications to the Government and Parliament. The annual report is made public by the HAEA.

In the field of application of nuclear energy the activities performed at different ministries are harmonized by the Atomic Energy Co-ordination Council.

The Ministry of Health undertakes the tasks of the Authority regarding issues related to radiation protection and concerning facility-level licensing and supervision of the storage and disposal of radioactive wastes. Other competent administrative bodies take part as special authorities in the licensing procedure of the Ministry of Health.

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.

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 establish technical, technological, financial and human conditions for a facility's safe operation;
- to prevent the occurrence of an inadvertent and uncontrolled nuclear chain reaction;
- to prevent the evolution of any unacceptable damage to employees, local population, environment or material assets, caused by ionizing radiation or any other factor;
- to maintain the radiation exposure of employees and population to the lowest level reasonably achievable;
- to continuously monitor radiation levels and provide the local population with relevant information;
- to minimize the production of radioactive waste;
- to continuously carry out activities to improve safety and to finance costs of 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 limits of human performance from the aspect of safety;
- to fulfil the obligations of the Republic of Hungary arising from international contracts in the fields of peaceful use of atomic energy;
- to ensure that the qualifications, professional training and health of employees are in line with the requirements;
- to hire only those subcontractors and suppliers that have an appropriate quality assurance system;
- to ensure the financial coverage of liability;
- to appropriately handle extraordinary events;
- to indemnify within a limited time a limited amount for damages caused due to the application of atomic energy;
- to ensure the physical protection of the establishment by armed guards, and to prevent unauthorized persons from access to nuclear materials and equipment;
- to make regular payments into the Central Nuclear Financial Fund to cover costs related to the final disposal of radioactive waste, the interim storage and final disposal of irradiated fuel, and the decommissioning of the nuclear power plant.

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 Authority

The various documents issued by the International Atomic Energy Agency set the basic principles of safety. These are the principles which the Authority 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 Authority" is the basic document of safety and it is supplemented by the Enforcement Policy.

In the spirit of these documents several assessments were performed by the Authority to survey the operator's safety culture. The IRRT mission of the International Atomic Energy Agency in 2000 and its follow-up mission in 2003, and the RAM projects of the Western-European authorities also contribute to the self-assessment of the Authority. Resulting from the review of its operation, in 2004 the Authority modified its procedures and its organizational structure, accordingly.

10.1.1 Objectives

The key objective of the Authority's activities is to ensure that the local population, the environment, and the operating personnel do not suffer any harm due to effects originating from a nuclear installation. Another of the Authority's objectives is to oblige the Licensee to completely fulfil the tasks related to its responsibility to maintain the full-scale safety of the nuclear installation throughout its whole lifetime. The Authority exercises its control activities in order to achieve these objectives; these control activities comprise licensing, inspection, supervision, analysis, evaluation, 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. The fulfilment of all principles and criteria defined by the Authority is the warranty for achieving the above objectives.

10.1.2 Responsibility

The Authority is responsible for licensing and inspection of nuclear installations, systems and components along with the enforcement of official requirements.

In order to achieve these goals, the Authority shall be independent, competent and duly prepared; it shall clearly understand all processes under its supervision; and it shall be open towards the partner 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.

Additionally, the Authority has the responsibility of ensuring the emergency preparedness activities described in Chapter 16 of this Report. It is prepared to act as an independent assessor and advisor in such a process by making diagnoses and prognoses in the early phase of a potential nuclear accident. It is the Authority's task to approve the Emergency Response Plan of the licensees and to supervise their emergency preparedness.

10.1.3 Basic principles

The functioning of the Authority is regulated by the Government in accordance with the Act on Atomic Energy. The regulations governing the work and activities of the Authority 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 Authority should also set a priority list. Priorities should be examined not only from the viewpoint of risk reduction but also taking costs into account.

The Authority follows the above principles 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 major importance. To accomplish mitigation tasks, the role of the various components in the process of accident evolution and the availability of systems suitable for relieving interventions must be known;
- the probabilistic and deterministic approaches shall be used in a complementary way for assessing safety and when identifying weak points.

10.1.4 Practical side of the Authority's work

The Authority, when performing regulatory works
- 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 Authority always decides in favour of greater safety;
- endeavours to weigh every issue according to its importance. Importance is determined in relation to safety. Such weighing-up may not be a reason for breaching regulations required by law, nor for criticizing or neglecting the tasks required by law;
- takes the licensee’s viewpoints into consideration as reasonable;

- assesses the severity of incidents that may occur by processing them in an increasingly precise manner and utilizes the feed-back of experience gained in the operation process.

High standards of work shall be ensured through the operation and continuous maintenance of an internal quality management system. The Authority's quality management system is described in Section 13.3.

10.2 Safety policy of Paks NPP Ltd as the licensee

Govt. Decree 89/2005. (V. 5.) Korm. [II.7] concerning the implementation of the Act on Atomic Energy obliges the Licensee to prepare 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 (as a document) was created in order to summarize the main safety-related activities of Paks Nuclear Power Plant Ltd and to proclaim the principle of the priority of safety. It deals with defined methods of practical implementation only indirectly, since these are enforced through regulations, procedural orders, and instructions at a lower level.

The Safety Policy has uniform and full validity over each organizational unit and employee of the nuclear power plant. It determines the responsibilities and formulates expectations for each employee in order to maintain and enhance safety. It stresses the importance of the general responsibility of the NPP`s Director General and the particular responsibility of the Safety Director for realizing the safety and protection of the operating staff, the public, and the environment. 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 stresses the importance of training, information and feedback as a means of enhancing safety.

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 Safety Director 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 competence together with legal responsibilities, the NPP`s Director General set up the regulation hierarchy defined in the Quality Assurance 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 appropriate qualifications and have had the necessary training for carrying out their particular function. Qualifications depend on passing an examination that is either performed within the plant or in front of representatives of the Authority, depending on the potential effect on safety of the particular position. Licensing 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 contained in the Education Manual. 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 abnormal event. 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 ongoing process and follows a detailed, structured format with work instructions. An administrative instruction guarantees that only those jobs 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 Training Centre of the nuclear power plant contributes to the preparedness of the maintenance 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 provision of all safety-, human resource-, and material-related conditions necessary for such work.

It is the task of the maintenance staff to document accurately all work that is carried out and to archive such documents.

The tasks of the technical support organization are as follows:

- drawing 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 main overhauls, 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 main overhauls;
- 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 contractors

On the premises of the nuclear power plant, work may be performed only by external contractors holding a valid qualification approved by 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 procedural order approved by the Authority, under regular inspection by the Authority. Paks Nuclear Power Plant Ltd is responsible as auditor for the carrying out of the auditing and evaluating procedure and to ensure that the conditions for qualification remain fulfilled.

The fulfilment of requirements of the Quality Management Manual – and those of the more detailed internal regulations – is mandatory for all outside organizations and contractors performing work on the site of the nuclear power plant. The hiring organization inspects all work performed by an outside contractor 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.

11. Financial sources and human 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 Authority

In order to ensure the normal operation of the Authority, 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 Authority;
  - to cover the development costs related to the emergency preparedness and response activities;
  - to cover the costs of the Authority as a consequence of its international obligations.
- Licensees of nuclear installations are obliged to pay a supervision fee to the Authority in the manner and to the extent defined in the Act on Atomic Energy.

Thus, the Authority is financially independent of nuclear installations and its funding is sufficient for carrying out its duties efficiently. *A legal guarantee had existed until October 11, 2009 that the income of HAEA, except for income from fines, shall be used exclusively for covering its operation; this guarantee ceased as a result of the amendment to the Act on Atomic Energy.*

11.1.2 Financial resources of the Licensee

Paks Nuclear Power Plant Ltd (Producer) and MVM Power Trading Ltd (Trader) 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 2013. Based on the agreement, the energy not required by the Trader can be sold on the free market. Nevertheless, due to the competitive price level (i.e. below the import price) of the Producer the Trader has purchased all offered energy. Thanks to the competitive price, the produced electric energy produced will be reasonably saleable on a long-term basis, thus the financial resources needed for the maintenance of safety will be at the disposal of the nuclear facility.

The Act on Atomic Energy required that a fund, viz. the Central Nuclear Financial Fund, be created in 1998 for financing interim storage and final disposal of radioactive wastes and spent fuel elements and decommissioning of nuclear installations. In order to fulfil these requirements an independent organization, the Public Limited Company for Radioactive Waste Management, was established by the HAEA. The amount to be paid into the Fund annually by the nuclear power plant is calculated by the re-established company (now a limited liability company) on the basis of planned investment and operational costs along with international data. These payments are approved by Parliament as part of the act dealing with the annual budget agreed upon with the Hungarian Energy Office and with the Hungarian Atomic Energy Authority. These payments, based on the Act on Atomic Energy, shall be considered when determining the price of electric energy.

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, and chemical engineers. The syllabus of the Faculty of Mechanical Engineering of the Budapest University of Technology and Economics 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 Authority

Between January 1, 2007 and December 31, 2009, the average number of staff of the Authority was 85. Of this number some 87% are professionals holding a higher education degree (university or college), about 45% have two or three degrees (the second degree is usually in disciplines dealing with nuclear techniques). About 23% have a PhD, or an advanced academic or higher degree.

Those employed by the Authority may perform official activities on their own (licensing and inspection) only if they pass a nuclear safety or nuclear safeguards inspector's examination.

To acquaint the staff of the Authority with the practices of the power plant, their training is done mostly at the plant itself or in another form which conforms to the training system of the power plant. 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 Authority 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 emergency preparedness training programme is an independent and ongoing part of the training plan.

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

- *learning is a lifelong process;*
- *highly qualified humans are the HAEA's most important asset, in view of which it expects and urges the acquisition and maintenance of work-related knowledge;*
- *organizational training is based on the recognition, identification, adaptation and continuous development of efficient learning methods;*

- *all participants are motivated by knowing that the lessons learnt contribute to their performing their daily work at a higher level and with increased efficiency.*

As a part of its training system, the HAEA prepares annual training plans, evaluates the realization of the previous plan and feeds back the experience. Depending on its possibilities and needs, the HAEA joins the training programmes of national and international (IAEA, NEA, etc.) organizations, follows and makes use of the available information thereof, and continuously assesses and supports the individual training needs that are in harmony with the organizational objectives.

In 2009, the HAEA, through a self assessment process, revised the procedures of its training system; the recommendations on further developments will be included into its procedures.

