REPUBLIC OF HUNGARY

National Report

Document prepared in the framework of the
Convention on Nuclear Safety

Fourth Report, 2007

CONTENTS

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 declares that nuclear safety is given priority 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 its licensing and inspection activities,
- the operator is committed to the priority and continuous improvement of safety concerning the activities it carries out.

Budapest, July 2007

Dr. József Rónaky
Director General of the Hungarian Atomic Energy Authority

2. Introduction

National energy policy

The energy policy of Hungary currently in force was approved by Parliament in 1993.

The principles and strategic objectives of that energy policy have remained unchanged. Certain aspects of the strategic objectives have already been implemented, and the organizational, economic and legal conditions conforming to the market economy have also been developed.

The basic energy policy principles of primary importance are as follows:

- creating a domestic energy market taking into account the national peculiarities, complying with the principles of the unified European energy market, ensuring the competitiveness of the economy in the interests of the energy consumers;
- enforcing the environmental protection requirements both with regard to the existing generating or consumer equipment and to their future development in order to realize sustainable development;
- intensifying the role of energy conservation, increasing the efficiency of the use of energy.

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 was *33% in 2004, 38.6% in 2005 and 37.6% in 2006*. These figures illustrate that nuclear energy is a vital and strategic issue not only for the electric energy supply of the country but also for the country as a whole, and this is expected to remain so in the coming years.

Significance of nuclear safety

Act CXVI. of 1996 on atomic energy (hereafter 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 internationally in high esteem is demonstrated by their active role on 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 World Association of Nuclear Power Plant Operators (WANO), the WWER-440 operators' club, the WWER users' group, the International Nuclear Safety Program (the so-called Lisbon Initiative), the Nuclear Maintenance Experience Exchange (NUMEX) 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.

Hungary joined the European Union and, at the same time, the European Atomic Energy Community (EURATOM) on May 1, 2004. Since that time Hungarian experts regularly take part in the work of the relevant organizations of the European Union.

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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. Modification of structure of the report was carried out in order that the sequence of the specific chapters follows the chapters of the Convention on Nuclear Safety. Important processes have not been omitted from the current document; the detailed descriptions are placed in the Annexes. *Changes carried out compared with the previous report are indicated in Italics.*

The data presented in this report reflect the situation as at December 31, 2006.

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

Since the submission of the Third National Report no fundamental change has taken place in the number of nuclear installations. Measures introduced following the recommendations of international reviews have led to further safety enhancements.

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 addressed to the Report of Hungary. The main events that have taken place since the submission of the previous National Report are the following:

- *Hungary joined the European Union and, at the same time, the European Atomic Energy Community (EURATOM) on May 1, 2004. Since that time experts of Hungarian Atomic Energy Authority regularly take part in the activities of the "Working Party on Atomic Questions" of the European Council, and of several other relevant working groups of the European Commission.*
- *Fuel elements damaged during the serious incident that occurred on April 11, 2003 (in shaft No. 1 of Unit 2 of Paks NPP) were removed from the shaft by the end of 2006. Details of that work are described in Annex 8.*
- *The Hungarian Parliament, on November 21, 2005, by Parliamentary Resolution 85/2005 (XI.23) contributed in principle to launching the preparatory activity aimed at establishing a radioactive waste storage facility for low and medium level radioactive wastes. This resolution made it possible to begin the work on the storage facility in 2006.*
- *The Hungarian Parliament, in 2006, approved Act LVII on central state administration bodies. This Act defines the concept of a government office: "a government office is a central state administration body established by a parliamentary act and operating under the control of the government"… "Supervision of a government office is performed by a minister designated by the prime minister"… "A government office cannot be instructed concerning its tasks". The act referred to above classifies the Hungarian Atomic Energy Authority as a government office.*
- *The Nuclear Safety Code was issued as appendices of the Govt. Decree 89/2005. (V. 5.) Korm. on Nuclear Safety Requirements of Nuclear Facilities and Related Regulatory Activities. In the frame of regulatory tasks further development of the nuclear safety requirement system was continued taking account of the latest scientific results as well as of domestic and international experience.*
- *At the end of 2006 the Hungarian Atomic Energy Authority signed the RESPEC contract in the framework of which the HAEA provides expert support to the European Commission in case of nuclear or radiological emergencies of EU concern.*

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 (hereafter 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.