11.2.2 Human resources of the Licensee

As of 31 December 2009, the employees of Paks Nuclear Power Plant Ltd numbered 2,399 of whom 87 are heads of divisions or higher level executives. The number of those engaged in operations is 808; the number of maintenance staff is 541, and the number of others ensuring support (safety, security, technical, economic and human) activities is 1050. Of the total number of employees 35% have a higher education degree. Of the operating personnel, 376 have a valid official license for performing numerous types of work.

Within the nuclear power plant, the system of expert training is well regulated; the financial, material and human conditions are also assured by the plant. The expert training system is job-oriented and consists of a series of modules ordered in hierarchic structure. Theoretical training is always followed by practical training. Both theoretical and practical training programmes are concluded by exams the passing of which entitles the individual to be employed in a particular position. However, training does not come to an end on obtaining the qualification: training courses and check-ups aimed at increasing knowledge continue together with periodic adequacy tests every three years. Annual medical and psychological fitness tests are also a prerequisite.

For posts of greater responsibility and vital to safety, training courses conclude with an official licensing examination. The method and content of the examination are contained in the given licensing procedures and instructions.

In addition to general basic training, 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.

Paks Nuclear Power Plant Ltd trains its experts at its own cost and in its own training centres. The training infrastructure is suitably developed; the training centres are well equipped. All teachers and instructors are well qualified and highly motivated and, in addition to being involved in education, they are also engaged in technical development.

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

The Maintenance Training Centre established with the support of the International Atomic Energy Agency is unique with its real primary components and the first class mechanical equipment in its training workshops. A special feature is that training and education make use of full-scale primary components (reactor vessel, steam generator, main circulating pump, etc.) under inactive conditions.

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 Authority 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.

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 abnormal events, further data can be derived concerning the probabilities of the occurrence of events originating from human error.

An employee satisfaction and commitment survey was conducted for the third time at Paks Nuclear Power Plant Ltd in November 2009. The survey was aimed at providing the management with information on a number of factors:

- *on the opinions and motivation of employees,*
- *on the degree of the employees' satisfaction and commitment, and on any influencing factors,*
- *on how to assess the employees' judgement on the actual level of nuclear safety culture is judged by the employees.*

It could be concluded from the survey that the proportion of employees committed to Paks Nuclear Power Plant Ltd has significantly increased, the majority of the employees have a positive opinion on the workplace, strong emotional ties exist between employees and the company, and the employees make every effort to do outstanding work performance. The number of those satisfied with the nuclear power plant as a workplace has also increased compared with earlier years; only a small number of employees were critical in this respect.

12.2 Manpower selection

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 for the given job and in addition meet the appropriate medical and psychological requirements.

The recruitment and employee selection process requires close cooperation between the professional organizations and the human relations division since the manager of the commissioning organization defines the professional requirements for the position to be filled, while the human relations division performs preparation, screening and evaluation. Those candidates who had worked earlier or work currently on the site of the nuclear power plant and have practical experience get preference during the selection process. The selection process applied by Paks Nuclear Power Plant Ltd also includes a psychological aptitude test and measurement of skills required for a given job or position. The psychologist provides a detailed evaluation on the results of aptitude tests and the measurements of skills, and then prepares a list of suitable list of candidates.

In order to prepare new employees or staff who are taking up a new position or a new job, Paks NPP Ltd operates tutorial programmes. The tutorial system provides support for newcomers to learn about the new job and the work environment as well as the necessary technical skills; moreover, it facilitates the transfer of knowledge from those having special and wide- ranging professional experience.

12.3 Improvement of working conditions

The Collective Contract of the plant limits overtime to 4 hours per day and a total of 8 hours per week which altogether should not exceed 300 hours a year. The valid rules are in accordance with the related effective stipulations of Act XXII of 1992 on the National Labour Code [I.1]. As this means a particularly strict limitation of overtime work, the Human Relations Division keeps comprehensive records of the workload of employees.

In order to ensure undisturbed work, some while ago the NPP established and has ever since operated a social system whose scope in several areas reaches far beyond the services usually available, and thus this social system's quality and standard are much higher than the average in Hungary.

Since 2009 the work of the psychology unit is carried out by a highly specialized psychologist who is also a mental health expert. The health centre operated in the framework of the psychology unit provides such a beneficial environment together with its programmes that it contributes to a considerable extent towards the maintenance and improvement in efficiency as well as the health of the employees.

12.4 Future aspects 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, and to obtain the necessary operating license for that. With the lifetime extension, the possibility of perspective life cycles occurs, and thus the interest of specialized personnel can be preserved and the appropriate recruitment can be ensured.

Paks Nuclear Power Plant Ltd has maintained a performance and competence assessment system covering each of its employees since 2009. The system includes the assessment of job-specific tasks, professional preparedness and motivation. Employees are provided with regular personal feedback on their work as well as judgement of personal expectations belonging to his/her job position.

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 the 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 power plant are regulated in a separate procedural order. Any human error found during an investigation is required to be analysed in detail. Specialists help to identify initiating causes, participate in any psychological analysis and also help to define 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 (proper temperature, lighting, noise and vibration levels, and clean air) in accordance with prescribed values are considered a priority. If it is thought that any of these conditions in a particular workplace does not meet the requirements, accurate measurements are performed on the basis of which supplementary steps 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 by re-construction and modification so that the probability of repeating errors is reduced. All tools, measuring instruments, maintenance and all other special equipment, meet the requirements both for quality and quantity.

13. Quality assurance

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. There are still certain professional areas where Hungarian directions and standards have yet to be prepared: in these cases the approaches are followed of those countries where an advanced nuclear industry exists. It is of paramount importance that those who provide any form of supply to the power plant are 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, …. which possess appropriate quality assurance systems can take part in activities related to nuclear facilities, nuclear systems and equipment". Moreover the Act on Atomic Energy requires that in the field of application of nuclear energy only such individuals may be employed who meet all the necessary requirements, such as qualifications, and the necessary personal standards and health, etc. The adequacy of the management system itself shall be examined and certified.

The principles of the quality management system are included in Volume 2 of the Nuclear Safety Code, and these requirements were composed according to Code 50-C-Q of the International Atomic Energy Agency and by taking account of ISO 9001:2000 standard. The volume on quality assurance and the associated guidelines enforce the requirements of the law and define the quality management expectations not only towards the operator but also towards the suppliers.

13.3 Quality management system of the Authority

The HAEA was among the first of the bodies of the Hungarian central public administration to introduce a quality management system in accordance with the standard MSZ EN ISO 9001:2001 (ISO 9001:2000). Pursuant to the standard, the certification shall be renewed every three years and a supervisory audit shall be conducted every year. *As a result of the third renewing audit (conducted in 2009), certification of the power plant became valid for a further three years, until March 2012. According to the certification,* *the quality management system of the HAEA in the field of "peaceful and safe application of nuclear energy" complies with the requirements of the ISO 9001:2001 international standard. It was also concluded during the audit that a new strategic plan should be elaborated in view of which a new concept for regulatory activities has to be developed.*

In order to get to know the employees' opinion on the organization and its operation and performance, HAEA's management introduced the organizational self assessment system called Common Assessment Framework (CAF) - as suggested by the government. The CAF was developed as a result of the cooperation between those ministers of the European Union who are responsible for public administration. The system provides such a self assessment framework which was directly developed for public administration bodies, by taking into account the differences among them. The results of the self assessment conducted in 2008 contributed to the elaboration of plans and actions aiming at the development of the organization.

13.4 Quality management system of the nuclear power plant

13.4.1 Management

Paks Nuclear Power Plant Ltd, as the operator and licensee of the nuclear power plant, operates 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; compliance of the system with the requirements can be seen in Chapter 17 of the Final Safety Analyses Report. Paks NPP Ltd has an integrated system, thus the environmental protection, physical protection, labour safety, radiation protection and fire protection requirements for the personnel were all considered besides the quality requirements during the development thereof. The integrated approach ensures that these requirements are complied with in addition to the overriding priority of safety. The integrated management system is a complex system, it covers the full scope of the basic activity; consequently it covers each process as well as defining 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 assurance system of the plant. 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 plans, the quality management organization regularly reviews the operation of the system. The auditors reviewing the system receive special training; however, experienced experts may be asked to contribute to the auditing 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 Authority, 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 called for in regulations, process instructions, procedural orders, 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 assurance of operation.

The maintenance instructions, process instructions, procedural orders and their implementation ensure the proper control of the management of maintenance process.

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

13.4.3 Control

The safety and quality assurance organizations of the nuclear power plant exercise internal control over the executing organizations.

Control relates to the approval of documents describing execution conditions for daily activities and during on-site supervision of actual operation. Control also relates to audits that assess the system level and practical compliance with requirements defined for a given operational area.

Organizations and process-owners monitor the efficiency of their own operation through a self-assessment process.

The power plant audits the adequacy of the quality assurance systems of suppliers in a planned and documented way, particularly the meeting of requirements and the efficiency of its operation.

13.5 Role of the Authority in checking the quality assurance system

The Authority 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 is required to be reported.

Pre-planned inspections are performed according to the annual schedule of the Authority and according to the overhaul decision for units under refuelling. Non-scheduled single inspections are performed relating to events adversely affecting quality, or upon the individual decision of the authority.

The areas of the operator's quality assurance system regularly inspected by the Authority are as follows:

- structure of the organization,
- training and qualification of staff,
- documentation,
- management of non-conformances,
- normal operation,
- maintenance and repair work,
- nuclear fuel management,
- selection of contractors,
- design,
- acceptance inspection at manufacturers,
- modifications.

Checking up on supervisions includes both independent assessments and those performed by the management. Official inspections are carried out according to written procedural orders approved by the Authority's Director General and are made known to the Licensee.

The quality management organization of the Licensee has primary responsibility for taking improvement measures related to findings identified during official inspections and to report these measures. If this is neglected or not performed adequately, the Authority in a special resolution will itself demand the improvement measures.

Comprehensive inspection of the management of Paks Nuclear Power Plant Ltd

The HAEA conducted a comprehensive inspection in the field of organizational and administrative factors at Paks Nuclear Power Plant Ltd. This inspection included the safety attitude of the management and the organization as a whole, the management of suppliers, feedback of operating experience, and knowledge management.

During the inspection the Authority utilized various approaches (e.g. interviewing, walk-down) during the inspection. After completing the on-site part of the inspection, an evaluation report was prepared and then sent to the management of the plant with the aim of promoting the development of an action plan based on the regulatory observations.

The underlying reason for the inspection was principally because the management of Paks Nuclear Power Plant Ltd now faces such significant challenges (e.g. liberalization of the energy market, establishment of the Hungarian Power Companies Group) which require fundamental organizational and management changes.

14. Assessment and verification 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 authority 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 The system of safety analysis reports

The method of preparation and application of safety analysis reports is set out by legal regulation at Government Decree level. The official procedure related to a nuclear installation is based on the Preliminary Safety Analysis Report; this 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 national attributes into consideration.

Govt. decree 89/2005. (V. 5.) Korm. [II.7] stipulates that the Final Safety Analysis Report should be updated annually, so that the safety analysis report can serve as an authentic and ongoing basis for assessing the safety of the nuclear installation throughout its entire lifetime.

The Authority 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. 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 Authority. In the Periodic Safety Review Report, the Licensee presents the factors determining the operating risk of the installation as compared to those contained in the Final Safety Analysis Report. This serves as a basis for the Operating License. If needed, the Licensee takes safety improvement measures to eliminate or moderate risk factors. The Licensee is required to propose a programme of safety improvement measures that includes the establishment of deadlines, and this programme is then submitted to the Authority as part of the Final Safety Analysis Report.

The Authority 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

There are specific International Atomic Energy Agency 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). These recommendations schedule regular reviews every ten years thereby providing a comprehensive view of the safety of nuclear power plant units and, by virtue of their systematic approach, they are suitable for defining necessary safety improvement measures and priorities.

In Hungary, the Authority issued a guideline about Periodic Safety Reviews. The guideline 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 in accordance with the new Act on Atomic Energy which entered into force in 1997, and the related regulations.

The upcoming Periodic Safety Review was conducted jointly for all 4 units. The deadline for submitting that Periodic Safety Review Report was December 31, 2007. The Authority approved the report on December 15, 2008 and ordered the carrying out of 169 safety improvement measures. Each of these measures involved a specific intervention or action all of which were required to be accomplished by the defined deadline, but none of them threatened the safety of the continuous operation of the plant.

The measures were grouped as follows:

- *very important corrective measures, whose accomplishment by the deadline was a condition for being granted an operating license (23 measures);*
- *important corrective measures, whose omission may entail a regulatory enforcement process (84 measures);*
- *non-safety-relevant deficiencies (3 measures);*
- *exemptions from compliance with the requirements of the Nuclear Safety Code, as granted by the Authority during the regulatory assessment of the Periodic Safety Review (11 exemptions);*
- *modifications and corrections in the Final Safety Analysis Report as required by the Authority (29 measures);*
- *monitoring of the progress in the implementation of corrective measures (2 measures);*

- *measures to be accomplished by June 30, 2009 (17 measures).*

The operating licenses of Units 1-4 are justified by the Periodic Safety Review Report; the extension of the service lifetime beyond this period will be handled separately.

14.2 Verification of safety

14.2.1 In-service inspections and tests, material testing

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

14.2.2 Ageing management of equipment

In the Nuclear Safety Code issued as an annex to Govt. Decree 89/2005 (V. 5.) Korm. [II.7], separate sub-sections are designated to the topics of ageing and lifetime management. Ageing management of equipment at Paks NPP is 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 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 ones are installed at different locations of the reactor building important from both structural and mechanical points of view. The earthquake monitoring system provides adequate measurement data for the evaluation procedure.

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 shut-downs triggered by false signals, the earthquake alarm and protection system currently operates off-line. In accordance with international recommendations and with modern practice, the criterion for unit shut-down 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.

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 (i.e. protection against radiation directly affecting humans) belongs to the Ministry of Health; the technical issues of plant radiation protection is the task of the Authority; the issue of releases and thus the protection of the environment belongs to the Ministry of Environmental Protection and Water; tasks related to the radioactivity of the soil, food-stuff, and vegetation belong to the competence of the Ministry of Agriculture and Rural Development.

The Act on Atomic Energy allocates regulatory and professional administrative tasks to several authorities and defines the tasks of the user 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 [III.1] 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 contains commensurate regulation 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. Every user is obliged to prepare an internal radiation protection rule, which should be approved by the competent authority; in this case the National Public Health and Medical Officer Service. 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.

- Ministerial Decree 15/2001. (VI. 6.) KöM of the Minister of Environmental Protection 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 [II.5] aims at adopting 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 information of the European Commission;
- publication of results in annual reports.

- Ministerial Decree 47/2003. (VIII. 8.) ESZCSM of the Minister of Health, Social and Family Affairs [III.3] stipulates the conditions of interim storage and final disposal of radioactive wastes. Concerning 0final 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.

- Govt. decree 89/2005. (V. 5.) Korm. [II.7] placed the technical issues of radiation protection related to nuclear installations and their systems and equipment in the Authority's scope of competence. These issues are addressed in the Nuclear Safety Code the volumes of which are the appendices of the decree.

  Annexes 1 and 2 of Volume 1 of the Nuclear Safety Code define the contents of the radiation protection related sections of the Preliminary and Final Safety Analysis Report required for the application of the establishment and operating licences. The same volume prescribes the regular analysis of radiation protection indicators of operation and utilization of experience within the framework of the periodic safety review.

  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 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 apprentices[3]	Members of the public
Effective dose	100 mSv/5 years, and within this 50mSv/year	6 mSv/year	1 mSv/year
Dose equivalent for the lens of an eye	150 mSv/year	50 mSv/year	15 mSv/year
Dose equivalent in skin and extremities	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.

(2) Pregnant women are not permitted to be occupationally exposed.
Breast-feeding mothers are not allowed to work with unsealed sources.
Under special circumstances higher exposures may be permitted for volunteers provided that the doses received shall not exceed 50 mSv/year and the period of permission shall not exceed 5 years.

(3) These limits apply to apprentices and students aged between 16 and 18 years who are participants in a specialized course on subjects concerned with radiation and its use. For all other secondary school students, the dose limits are identical 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 Paks Nuclear Power Plant, every worker employed in a radiation hazardous post (including both outside and plant employees) is monitored by a regulatory film dosimeter. The internal rules of Paks NPP require full-scope operative dosimetry inspection. In accordance with these rules, every worker who performs any activity within the controlled area has to wear an electronic dosimeter.

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

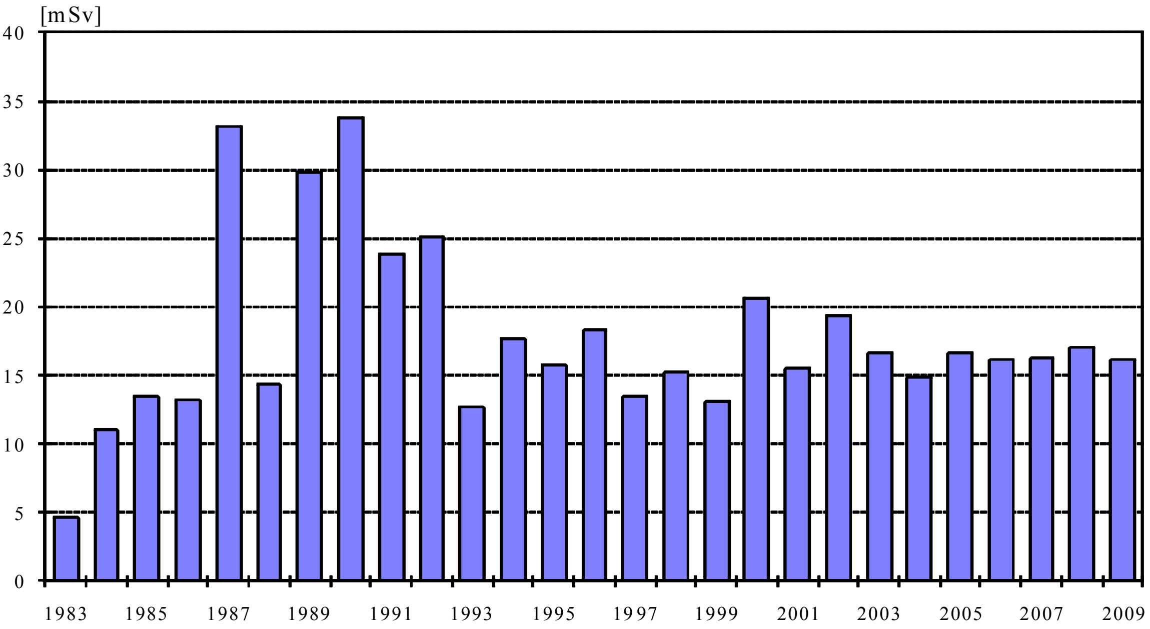

Figure 15.3.1-1. Maximum annual individual doses according to regulatory film-dosimeter readings

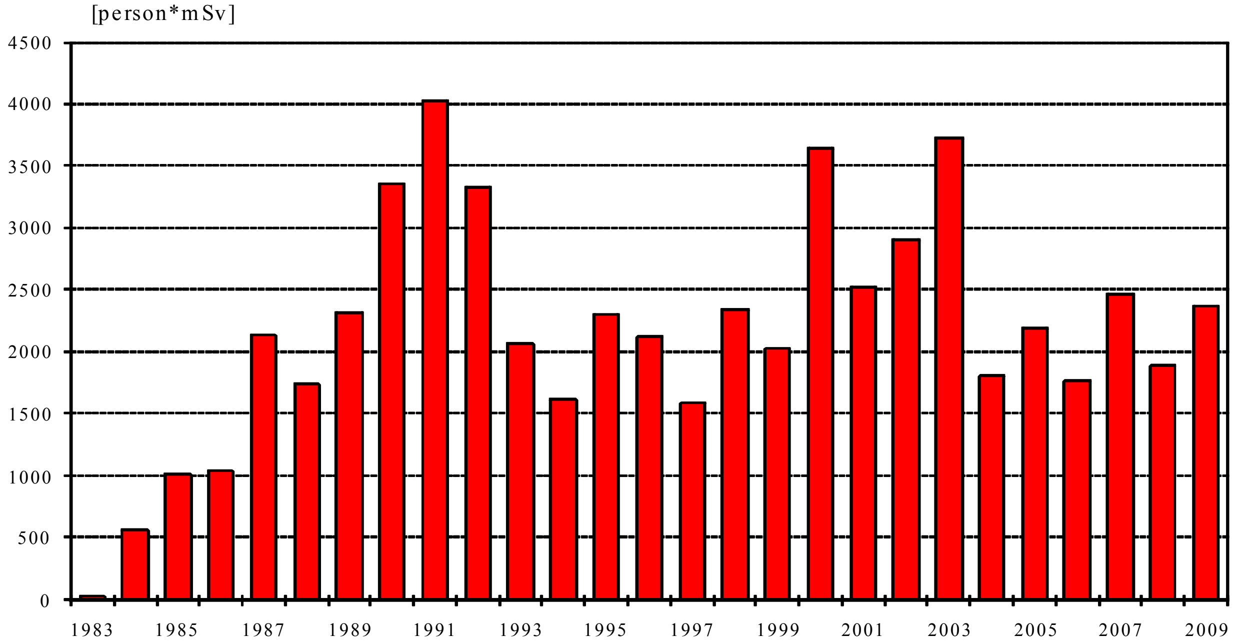

Figure 15.3.1-2 Annual collective doses according to regulatory film dosimeter readings

15.3.2 Annual collective doses according to regulatory film dosimeter readings

At Paks NPP the highest level of radiation exposure of plant personnel originates from overhauling activities during 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 outages.