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 *fourth* 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 Third Review Meeting (Vienna, 2004).

The National Report includes in its four main parts:

- fulfilment of general provisions, 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); and
- survey 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 operating 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 authorities.

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 the reactor	*1375 MW, 1485 of Unit 4 after power uprate*
Electric power output of a unit	*470 MW* *Min. 500 MW of Unit 4 after power uprate*
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	*282 ± 2 °C, 284 °C of Unit 4 after power uprate*
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 U 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 units of type WWER-440/V-213; both the moderator of the reactors and the coolant are 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 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 dealing with 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 ensured by diesel generators. These systems are supplemented by passive systems. Two saturated (wet) steam turbines operate in each unit. The original nominal thermal power of each unit was 1375 MW, and the nominal electric power outputs of the four units were 440 MW. *During the period from the commissioning of Unit 1 in 1983 until 2001, by upgrading the plant the electric output of the units was increased to 467 MWe, 468 MWe, 460 MWe and 471 MWe, respectively, while the thermal power of the units remained unchanged. As a result of an additional power uprating programme decided in 2001, the thermal power of Unit 4 was increased to 1485 MW and the electric power to min. 500 MW in 2006. Uprating of the electric power of Paks Nuclear Power Plant though with unchanged thermal power was made possible by enhancing the core control system applied in the reactors of the plant and accurate and reliable operation of the reactor core design system. In order to uprate the thermal power, introduction of further enhanced type fuel was also necessary.*

The designers of the power plant chose the so-called twin-unit version. The turbine hall 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, the Hungarian Atomic Energy Authority, requires submission of safety reports for licensing of the installation, and always prescribes the application of a quality assurance system.

During the course of their work, nuclear safety inspectors are obliged to take decisions in a conservative manner biased towards safety should any not clearly assessable situation arise.

Hungary introduced a decree in 1993 stipulating the performance of periodic safety reviews and submission of safety reports containing results of such assessments.

The first periodic safety review of Paks NPP was completed for Units 1 and 2 by the end of 1996, and for Units 3 and 4 by the end of 1999. Taking account of the results of Periodic Safety Reviews the Authority determined the validity of long-term operation license as December 31, 2008 for Units 1 and 2, and as December 31, 2010 for Units 3 and 4. In the regulatory decision concluding the review carried out during the previous term of reporting, the Authority extended the validity of the long-term safety operation license of Units 1 and 2 of Paks NPP to December 31, 2008.

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 included in Table 19.8.3.

6.1.3 Safety improving measures

Between 2004 and 2006 the following major safety improving measures were implemented:

- *seismic reinforcement of turbine hall structure and certain brick walls;*
- *increasing of emergency water reserve stored in hydroaccumulators and reduction of its pressure;*

Implementation of the measures mentioned below which were within programmes launched earlier is due to take place in the coming years:

- *technical modifications necessary for severe accident management, and elaboration of severe accident management guidelines;*
- *qualification and/or reinforcement of relays and switch boxes are not at present qualified for earthquakes;*
- *management of primary to secondary leakage by feeding back the radioactive medium to hermetic compartments.*

Thanks to the measures that have already been implemented the safety of all units has been further enhanced. Paks NPP performed an analysis of fire and flooding events evolving within the technology. *It was found that core damage frequency both for operating reactors and for reactors that is shut down for maintenance and refuelling has decreased by a total of more than one order of magnitude.*

Decrease of core damage frequency due to internal events between 1995 and 2006 can be observed in Figure 6.1.3.