The dose planning, radiological permission to carry out particular maintenance operations 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 overhaul period just after shut-down of the unit, in the immediate surroundings of main components and in rooms involved in overhaul work. Data gathered on the radiation conditions provide a useful source 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 operative dose values received at the power plant. *Collective doses for the period 2007-2009 are given in the following table.*

Table 15.3.2-1: *Exposure of maintenance personnel between 2007 and 2009*

unit/year	***collective dose [person*mSv]***		
	2007	***2008***	***2009***
I	*995*	*230*	*281*
II	*241*	*532*	*347*
III	*223*	*257*	*741*
IV	*127*	*80*	*233*

The 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. *Between 2007 and 2009, no internal exposure exceeding the recording level of 0.1 mSv took place. With regard to the tritium activity-concentration measurement in urine, values reaching or exceeding the recording level (2.5 Bq/cm^3) 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 cases***	***max. concentration [Bq/cm^3]***	***max. committed effective dose [µSv]***
2007	*147*	*65*	*130*
2008	*33*	*14*	*28*
2009	*33*	*60*	*120*

Dosimetry control of workers employed from outside companies is carried out by the power plant staff.

Summing up, it can be established that the official dose limits have not been exceeded during the operation of the 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.

The basic radiation protection training, upgrading and supplementary courses, along with the regular examination of knowledge comprise transfer and inspection of knowledge on radiation protection optimization.

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 overhauls, a technical measure that is used is the shut-down cooling schedule, aimed at reducing the deposition of corrosion products during cool-down.

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 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 and 10 μSv/year for the Spent Fuel Interim Storage Facility). The release limitation system required by Ministerial Decree 15/2001. (VI. 6.) KöM of the Minister of Environmental Protection [III.3] 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 release limit criterion data and usage of limit in the last three years for Paks NPP are outlined in Table 15.4.1. The data of the table clearly shows that the releases were very low.

Table 15.4.1. *Releases from plant units*

Year	*Number of operating units [db]*	***Release limit criterion***	***Usage of limit** [%]*
2007	*4*	2.8×10^{-3}	*0.28*
2008	*4*	2.5×10^{-3}	*0.25*
2009	*4*	2.2×10^{-3}	*0.22*

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

The site of the power plant is divided into 2 zones: a free access zone and a controlled zone. 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 audio warning (alarm and emergency levels). 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:

- 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 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.

In addition, type-C sampling stations which measure dry-out activities and doses 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 power plant, e.g. water, mud, fish, plants, milk and soil. So far, measurements have shown *only in a few 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.

Reconstruction of the Workplace and Technological Control System took place between 2008 and 2009. The new system operates with high reliability.

At the Spent Fuel Interim Storage Facility 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 of the environment is constantly carried out by the competent authorities as well, independently of the monitoring system operated by the Licensee. Generally speaking, 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 scopes of competence are shared among the HAEA, the National Public Health and Medical Officer Service and the Ministry of Environmental Protection and Water. The measurement system of the various authorities consists of several monitoring networks complementing each other; these networks belong to departments in accordance with the task-sharing specified in the Act on Atomic Energy.

The South-Transdanubian Regional Institute of the National Public Health and Medical Officer Service regularly inspects the workplace radiation protection conditions of the nuclear power plant by involving the National Research Institute for Radiobiology and Radiohygiene as a professional body.

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

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

The Regionally Competent Section of the South-Transdanubian Environmental, Nature Conservation and Water Management Inspectorate verifies the fulfilment of requirements related to discharge limits and other environmental stipulations contained in resolutions applicable to Paks NPP. The Inspectorate is an environmental protection licensing authority of the first instance but it also participates in other licensing procedures as a special authority.

Various activity concentration values of soil, veterinary products and foodstuff are monitored by the National Public Health and Medical Officer Service, the National Research Institute for Radiobiology and Radiohygiene, the South-Transdanubian Environmental Protection and Water Management Inspectorate and the Central and Regional Food-Chain Laboratories.

The Environmental Radiation Protection Monitoring System of the authorities performs independent 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 Institute for Radiobiology and Radiation Hygiene. The Authority 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 gather monitoring results measured at various places into one central database the Government created, at the end of 2002, the National Environmental Radiation Monitoring System (OKSER). The chairperson of the committee managing OKSER is one of the two deputy directors general of the HAEA; the Information Centre operates in the National Research Institute for Radiobiology and Radiation Hygiene. *The 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 structure of the national disaster management system, the tasks of the Governmental Co-ordination Committee, the Operative Staff and the defence committees and of the Scientific Council are governed by Govt. Decree 179/1999. (XII. 10.) Korm. [II.2]. Govt. Decree 248/1997. (XII. 20.) Korm., amended by Govt. Decree 40/2000. (III. 24.) Korm. regulates the organization and tasks of the Hungarian Nuclear Emergency Response System in agreement with modern public administration structures. Govt. Decree 165/2003. (X. 18.) Korm., promulgated upon the accomplishment of the EU harmonization process of the legal system, is compatible with the European Union's Council Directive 89/618/Euratom of 27 November 1989 on informing the general public about health protection measures to be applied and steps to be taken in the event of a radiological emergency.

16.1.2 Operation of the Hungarian Nuclear Emergency Response System

The preparation for and response to disasters is managed by the Governmental Co-ordination Committee.

The composition of the Governmental Co-ordination Committee is as follows:

- chairman: the minister responsible for defence against disasters, currently the Minister for Local Government;
- members: *ministers responsible for responding to various emergencies. At the chairman's invitation, the Director General of the HAEA takes part in the meetings of the Governmental Co-ordination Committee with consultation rights.*

Under normal circumstances, organizations of the Hungarian Nuclear Emergency Response System carry out preparatory work and training: several organizations perform ongoing tasks related to data acquisition, planning, information or co-operation.

A nuclear emergency is declared or withdrawn by the chairman of the Governmental Co-ordination Committee or, in case of urgency and for the area under his control, by the chairman of the County (Capital) Local Defence Committee, based on the information received from the nuclear installation.

If a nuclear accident occurs, it is the task of the Nuclear Emergency Response Working Committee to provide the professional decision support. *The Nuclear Emergency Response Working Committee operates on the premises of HAEA with experts from designated ministries; it is headed by the Director General of the HAEA.*

The employment of intervention forces is subject to the recommendation of the head of the Operative Staff. The Operative Staff consists of delegates of the National Directorate General for Disaster Management and the ministries concerned. The head of the Operative Staff is appointed by the Minister for Local Government. The Governmental Co-ordination Committee has a Scientific Council to support its activities and decisions.

Members of the nuclear emergency section of the Scientific Council of the Governmental Co-ordination Committee are invited to serve on the Council by the Director General of the Hungarian Atomic Energy Authority. The main duty of the Scientific Council is to offer technical and scientific aid to support the decision-making process and the decisions themselves in order to enhance emergency preparedness and to respond to the consequences of an emergency.

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; in the counties and in the capital it is the chairman of the regionally competent County (Capital) Defence Committee, while at national level it is the chairman of the Governmental Co-ordination Committee.

The chairmen of defence committees in the counties and the capital designate organizations under the scope of their authority to evaluate the severity and respond to the impacts of nuclear emergency, the tasks of which are as follows:

- *evaluation of nuclear threats to the capital and the counties and specification of the related tasks,*
- *development and upgrading of emergency response and action plans,*
- *implementation of response tasks in a nuclear emergency,*
- *provision of personal, organizational and technical conditions for local public information.*

In the case of a nuclear emergency, it is the task of the Hungarian Atomic Energy Authority to evaluate the nuclear safety and radiation conditions. The following facilities were established to achieve this goal: Centre for Emergency Response, Training and Analysis (CERTA) of the Hungarian Atomic Energy Authority, Nuclear Emergency Information and Evaluation Centre operated by the National Directorate General for Disaster Management, Information Centre of the National Environmental Radiation Monitoring System operated by the Ministry of Health. The operation of the centres provides an analysis of the nuclear emergency, a quick assessment of the likely consequences and draws up a list of recommendations for protective actions.

The National Directorate General for Disaster Management performs the tasks related to early notification initiated by radiation monitoring alerts. The Directorate operates the Real-time, On-line, Decision Support System (RODOS) developed for the European Union.

16.1.3 The National Nuclear Emergency Response Plan

The High-Level Working Committee established by the Governmental Co-ordination Committee completed their review of the National Nuclear Emergency Response Plan in 2008. The National Nuclear Emergency Response Plan follows a multi-level approach; the emergency response plans of nuclear facilities, counties, departments and organizations with national competence are built on each other in the same structure. The scope of the National Emergency Response Plan covers the knowledge and duties with regard to the operation of the National Emergency Response System. Its basic elements are as follows:

- emergency design basis;
- organizational structure of the National Emergency Response System, organizational responsibilities and system of cooperation;
- operating modes of the National Emergency Response System, the order of alerting and communication;
- tasks of the National Emergency Response System in normal, alert, emergency and recovery operating modes;
- treatment of radiation injuries;
- public information.