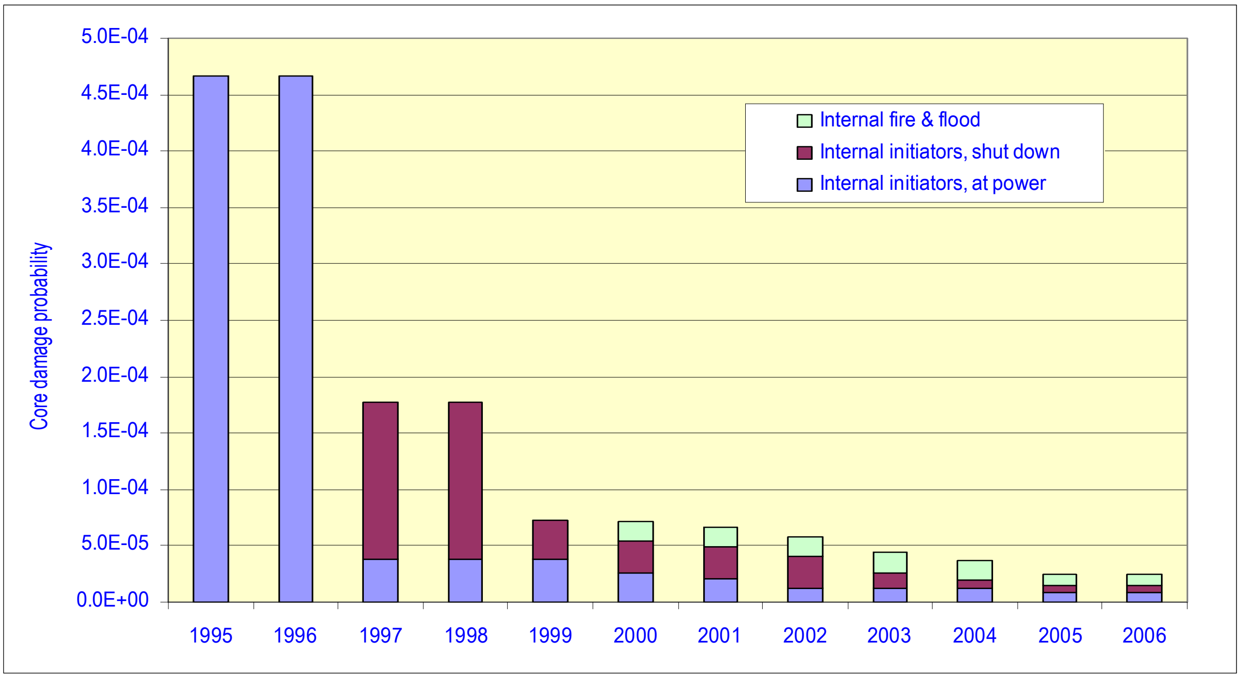

Figure 6.1.3: Overview of core damage frequency due to internal events

Paks NPP Ltd. performed seismic assessment of the selected reference unit and it determined the value of anticipated core damage frequency. By virtue of significant similarity and architectural identity of the units, this value is valid for the other units as well. *Subsequent to reinforcement work carried out after the first assessment, 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 $6.6x10^{-5}$ per a year.*

6.2 Spent Fuel Interim Storage Facility

Since the possibility of returning spent fuel assemblies from Paks NPP to Russia had become increasingly uncertain, the construction of an interim storage facility on the site of the nuclear power plant became necessary. In view of this, Paks NPP commissioned a British company (GEC Alsthom) to build a dry storage facility of MVDS type. One of the advantages of this type of technology is that the number of storage vaults can be increased in a modular system. The positioning of modules in a row allows the use of a common reception building and loading equipment. Each module is capable of storing 450 fuel assemblies. 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 surrounded by concrete walls. The removal of residual heat generated by irradiated fuel takes place by natural flow of air through the vaults and the connected stack system. This cooling process is self-regulating. The cooling air does not come into direct contact with the fuel assemblies as they are in a sealed environment.

It is intended to store the spent fuel assemblies removed from reactors for a period of 50 years.