Subsequent to the approval of the new Plan, during 2008 and 2009, each organization involved in national nuclear emergency response reviewed its own emergency response plan. The national plan review was carried out in a harmonized manner, in accordance with the guideline prepared by the High-level Working Committee and published by the Director General of the HAEA on behalf of the chairman of the Governmental Co-ordination Committee. In concert with the resolution of the Governmental Co-ordination Committee, the High-Level Working Group constantly monitors the national Plan and prepares for its next review as well as developing methodological guidelines addressing different technical issues.

16.1.4 Nuclear emergency response system of the nuclear power plant

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

One starting point of 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 an emergency, the actions determined upon the declaration of the emergency class shall be introduced or shall prepare 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; these levels are taken into account as a means of determining the protective actions to be introduced.

Evaluation of radiological conditions is supported by the on-line, real time computer simulator of the NPP, which calculates the expected and averted doses by taking into consideration the environmental radiation and meteorological data.

The territory of Hungary is not affected by the 30 kilometre urgent protective action zones of those foreign nuclear power plants that are located near the border. Moreover, the same intervention levels shall be used in the 300 kilometre zone regarding restriction of foodstuff consumption as defined in the Hungarian legislation for this zone of Paks NPP.

16.1.5 Comprehensive Emergency Response Plan of Paks Nuclear Power Plant

The main document of emergency preparedness in the power plant is the Comprehensive Emergency Response 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 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 Response 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 Preparation 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 defined in the National Emergency Response Plan.

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 International Atomic Energy Agency and also participates in the exercises organized within the framework of the ECURIE system of the European Union.

The HAEA Emergency Response Organization takes part in the following types of exercise:

- alerting exercises to test the availability of the organization;
- methodological exercises for one of the groups of the organization without the participantion of any others, in order to drill the emergency tasks based on a specific emergency scenario;
- full scope exercises to check the performance of the whole HAEA Emergency Response Organization;
- internal communication exercises and international communication exercises initiated by the European Commission and bilateral countries.

The whole personnel of the plant shall be prepared for emergency tasks. The members of the emergency response organization are regularly trained for their specific tasks. The plant performs exercises in accordance with the annual *training* and exercise plan approved by the Authority. *The various types of exercise are grouped according to their objective (practicing or testing), participation (complex, management or partial), and according to the type of initiation (announced or un-announced). During the preparation of complex and management exercises, the plant communicates with the off-site emergency organizations to facilitate the cooperation.*

The individual organizations hold partial exercises independently of the central emergency management. The National Emergency Response Plan also sets out the order of communication tests as a means of testing the availability and reliability of the contact points.

16.2 Informing the public and the neighbouring countries

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

In an emergency the alarm procedure is carried out with the help of the civil defence organization 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. *A total of 227 modern public alarm and information devices operate in 74 settlements. Because the acoustic heads of these devices have their own power supply, they are still operable in case of short circuit. The high power sound emitters are capable of broadcasting voice signals as well as siren signals. The system may be launched upon the order of the chairman of the general assembly of the three counties concerned from the Protected Management Post of the plant, from the plant management centre, from mobile equipment and from the duty service of the Tolna County Disaster Management Directorate.* In an emergency, it is the duty of the national public media to provide appropriate information, but the 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 Authority. 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 also receive SMS notification on the related events of the plant.

Supported by Paks NPP 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 plant and the settlements involved, and it also serves for information and preparation of the public for emergency situations. It supplies regular information about the emergency preparedness activities of Paks NPP based on links with the national media.

In the case of an emergency occurring close to the Hungarian border in another state, the central organizations of the national emergency response system will inform the public on the emergency situation and the protective actions to be implemented through the public media on the basis of the information provided by foreign partner authorities.

16.2.2 International relations

<u>International conventions</u>

The Republic of 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 International Atomic Energy Agency established the I International Response Assistance Network and its 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.*

At the request of the International Atomic Energy Agency, in order to update the database the HAEA, together with the competent domestic organizations, again surveyed the assistance capabilities of Hungary. As a response to the IAEA's request, a summary was sent containing the offers of help from the following organizations: KFKI Atomic Energy Research Institute, Ministry of Foreign Affairs, Hungarian Atomic Energy Authority, National Directorate General for Disaster Management, Hungarian Meteorological Service, National Research Institute for Radiobiology and Radiohygiene, Paks Nuclear Power Plant. Laboratory capabilities, measurement devices and radiation protection and nuclear expertise were offered as assistance to the IAEA with the stipulation that the conditions for providing the actual assistance would be specified by Hungary on a case-by-case basis.

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, which came into force in Hungary on 27 April 1992.

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

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 Emergency Response Plan.

Hungary is member of the European Community Urgent Radiological Information Exchange (ECURIE) system, in the framework of which the country in which an accident occurs 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 which has been running since April 1, 2007 the HAEA's 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 as preparation for such situations. The support covers the registration and handing over of technical data of nuclear installations, analysis of the situation, evaluation of atmospheric dispersion of a release, 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, mutual provision of information, and co-operation: Austria (1987); the Czech Republic (1991); Slovakia (1991); the German Federal Republic (1991); Slovenia (1995); Romania (1997); Ukraine (1997) and Croatia (2000).

International data exchange

Hungary pursues bi-lateral radiation data exchange with Austria, Croatia, Slovenia and Slovakia. In addition, 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.

The National Directorate General for Disaster Management represented Hungary in the EURANOS (European approach to nuclear and radiological emergency management and rehabilitation strategies) project aimed at combining the developments related to nuclear and radiological emergency management. The key element of the project was a demonstration activity the essence of which was to test the new methods and tools developed in the project at such locations where they are intended to be used in the future.

The Austrian Federal Ministry for Agriculture, Forestry, Environmental and Water Management and the National Directorate General for Disaster Management concluded an agreement on May 23, 2006 about data exchange of gamma dose rates of radiological early notification systems. As a conclusion of the agreement modern radiation monitoring equipment of high-sensitivity was installed in Gerjen (a village in Tolna County close to the plant), the official handing over of which took place in 2007. The station also has a meteorological measuring system and provides data every half hour to the Nuclear Emergency Information and Evaluation Centre of the National Directorate General for Disaster Management. Most of the data of the station appear in a display located in the Mayor Office of Gerjen and the data are also accessible via Internet.

In parallel, the National Directorate General for Disaster Management monitors the radiation data obtained from the 10 similar measuring stations of Austria and is provided with access to the background data display system of the Austrian State Centre for Early Notification.

In addition to the data of 24 stations, after an agreement concluded in September 2007 with the Slovakian party the data of 32 additional measuring stations are received in the National Directorate General for Disaster Management. In December 2007 the experts of Romania and Hungary expressed the intention to sign a similar bilateral agreement for data exchange.

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^{o}34'24" (northern latitude) and 18^{o}54'53" (eastern longitude). The area of the site is 585 ha, it is the property of Paks Nuclear Power Plant Ltd, and there is an additional 68 ha that has been appropriated for the purposes of potential extension. The site is used exclusively for activities related to the generation of nuclear energy.

The main 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 man-made hazards

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

The region as a whole 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 partially independent of the plant; it has its 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 safety landing 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 power plant. Based on conservative estimates *the probability of any heavy transport or military aircraft crashing or falling on the plant's most sensitive area from the safety viewpoint is below the regulated screening value ($1x10^{-7}$/year).*

Analysis of road and waterway accidents during the transport of hazardous substances based on the most up-to-date statistics indicates that the probability of a release of hazardous substances that would reach the plant site and cause any process actually jeopardizing the safe shut-down of the units (e.g. poisoning or explosion) is below 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 levels of reliability 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 man-machine interfacing. .

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 89/2005. (V. 5.) Korm. [II.7] (as amended by Govt. Decree of 249/2005. (XI.18.) Korm. [II.8]) 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 Authority revised the design volume in 2009, together with the other volumes of the Code. The requirements reflect the most recent nuclear safety standards and stipulate in detail those principles commensurate with 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 accidents.

18.1.2 Application of proven and verified technologies

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

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

Safety functions, and the safety systems, structures and components fulfilling these functions shall be categorized into safety classes according to their influence on safety. 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 operation, 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 transients, and design basis accidents.
- 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 Paks Nuclear Power Plant

The design of the 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. In spite of this, due attention was not given to the following: the basic design requirement related to protection against natural phenomena; the basic design requirement related to external dynamic effects; and the various basic requirements concerning the unit control room.

Paks NPP was designed in such a manner that during normal operation and in case of transients occurring relatively often, 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 accidents that were used for the design of the 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 power plant was designed in such a way that as a consequence of design basis accidents the amount of radioactive substances released into the environment and the radiation dose of workers may not exceed corresponding health limits. Management of accidents that are more severe than design basis accidents 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 accident 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.

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 the management of potential severe accidents.*

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 analyse 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 Paks NPP was established and commissioned, Hungarian practices followed those accepted in the developed countries. Based on the Technical Design provided by the supplier, a Pre-installation Safety Analysis Report was prepared, which was followed by the Preliminary 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 power plant needed to be re-evaluated. The Hungarian Atomic Energy Commission launched 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 was concluded successfully at the beginning of 1995 and brought reassuring results; it had not revealed any major deficiency. Analyses of the first Periodic Safety Review 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 WWER-440/213 type units came to an end. The confinement used at the WWER-440/213 reactors of Paks NPP was proved to be adequate for design objectives; in other words, when a design basis accident takes place the environmental release can be managed within the regulatory limits.

Within the framework of the continuously developed and extended level-1 PSA, *probabilistic safety analyses* concerning technological initiating events characteristic for full power and shut-down states, and also those concerning internal flooding, fire, high energy pipe ruptures and seismic initiating events 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 analysis of external natural phenomena other than seismic events is under way.*

In order to determine the risk of a large radioactive release, a level-2 PSA containing all formerly analysed 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.

Emergency calculations had earlier been made for the full scope of the design basis. The documentation of the Periodic Safety Review 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 WWER 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 using upgraded fuel containing burn-up poisons.

Based on the deterministic 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. The specific documents contain the strategy of accident management procedures to be developed *and the modifications proposed to be implemented to realize severe accident management*.

As a result of the AGNES project and of the Periodic Safety Review, the Final Safety Analysis Report of the nuclear power plant could be re-issued.

The Hungarian Atomic Energy Authority together with repealing the Preliminary Safety Analysis Report approved the first version of the Final Safety Analysis Report and accepted it as the current safety analysis of Paks NPP. After approval, the modification of the Final Safety Analysis Report is possible only with the consent of the Hungarian Atomic Energy Authority.