From 2007 onwards, the capacity 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 second phase is due to be completed by July, 2007. The capacity of the facility can be increased for interim storage of all irradiated fuel generated during 30 years of operation. *By the end of 2006 a total of 4747 fuel assemblies had been loaded into the storage facility. Currently the loading of the 8th chamber and establishment of the next 5 (12-16) modules is in progress. Module 16, according to the plans, will be made available for receiving the canisters containing damaged fuel elements. In order to accept damaged fuel elements, significant additional modifications will also be necessary beyond the mechanical design modifications introduced in the chamber of module 16.*

The holder of the operating license of the Interim Spent Fuel Storage Facility is the Public Agency 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 belong 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 the decennially due nuclear safety review of Budapest Research Reactor was completed. *Based on the results of the safety review, the Authority issued a license for further operation and for performing activities described in the Final Safety Analysis Report. The operating license is valid until revocation.*

Main technical data of the reactor:

- tank-type reactor, the material of the tank is an aluminium alloy;
- coolant and moderator: light water;

- fuel: VVR-SM and VVR-M2, 36% enrichment;
- nominal thermal power: 10 MW.

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. Based on the Periodic Safety Review performed in 1996, the license was renewed by the Authority for a further 12 years. *At the beginning of 2006 the second Periodic Safety Review was launched; this review is expected to be completed during the summer of 2007.*

Main technical data of the reactor:
- pool-type reactor;
- coolant and moderator: light water;
- fuel: EK-10, 10% enrichment;
- rated thermal power: 100 kW.

B. LEGISLATION AND REGULATIONS

7. Legislative and regulatory framework

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 (the Act on Atomic Energy) which entered into force on July 1, 1997. The Act on Atomic Energy considers all legislative, authority-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 the article: "In the use of atomic 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 priority of nuclear 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 broken.

7.1.1 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 2004-2006 the following laws were promulgated:*

- *Act LXXXII of 2006 on the promulgation of safeguards agreement and protocol on the implementation of paragraphs (1) and (4) of article III of the treaty on non-proliferation of nuclear weapons, and on the additional protocol attached to the agreement.*

- *Governmental decrees:*
  - *Govt. Decree 50/2004. (III. 23) Korm. on the licensing of import and export of dual-use products and technologies;*
  - *Govt. Decree 155/2004. (IX. 23.) Korm. on the licensing of transboundary shipment of radioactive wastes;*
  - *Govt. Decree 263/2004. (IX. 23.) Korm. on international transport of nuclear and dual-use nuclear products;*
  - *Govt. Decree 257/2006. (XII. 15.) Korm. on the declaration of certain public administration regulatory cases corresponding to the low and medium level radioactive waste storage facility under construction in Bátaapáti of considerable importance.*
- Ministerial decrees:
  - *Ministerial Decree 33/2004. (VI. 28.) BM of the minister of the interior on central and local registration of radioactive materials;*
  - *Ministerial Decree 14/2005. (VII. 25.) IM of the minister of justice on the operation and procedure of the Central Nuclear Financial Fund.*

7.2 Legislative and regulatory framework

7.2.1 Safety Code

Most of the regulatory procedures related to the safety of nuclear facilities, primarily to the safety of the NPP, are regulated by Govt. Decree 89/2005. (V. 5.) Korm.
As its appendices the following code volumes were issued:
1. *Regulatory procedures related to nuclear power plant*
2. *Quality management requirements for 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 spent fuel interim storage facility*

The safety code entitles the director-general of the Authority to issue guidelines on the method of implementation of requirements. In the framework of implementation of regulatory tasks the modernization of the nuclear safety requirement system has been proceeding taking account of the most recent scientific results as well as of domestic and international experience.

Further detailed regulation of tasks originating from the implementation of legal requirements is provided by the internal rules and procedure system developed and operated by the Authority and by the Licensee.