Paks Nuclear Power Plant Ltd reviewed the Final Safety Analysis Report in 2004. The aim was to prepare such an advanced basic document which would serve as basis for the licensing process for extending the lifetime of Paks Nuclear Power Plant. This document shall be updated annually in line with the regulatory prescriptions. Extension of time *limited ageing analyses required for supporting the extension of design lifetime are in progress, the essential ageing management programmes have been commenced.*

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. The latest updated Final Safety Analysis Report was submitted to the Authority in December, 2007.

In accordance with international expectations and the requirements of the European Union, the identification of initiating events belonging to the extended design basis (beyond design basis) was carried out. Analysis of beyond design basis cases and the concluding update of the Final Safety Analysis Report is in progress, it is due to be completed by the end of 2010.

19.2 Operational limits and conditions

19.2.1 Technical Specifications

As the key element of the operating documentation the Technical Specifications, contain the operational limits and conditions of safe operation.

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 only after regulatory approval.

19.3 Documents regulating operation

The quality management system of Paks Nuclear Power Plant Ltd encompasses the regulations (codes, procedures), and instructions (maintenance, handling, operation, inspection etc.) 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 and emergency situations.

The procedures include action level regulations or, if it is justified due to the complexity or safety impact of a given action 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 contractors should be provided as specified by the contracts.

The 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 Ltd to create a hierarchic system of procedures that are built on each other and by means 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 shut-down 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.

19.5 Technical support

19.5.1 Maintenance

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

The system of maintenance and overhauls has remained unchanged, its detailed description can be found in *Annex 4*.

19.5.2 Technical background

Technical and preparatory bodies

In the present organizational system of Paks NPP, technical support is basically divided according to crafts. 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 economic 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 crafts, and execution of tasks and assessments serving for preserving the qualified state of equipment.

- Execution of technical and closely related safety and finance-related calculations, analyses and reviews.
- Technical design, preparation of technical applications to the Authority, maintenance of respective technical documentation.
- Preparation for archiving of technical documentation, and delivery of archive material to storage.
- Justification for and preparation of technical developments (e.g. operation beyond design lifetime, power uprate, extension, decommissioning).
- 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.
- Drawing up of company-level development and investment programme.

Decision support committees

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 Decision Maker Forum*, the Maintenance Working Committee and the *Operation Monitoring Committee*.

Domestic and foreign support institutions

The nuclear power plant maintains close relations with all Hungarian companies performing support activities for the plant.

The power plant 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 of outstanding experience in nuclear technology, such as IVO/FORTUM, Siemens/FRAMATOME, Westinghouse, EdF and Nuclear Electric.

Based on contracts currently in force, the general design services are provided by *MVM ERBE ENERGETIKA Engineering Ltd.*; the principal consultant is the KFKI Atomic Energy Research Institute.

19.6 Reports to the Authority

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

19.6.1 Regular reports

- Quarterly report: notifying the Authority of the operational history, current issues of operation and most important factors affecting operation;
- annual report: based on the quarterly reports, but upon the greater amount information being available due to the 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 based on any changes relating to nuclear safety that may have taken place in the installation;
- reports on overhaul and repair activities: concerning repair activities affecting safety and overhauls accompanied by refuelling;
- other information: providing the Authority with up-to-date information.

19.6.2 Event reports

- Events under the obligation of immediate reporting are required to be notified to the Authority 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 Authority within 16 hours following the occurrence;
- all occurrences subject to reporting are to be submitted to the Authority in writing within 24 hours of their occurrence;
- an event investigation report should be submitted to the Authority within 30 days of the occurrence of any event.

19.7 Feedback

19.7.1 Own operating experience

Data acquisition and processing became craft-specific as far as equipment and activities are concerned within the mechanical, instrumentation and control and electrical engineering crafts. As a result of this, monitoring and the utilization of data received also differ in depth and complexity. A joint database of failures from different crafts 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 regulatory framework has been prepared.

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

During the period 1992-2009 the safety related events that occurred at Paks Nuclear Power Plant were classified to INES as seen in Figure 19.7.1. One INES-1 and one INES-2 event took place in the period of this report (2007-2009).

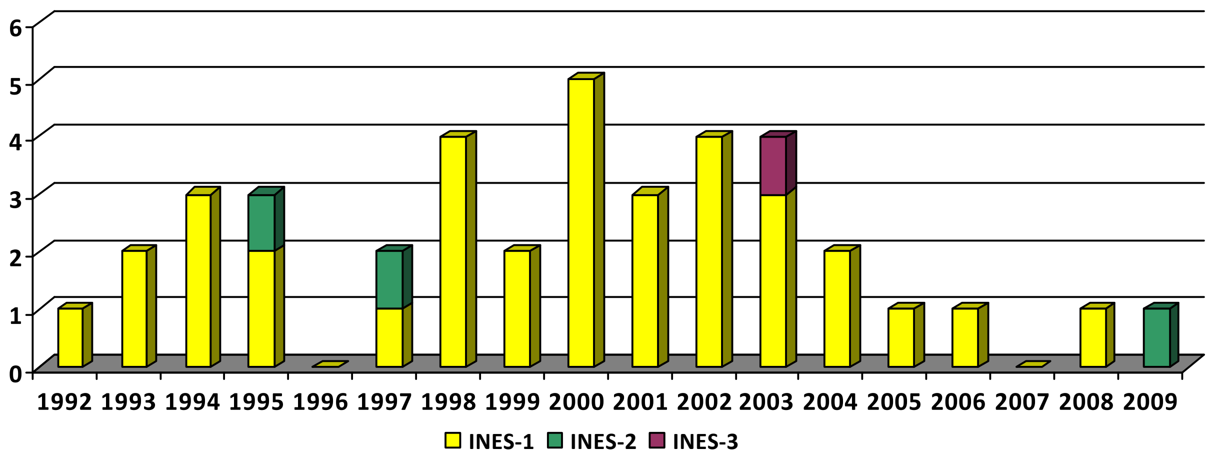

Figure 19.7.1: *Number of INES 1, 2 and 3 events from 1992*

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 Safety and Quality Management Committee reviews the safety indicators, the lessons learned from event investigations, and the status of accomplishment of all measures taken. The Safety and Quality Management 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. Paks Nuclear Power Plant Ltd takes part in the work of large international nuclear organizations (e.g. International Atomic Energy Agency, OECD Nuclear Energy Agency). There exists closer co-operation 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 WWER-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
annually between 1984 and 1987	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	Peer Review	WANO
1992	ASSET	IAEA
1993-1996	Site seismicity - 6 occasions; seismic safety programme – 2 occasions	IAEA
1995	Post-ASSET review	IAEA
1995	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	*Peer review*	*WANO*
2008	*Follow-up of peer review*	*WANO*

The last international review took place in 2005, the follow-up mission of which was completed in 2008. During the follow-up mission the WANO experts came to the site and reviewed the progress on the deficiencies revealed in the course of the 2005 mission. Paks Nuclear Power Plant fully resolved 10 issues out of the 19 areas designated for improvement. It means that these issues received the best grade (grade 3) of the four-level (0-3) scale of the WANO. With regard to the other 9 issues the progress was qualified as satisfactory, and the WANO experts recommended the continuation of the tasks. None of the issues were grade 0 or 1, which would have meant that the measures were insufficient or omitted.

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

It is the power plant`s intention to continue the practices followed to date and have the plant assessed by major international review teams in the future, at least every 3 years.

19.7.4 Radioactive wastes

On September 29, 1997 Hungary signed the joint convention established under the umbrella of the International Atomic Energy Agency on the safety of management of spent fuel and radioactive wastes. This convention 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 Ministerial Decree 47/2003. (VIII. 8.) [III.3] ESZCSM of the Minister of Health, Social and Family Affairs.

The safe handling of radioactive wastes of the nuclear power plant is the responsibility of the entity generating the waste, i.e. Paks Nuclear Power Plant Ltd. The collection, processing and interim storage of wastes is part of the operating tasks; preparations for safe final disposal are being made within the framework of a national project.

According to the Act on Atomic Energy and its executive decrees the responsible organization for disposal of radioactive wastes and for interim storage and final disposal of spent fuel 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 Hungarian Atomic Energy Authority; the Fund itself is disposed by the minister supervising the Hungarian Atomic Energy Authority.

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 power plant were transported to Püspökszilágy (30 km from Budapest), within the framework of a contract concluded with the approval of the Authority. Since 1997, solid radioactive wastes from the power plant have not been transported to the above-mentioned site. *By the end of 2004 the original capacity of the storage facility had been exhausted. Under the currently running safety improvement programme, and because of the reclassification and repeated processing of the disposed waste, an additional capacity for several years will be released for the disposal of non-power-plant radioactive wastes.*

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. Then, based on the resolution in principle of Parliament and the positive result of the local referendum the establishment of the National Radioactive Waste Repository commenced in 2006.

In the first phase of the establishment, by autumn 2008 the most important surface facilities of the National Radioactive Waste Repository had been completed, and the commissioning licence was granted on September 25, 2008. With this achievement the interim storage of waste prior to final disposal became possible, at least in respect of some part of radioactive wastes (altogether 3000 barrels of 200 l) stored in the plant. In this was the extension of storage capacity at the plant became unnecessary. In the second phase, the total surface installation will be accomplished and the first two chambers of the subsurface repository volume designed to finally dispose of the waste will be constructed.

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 so as to give priority to the construction of the National Radioactive Waste Repository for low and medium level radioactive wastes.

A new concept has to be drawn up for the further research programme, which takes into account the lifetime extension of Paks Nuclear Power Plant and the latest international trends and results relating to closure of the fuel cycle. Preparation of tests aimed at supporting the concept and comparison of potential versions is already in progress; it is expected that the coming years will see the development of the concept.

20. Plans on safety improvement

This chapter summarizes safety improvement plans and measures to be implemented which have already been described in detail in previous chapters.

Safety improvement activities currently in progress include several of those whose implementation had begun earlier (e.g. management of primary to secondary leaks), modernization of certain safety components due to obsolescence (e.g. replacement of diesel instrumentation) and developments related to the further improvement of human factors.

A human- factor-related improvement is the further development of symptom-based operating procedures, their extension for non- power operation of the reactor, incidents of the spent fuel pool, and for management of severe accidents.