7.2.2 Licensing procedure

The basic principles of licensing procedure of the nuclear power plant, and the concerned authorities taking part in licensing procedure 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, a license shall be obtained from the authorities for all phases of operation (siting, construction, commissioning, operation, decommissioning) during the lifetime of a nuclear power plant. Moreover, a separate license shall be obtained for all plant level or safety related equipment level modifications. Within the licensing procedures, technical aspects are enforced by legally delegated authorities. The Authority shall take account of opinions of legally delegated special authorities.

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 environmental protection authority then sends the preliminary impact study to the relevant authorities to seek the opinion of authorities 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. *In harmony with the Espoo Convention (promulgated by Govt. Decree 148/1999. (X. 13.) Korm.), the Govt. Decree 314/2005. (XII. 25) Korm. on environmental impact study and unified environmental usage license has implemented modification of the European Economic Community directive 85/337 by the 2003/35/EC directive. According to this, if transboundary environmental impact is possible then the partner-states should be notified by sending them the preliminary impact study. The 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 safety-related licensing of a nuclear installation takes place after the environmental licensing. The environmental protection authority plays the role of special authority in the course of licensing a nuclear installation.

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

Those licences to be issued based on Act CX. of 2001 on Electric Energy are also required for establishing and operating a nuclear plant.

Licenses are valid for fixed periods; on request and provided that the necessary requirements are fulfilled, they may be extended. A Licensee can appeal against the decisions of the Authority; if an appeal is made against a regulatory decision it is re-judged by the authority of second instance. Appeals against the decision of the authority of the second instance may claim the right to take the case to court.

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 decision on the further validity and conditions of the operating license is made within the framework of the 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 inspection 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 advanced notice, should it be justified. Such inspections may be performed periodically 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, inspecting any documentation or checking a report prepared by the Licensee, or any combination of those. The Authority prepares a programme for comprehensive and periodic inspections, and notifies those involved in due time. 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 special 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 taking 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 immediately 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 inspection 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 measures if necessary.

The Authority independently evaluates the safety performance of the licensees based on their periodic reports. *As a means of extending the assessment tools, also taking into account international methodological experience, the Authority introduced the system of safety indicators for Paks NPP in 2001, for the Spent Fuel Interim Storage Facility and for the Training Reactor and the Budapest Research Reactor in 2006. The term "safety indicators" means a set of measurable parameters which, among others, measures the performance of the organization and that of the human factor. The safety indicators cover many fields, such as number and effects of shutdowns and power drops due to internal events during operation, activation of protection systems fulfilling basic safety functions, state of equipment, evolution of working accidents, human commitment, and ability to keep to deadlines. The accumulated statistical set of indicators provides a possibility both for comprehensive evaluation and as a means of highlighting various issues. The fundamental basis for assessment is provided by evaluation of indicators and events, however, experience gained from regulatory procedures also contributes towards the preparation of the reports.*

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 public administration authority procedures and services*, the Act on Atomic Energy, Act IV. of 1978 concerning the Penal Code, and in Govt. Decree 114/2003. (VII. 29.) Korm.

Should there be any deviation from the regulations in force, the Authority may initiate an administrative procedure 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 license 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 official license 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 the NPP 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 strengthen the power of the Authority. The goal of the periodic review of the Nuclear Safety Regulations determined by law is that of taking into account the scientific results and international experience since these help to ensure the appropriate regulation background for the upcoming period.

The latest revision of Nuclear Safety Codes was accomplished during the considered period, the new regulations came into force in May, 2005. The new requirement system was extended or specified in certain fields including requirements for pressure piping and pressure vessels, building structures, programmable tools, chemical planning, and water supply.

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

Termination of the review of the Nuclear Safety Code will entail reviewing a set of guidelines. Correction and specification of regulations and the involvement of such fields that have so far remained outside the scope of guidelines will improve the enforceability of regulations.

Discharging of legal authority is facilitated by the enforcement policy formulated as the legal aspect of the Safety Policy issued in 1996, it summarizes the objectives and necessity along with legal resources. An enforcement procedure was also developed to help to realize the enforcement policy. Subsequent to modification of the Act on Atomic Energy, by legal authorization, rules for special enforcement procedures shall be stipulated by governmental decree. Elaboration of this decree has been launched.

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 relevant 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. *Until November 10, 2004 the minister of the interior acted on behalf of the Government, since then, by virtue of Prime Minister's Resolution 76/2004. (XI. 10.) ME, the minister of justice (currently minister of justice and law enforcement) fulfils this function.*

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 supervision 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 concluded with the International Atomic Energy Agency dealing with the non-proliferation of nuclear weapons, along with the registration and supervision of nuclear substances.

Hungary joined the European Union and, at the same time, the European Atomic Energy Community (EURATOM) on May 1, 2004. Since that time experts of the Hungarian Atomic Energy Authority regularly take part in the activities of the "Working Party on Atomic Questions" of the European Council, and of several other relevant working groups of the European Commission. Experts of the Hungarian Atomic Energy Authority represent Hungary at WENRA (Western European Nuclear Regulators' Association) meetings.

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

In accordance with Hungary's two-tier administrative system, a unit of the Authority, the Nuclear Safety Directorate, acts as an authority of the first instance in nuclear safety issues; in the second instance the Director General of the Authority assumes responsibility.

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 cases 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' activity.
- 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.

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 Safety Convention 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 management of quality control 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

The Authority has established technical co-operation with authorities of WWER-operating countries via the WWER Regulators' Forum. The Authority has signed mutual information exchange agreements with the relevant organizations of Canada, France, Romania, Russia, the United Kingdom, and the United States of America. The Authority is also a beneficiary of many of the European Union's PHARE programmes, and an active participant of the regional projects of the International Atomic Energy Agency (IAEA). Hungary has been a member of the OECD since

1996; there are Hungarian representatives in eight committees of the Nuclear Energy Agency. The Authority takes an active part in the work of the "CONCERT" group, and in other working groups operated by the European Commission.

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 striving to present a thorough description of its work. It publishes newsletters every quarter on the most important events relating to the safety of nuclear energy and to its regulatory activity. It informs the public by organizing press conferences and issuing press releases dealing with the most important issues concerning the safe application of atomic energy. The most important form of information activity is the annual report to be submitted to the Government and Parliament, the preparation and publication of which is the task of the HAEA.

An Internet-based service is integrated into the communication policy of the Authority. One can find the National Report on the Authority's home page (http://www.haea.gov.hu), both in Hungarian and in English.

8.2 Independence of the Authority

The Hungarian Parliament approved, in 2006, Act LVII 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. On November 10, 2004 the minister of justice (currently minister of justice and law enforcement) was designated by the decision of the prime-minister to supervise the Hungarian Atomic Energy Authority.

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 of radioactive wastes. Other competent administrative bodies take part as special authorities in the licensing procedure of the Ministry of Health.

In order to support its activities, the Authority has concluded separate agreements with several scientific institutions. Such an agreement seals the co-operation with the KFKI Atomic Energy Research Institute, the Electrical Power Research Institute Ltd. (VEIKI), the 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.

The 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 theme 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.

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 personal 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 prescribed requirements;
- to hire only those subcontractors and suppliers that have an appropriate quality assurance system;
- to ensure the financial coverage of liability (insurance);
- to appropriately handle extraordinary events;
- to indemnify within a limited time and under a certain 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 damage due to effects originating from the 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 inspection activities in order to achieve these objectives; these inspection activities comprise licensing, inspection, supervision, analysis, evaluation, and the enforcement of regulations.