The severe accident guidelines provide assistance to the operator to stabilize the unit and to return it to a controlled, stable state after such events which have led to major damage to the active core. These consequence-mitigating guidelines can be deployed for the cooling of corium, the reduction of radioactive releases, and the maintaining of the structural integrity of the containment.

Preparations are in progress to implement the under-mentioned technical modifications aimed at introducing severe accident management:

- *establishment of autonomous electric supply for pressurizer safety valve;*
- *installation of accident hydrogen-recombiners;*
- *spent fuel pool cooling circuit reconstruction;*

- *development of accident measurement system;*
- *reactor cavity flooding;*
- *external cooling of reactor pressure vessel;*
- *reinforcement of reactor cavity door.*

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 official instructions of Paks Nuclear Power Plant Ltd.

On the basis of the official instructions, 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 state of operation while involving the lowest possible risk;
- unit shut-down technological test – this checks the operability of components and systems taking part in the shut-down, and obtains information for maintenance work;
- overhaul technological test – this enables one to check the operability and function of components and systems maintained during overhaul;
- unit start-up technological test – this is a full-scope test following maintenance;
- non-scheduled technological test – this is a full-scope or partial testing that is necessary for verifying operability.

Scheduling of in-service tests

The tests in the first step are scheduled on an annual basis; the annual time schedule is prepared by considering the cycle times of tests. For the branches of multiple, redundant systems, tests are scheduled for different times. Specific dates and times of the performance of tests are decided upon at weekly planning meetings, when the operational status of the unit and the permissible deviation in cycle times are already known. Those tests prescribed in the Technical Specifications are planned from overhaul to overhaul. With these in mind, the allowed cycle time difference is ±4 days.

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 assurance 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 painstakingly processed.

Over a period of time the in-service tests performed have verified the adequate availability of components, structures and systems and means of protection. In some cases, supplementary measures had to be taken as a result of an unsuccessful test, but the operational safety of the units has never been jeopardized, and no unit has ever been shut down for this reason.

Tests related to overhauls

During overhauls three groups of tests are performed:

- before shutting down the unit, tests are scheduled to verify the systems necessary for shut-down and cooling;
- during the overhaul 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 overhaul 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 overhaul 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 weekend maintenance is decided after special consideration, when the nature of interventions and the time elapsed are already known.

The introduction of electronic testing instructions in relation to extension of service lifetime means a significant change in the system of testing. The essence of the method is that the testing process is supervised by a given unit computer, thus information becoming available during the test is recorded thereby enabling any subjectivity about the measuring of valve running times to be eliminated. The application of the method also provides an important contribution to the frequency testing of rotating machines. Data from electronic testing is able to be processed within the system of origin and can be uploaded to the central database where, as lifecycle data, further analysis is possible. The full introduction of the system will take some years; the part necessary for lifetime extension is due to be ready in the year 2010.

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 National Energetics and Energy Safety Engineering Inspectorate, competent at that time, and any modification requires the permission of the Authority. The documents are revised regularly and necessary changes are made.

One of the guidelines of the Nuclear Safety Regulations following the entry into force of the new Act on Atomic Energy prescribes the performance of periodic material testing on nuclear power plant components. The guidelines stipulate that the scheduling of nuclear power plant tests should be set in material testing framework programmes; their execution should be set in the testing technologies; and the requirements concerning evaluation should be laid down in a list of criteria.

In-service inspection

The scope of in-service inspection is defined by material testing programmes; these programmes 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 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 (mainly US) and domestic experience related to ageing and lifetime management;
- the aspects of nuclear safety;
- the ongoing development of scientific and technical knowledge.

Paks Nuclear Power Plant Ltd. conducts systematic ageing management activities for the components of safety classes 1-3, and for those that do not belong to safety class 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 are ensured by utilizing the maintenance effectiveness monitoring system that is currently in the introductory phase;
- 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 a passive function: (1) individually for critical components, (2) in groups for other components (component groups).

Systematic ageing management in relation to components fulfilling a passive function includes:

- 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 assurance, coordination, documentation);
- utilization of operational experience feedback.

The activities above are in harmony with the requirements derived from the following guidelines of the HAEA Nuclear Safety Directorate:

- regulatory supervision of the ageing management programme;
- list of equipment falling within the scope of the ageing management programme;
- quality assurance during ageing management of nuclear power plant components;
- consideration of ageing effects during the design of nuclear power plants;
- ageing management during the operation of nuclear power plants.

Selection of critical components

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 shut-down of the reactor core, and of structures inhibiting the release of radioactive substances (principle of defence-in-depth). During the selection procedure, the document of the International Atomic Energy Agency entitled "Methodology for the Management of Ageing of Nuclear Power Plant Components" together with the related guidelines of the HAEA played an important role.

As a consequence of taking the above aspects into account the plant performs systematic ageing management on about 47,000 passive components in safety classes 1-3. The components covered by the ageing management programme belong to one of the following groups:

- *Items listed in the regulatory guideline as critical components. Ageing management of all of these components is performed individually.*
- *Components managed on system component 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;*
- *reactor pressure vessel internals;*
- *reactor pressure vessel supporting structure;*
- *nozzles of main circulating loop and the connected pipelines;*
- *pressurizer*;
- steam generators;
- main gate valves;
- main circulating pumps;
- main circulating loop pipeline;
- seismic reinforcement of critical components.

As recommended by the relevant regulatory guideline, the plant implements comprehensive ageing management. Specific procedures are followed for examining technical issues related to systems, structures and components; for determining ageing management related tasks; and for implementing the comprehensive ageing management and operation of specific ageing management programmes. The procedures specify and harmonize the tasks of the organizational units involved in implementing ageing management.

Current status of ageing management

Taking into account craft-related differences the ageing management in the plant is carried out within the four crafts: mechanical, electrical, I&C and civil engineering. The systematic and coordinated activities are ensured by the respective procedures.

Specific ageing management programmes have been developed by the crafts, based on which the implementation of comprehensive ageing management has started. The electrical craft is an exception, where specific programmes for the ageing management of cables are only the supplements to environmental qualification. During the development of specific ageing management programmes the formerly applied condition-monitoring programmes and results had been used.

The results of ageing management are of major significance in the licensing process of lifetime extension in determining the technical and safety margins of important equipment and in developing and implementing lifetime management strategy. Ageing management utilizes both domestic and international good practices and results. New, previously unknown degradation processes may arise during the work; in such situations, targeted research and development may well be of benefit in gaining the necessary know-how.

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.

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. Up till now, 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 discharged into the Danube from the 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 stream 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 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 discharged 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 basement of the paleozoic-mezozoic basin.

Seismic-tectonic characteristics

The final evaluation of the seismicity of the site was elaborated with the help of experts of the International Atomic Energy Agency and this was accepted by the Authority. The value considered in original design was 6 on the MSK scale based on the catalogue of historical earthquakes in Hungary and on the isoseismic map that can be drawn from this. Seismicity is low in Hungary as a whole and even though comparatively 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. Relationships 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 these 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, this suggests 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 was put into operation in 1995 and the evaluation from the recent neo-tectonic 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 published annually for scientific purposes.

The basis for the assessment of soil liquefaction was a detailed geotechnical analysis of the site, following the recommendations of the International Atomic Energy Agency (50-SG-S9). The upper soil layer (about 30 m) at the site is a 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.

On the areas not exposed to the pressure at the base of buildings, the probability of soil liquefaction is less than 10^{-4}/year, thus in the case of a maximum design basis earthquake with a probability of 10^{-4}/year, no soil liquefaction can be expected.

ANNEX 4.: MAINTENANCE

The maintenance of the power plant aims at ensuring a high technical standard of equipment and the nuclear safety thereof; and to maintain its operability through reasonable expenditure. The key element of the maintenance system is that of being well planned with emphasis on prevention rather than repair. The basic objective is to carry out all maintenance activities (the overhaul of equipment, periodic maintenance with the units in operation, and so-called service-road maintenance that is carried out regularly through a maintenance review) in a well-planned, scheduled and regular manner.

General overhauls consist of the following activities:
- technical and safety reviews;
- periodic maintenance work;
- work prescribed by the authorities;
- repairing failures occurring during operation;
- safety improvement measures, modifications, reconstructions.

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

Regular maintenance reviewing serves as means of assessing the condition of operating equipment or that in stand-by mode. Maintenance of equipment is scheduled on the basis of such assessments.

Preparation is a key element of maintenance. Preparation is aimed at creating a database of the planned phases of continuous activities repeated periodically, and to establish optimal maintenance cycle periods in order to prevent unjustified over-maintenance.

Overhaul strategy

One of the most important factors affecting the availability of the power plant is the time required for overhauls. 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 overhauls to an optimal level both from the aspect of economic efficiency and the adequate use of the workforce.

The essence of the overhaul strategy is the introduction of three basic types of overhaul. These types and the related principles of implementation are as follows:

- major overhauls performed every 4 years;
  - modifications of larger scale, reconstruction work; the revision of main components in line with long-term schedules should be performed at this time;

- medium overhauls:
  - feasible technical and safety reviews, pre-assembly work related to larger modifications and reconstructions, certain modifications and work of periodic maintenance should be performed at this time;
  - it is advisable to define a maximum time period, which must not be exceeded when defining the time period taken; if the time period needs to be modified, then this is to be approved by the Maintenance Working Committee if the organization applying for such a permission provides sufficient justification;
- short overhauls:
  - only such work can be scheduled for this type of overhaul whose completion time does not affect the critical path (the reactor line);
  - the time taken depends on the shortest time necessary for the following process: shut-down, reactor dismantling, refuelling, reactor assembly, restarting.

Order of executing maintenance activities

The activities of maintenance as a main process of the plant are regulated by Maintenance Regulations and hierarchically subordinated process instructions and procedures. These documents include:
- the systems and components in question and their parts thereof;
- the activities to be performed;
- the materials used directly or indirectly during the activities.

Corresponding to maintenance, quality control activities are performed in accordance with regulating documents of main processes of Quality Inspection and 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 have been 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. The work instructions ensure the normal, well-organized work of organizations taking part in the maintenance, and their efficient co-operation.

The Overhaul Scheduling and Implementation Order includes all tasks related to documentation together with the names of the responsible personnel. The management body of overhaul scheduling is the Overhaul Planning Conference. Its work is regulated by conference rules. The implementation of a given overhaul is determined by the overhaul authorization plan, the overhaul net diagram, and other instructions 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 employed 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: ENFORCEMENT POLICY OF THE HAEA

The main elements of the enforcement policy of the Hungarian Atomic Energy Authority are as follows:

- Compliance with the conditions set out in the obligatory requirements; compliance with its actions - in harmony with international practice, assessment of the problems based on safety significance.
- It is expected that the effective regulations be followed on a voluntary basis by everyone concerned; based on this assumption the HAEA expects voluntary and independent revealing, reporting, and correction of any possible deviations from requirements. The HAEA`s enforcement activities relate to those cases deviating from this approach.
- The policy declares that the goal is to support efficient prevention measures and to introduce the earliest possible actions, with enforcement, if necessary. Detailed aspects and tools are given in the written procedure.
- Enforcement is strictly realized within the framework of the legal background, and does not extend to other occurrences that may take place despite careful prevention activities.
- Enforcement measures are necessary only after establishment of the infringement of requirements if compliance with the obligations could not be achieved without such intervention, or would be subject to delay, or the severity of occurrences demands explicit sanctions to prevent any recurrence.
- When the urgency and severity of regulatory enforcement actions are justified, at first the direct impact of infringements related to safety are assessed, and secondly their potential future impact on safety shall be assessed.

Implementation of the enforcement policy is regulated by a given procedure, which relies on the general rules of public administration procedures. Such a given procedure also addresses the situation when the violation of more obligations exists; when they are necessary, expedient or possible to be assessed in the framework of one procedure; and how the resultant safety significance of more infringements can be determined. The procedure discusses in detail against what standards and according to what aspects it is necessary to assess the safety significance of the violation of a prescription. The basis for assessment of severity is the safety classification of the system or equipment to which the violation corresponds and the type of requirement breached. Before the introduction of the aforesaid procedure the comments of Paks Nuclear Power Plant Ltd., as the principal Licensee, was sought.

According to Govt. Decree 114/2003. (VII. 29.) Korm. [II.6] the fine shall be at least HUF 50,000, but shall not exceed

- *HUF 50,000,000 for the licensee of the nuclear power plant in nuclear safety cases,*
- *HUF 5,000,000 for the licensee of other nuclear facilities.*

It is extremely important that the fine is only one of the tools of law enforcement. Other tools to be used before or together with fining:

- *warning of the licensee and calling upon the licensee to correct a non-compliance or infringement, setting a fair deadline for correction;*

- *ordering the obligation and giving a deadline;*
- *limiting the operating conditions.*

The law enforcement procedure was developed in 2002 and has been used ever since. There have been three cases when fines have been imposed since the entering into force of the enforcement procedure:

- *HUF 5 million due to fuel damage event in 2003;*
- *HUF 3 million due to the unlicensed import of NURES cleaning equipment in 2003,*
- *HUF 10 million due to the use of unlicensed material containing nickel in the sealing rings in the steam generators (71 cases);*

There were three more cases (see below) when the procedure was initiated, but on each occasion the case was terminated without imposing a fine after clarifying the situation:

- *due to employment circumstances of designers who did not have designer certifications in 2003;*
- *unlicensed activity performed in Shaft 1 of Unit 2 on October 5, 2004;*
- *breaching of deadlines of PSR tasks in relation to some instrumentation rooms in 2005.*

No fines were imposed by the Authority in 2009.

ANNEX 6:
ACTIVITIES AIMED AT EXTENDING THE LIFETIME OF PAKS NPP

Preliminaries

The most important element of the future objectives of Paks NPP, accepted as far back as January, 2001, is the extension of the design lifetime. Expert surveys performed till now have not revealed any technical or safety objection against operation of the plant beyond the design lifetime; moreover it is also a feasible business project. Preparatory work launched based on a number of surveys aims at keeping all four units of the NPP in operation for an additional 20 years after the expiry of original design lifetime, and at obtaining the necessary operating license. The preparatory activities include among others: ageing management and environmental qualification of plant equipment, monitoring of maintenance effectiveness, renewal and continuous updating of the final safety analysis report.

According to Govt. Decree 89/2005. (V. 5.) Korm. [II.7] on the HAEA's generic procedural rules in nuclear safety regulatory matters the intention to extend the service lifetime of the units shall be reported to the nuclear safety authority 4 years before the expiry of the design lifetime and, similarly, the programme shall be submitted that is aimed at creating the conditions of operability beyond the design lifetime. The applicability and the implementation of the programme shall be inspected by the Authority.

The environmental licensing procedure for lifetime extension was initiated by the NPP in 2003, in accordance with the requirements of governmental decree 20/2001. (II. 14.) Korm. [II.4] on environmental impact study. After the completion of the domestic and international procedure (see Annex 7 of the 4th report) the competent authority granted an environmental protection licence on the extension of the originally designed operating lifetime of Paks Nuclear Power Plant units by 20 years.

Technical preparatory tasks for lifetime extension

The complex technical preparatory activities for the lifetime extension include:
- *determination of ageing mechanisms requiring management;*
- *survey on the condition of systems, structures and components;*
- *evaluation of ageing management programmes and modification or development of new programmes;*
- *determination of validity and extendibility of safety analysis involved in licensing;*
- *maintenance of the qualified state and determination of necessary measures.*

A precondition for all of these was to establish an up-to-date and integrated management system in the plant, enabling the information related to the operation of the nuclear power plant to be available for each authorized user.

As a result of the work performed, in accordance with the legal requirements, Paks Nuclear Power Plant Ltd submitted to the nuclear safety authority the programme aimed at creating the conditions justifying the operability of the plant beyond the design lifetime. After requesting several supplements and holding consultations, the Authority evaluated the lifetime extension programme in a resolution issued on June 19, 2009 and gave permission for the implementation of the programme with the given stipulations. The Licensee shall, at least one year before the expiry of the design lifetime (i.e. in 2011 for Unit 1), submit the application to the Authority for the license to operate the unit beyond the original design lifetime.

LIST OF LAWS

I. Acts

I.1	*Act XXII of 1992*	*on the Labour Code*
I.2	*Act CXVI of 1996*	*on Atomic Energy*
I.3	*Act I of 1997*	*on the promulgation of the Convention on Nuclear Safety concluded in Vienna on the 20th September in 1994 under the umbrella of the International Atomic Energy Authority*
I.4	*Act IV of 1978*	*on the Penal Code*
I.5	*Act CXL of 2004*	*General Rules of Administrative Proceedings and Services*
I.6	*Act LVII of 2006*	*on the central state administrative organs and on the legal status of government members and state secretaries*
I.7	*Act CIX of 2006*	*on the amendment to legislation connected with the restructuring of governmental organizations*
I.8	*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.*
I.9	*Act CVI of 2008*	*on the amendment of acts relating to public health*
I.10	*Act LXII of 2008*	*Publishing Amendments to the Convention on the Physical Protection of Nuclear Material, Adopted by the International Atomic Energy Agency (IAEA) in 1979 and published by Legal Decree 8 of 1987, signed on 8 July 2005 at the diplomatic conference organized by the IAEA*

II. Government Decrees

II.1	*Govt. Decree 248/1997. (XII. 20.) Korm.*	*on the National Nuclear Emergency Response System*
II.2	*Govt. Decree 179/1999. (XII. 10.) Korm.*	*on the execution of Act LXXIV of 1999 on Disaster Management*
II.3	*Govt. Decree 40/2000. (III. 24) Korm.*	*on the amendment of Govt. Decree 248/1997. (XII. 20.) Korm. on the National Nuclear Emergency Response System*
II.4	*Govt. Decree 20/2001. (II. 14.) Korm.*	*on environmental impact study*
II.5	*Govt. Decree 275/2002. (XII. 21.) Korm.*	*on the monitoring of radiation levels and radioactivity concentrations in Hungary*
II.6	*Govt. Decree 114/2003. (VII. 29) Korm.*	*on the scope of activities, authority and penalizing rights of the Hungarian Atomic Energy Authority, and on the activities of the Atomic Energy Coordination Council*
II.7	*Govt. Decree 89/2005. (V. 5.) Korm.*	*on the procedures of the Hungarian Atomic Energy Authority in nuclear safety regulatory matters*
II.8	*Govt. Decree 249/2005. (XI. 18.) Korm.*	*on the amendment of Govt. decree 89/2005. (V. 5.) Korm. on the procedures of the Hungarian Atomic Energy Authority in nuclear safety regulatory matters*

II.9	*Govt. Decree 136/2008. (V. 16.) Korm.*	*on promulgation of the first modification of the Espoo Convention on Environmental Impact Assessment in a transboundary context of the UNO approved on February 17, 2001 in Sofia and of its second modification approved in Cavtat on June 4, 2004.*
II.10	*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*
II.11	*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 the United States of America and the Government of Hungary*
II.12	*Govt. Decree 362/2006. (XII. 28.) Korm.*	*on the National Public Health and Medical Officer Service and on the designation of the pharmacy public administration organization*
II.13	*Govt. Decree 34/2009. (II. 20.) Korm.*	*on the licensing of transboundary shipment of radioactive wastes and spent fuels*
II.14	*Govt. Decree 182/2009. (IX. 10.) Korm.*	*on amendment or repeal of certain government decrees in relation to the adoption of Directive 2006/123/EC of the European Parliament on services in the internal market and to the entering into force of Act CXI of 2008 on the amendment of Act CXL of 2004 General Rules of Administrative Proceedings and Services*

III. Ministerial decrees

III.1	*Decree 16/2000. (VI. 8.) EüM of Minister of Health*	*on the execution of certain provisions of Act CXVI of 1996 on Atomic Energy*
III.2	*Decree 15/2001.(VI. 6) KöM of Minister of Environment*	*on radioactive discharges to air and water during the use of atomic energy and its control*
III.3	*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*
III.4	*Decree 7/2007. (III. 6.) IRM of Minister of Justice and Law Enforcement*	*on the rules of accountancy for and control of nuclear material*
III.5	*Decree 19/2007. (VIII. 29.) ÖTM of Minister of Local Authorities and Rural Development*	*on specific fire protection rules for use of atomic energy and on the enforcement of the rules by the authorities*
III.6	*Decree 45/2008. (XII. 31.) KHEM of Minister of Transport, Communication and Energy*	*on the amendment of the joint decree 49/1998. (VI. 25.) IKIM-MKM of the Minister of Industry and Trade and the Minister of Civilization and Culture on professional training of employees employed in training and research reactors and on the authorization for activities related to the use of atomic energy*