It is also an objective 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 associated authorities and to society as a whole. Every possible effort must be made to gain and retain the confidence of the population and it shall make itself and its objectives fully transparent to the public. The HAEA meets all the above requirements. In addition, 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.
- Technical problems and human errors can be defined as initiators of accidents, thus the primary task is to minimize their frequency.
- Mitigation of any serious consequences originating from multiple failures is of a great 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 prescribed by law, nor for criticizing or neglecting the tasks prescribed by law.
- 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 the NPP as Licensee

Govt. Decree *89/2005. (V. 5.) Korm.* 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 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 for 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 Director of Safety who holds a transferred right of competence. The managers are responsible, within their respective organizations, for the fulfilment and enforcement of safety requirements in addition to enforcement of the Safety Policy. In order to define various tasks, responsibilities and 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 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 prescribed 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:

- elaboration 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 prescribed 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 outside contractors

On the premises of the nuclear power plant, work maybe performed only by outside 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 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 and
  - to cover the costs of the Authority as a consequence of its international obligations.
- Licensees of nuclear installations are obliged to pay an inspection 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. The income of HAEA, except for income from fines, shall be used exclusively for covering its operation.

11.1.2 Financial resources of the Licensee

Act CX. of 2001 on Electric Energy stipulates that energy producers are permitted to sell on the free market any electric energy remaining above the amount contracted for public purposes. However Paks NPP Ltd., in accordance with the requirements of governmental decision 2280/2001 and with the intent of the owner, currently sells the electric energy produced only under public purpose conditions.

The Act on Atomic Energy prescribed that a fund, namely the Central Nuclear Financial Fund, be created for financing interim storage and final disposal of radioactive waste and spent fuel elements and decommissioning of nuclear installations. In order to fulfil these requirements an independent organization, the Public Agency 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 Public Agency for Radioactive Waste Management 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 Section 4 of Article 63 of 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. At the Faculty of Mechanical Engineering of the Budapest University of Technology and Economics, the syllabus covers power plants and nuclear power plants within the framework of subjects related to energetics; in addition, there is a postgraduate course on nuclear engineering.

11.2.1 Human resources of the Authority

Between January 1, 2004 and December 31, 2006, the average number of staff of the Authority was 85. Of this number some 85% are experts holding a higher education degree (university or college), nearly 40% have two or three degrees (the second degree usually being obtained in disciplines dealing with nuclear techniques). About 16% have a PhD, or an advanced academic 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 material 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 education plan 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 education plan.

The Authority's representatives take part in international technical public life. They are active members of the working groups of the International Atomic Energy Agency, the European Union, and the OECD Nuclear Energy Agency.

11.2.2 Human resources of the Licensee

As of December 31, 2006, the number of individuals employed by Paks Nuclear Power Plant Ltd. is 2,651 of whom 93 are heads of divisions or higher level executives. The number of those engaged in operations is 819; the number of maintenance staff is 783, and the number of others ensuring support (security, technical, economical and human) activities is 1049. The composition of employees in relation to qualifications is as follows: 857 with a higher education degree, 1,389 with a secondary school qualification, and 405 skilled workers or people with other types of qualification. Of the operating personnel, 363 have a valid official license for performing numerous types of work.

Within the power plant, the system of expert training is well regulated; the material and personal conditions are also assured by the power 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 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. Employees 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, facilities of the training centres are well equipped. Teachers and instructors are well qualified and well prepared 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 has been continuously developed so as to follow the various modifications performed on the units. In addition to training of operators, the simulator plays an important role in technological development projects.

The Maintenance Training Centre established with the support of the International Atomic Energy Agency is unique in the world with its real primary components and mechanical equipment for 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.

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 prescribed for the given job and in addition meet the appropriate medical and psychological requirements. The corresponding manager and the employee himself or herself are jointly responsible for the fulfilment of all these requirements. Admittance to different areas of the nuclear power plant is permitted only on fulfilment of the above-mentioned conditions.

Training and examinations are conducted at the power plant and in a unified and identical way for both the NPP staff and hired outside employees.

Once a year every employee is required to have a medical check up. The fulfilment of psychological criteria is also checked annually in jobs requiring periodic examinations. Before taking the periodic examinations, one of the Authority's representatives checks whether all tests have been performed and all prerequisites have been met. Medical and psychological adequacy tests are subject to particularly strict constraints in the case of personnel engaged in operation, control, and supervision.

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 rules valid in the plant are in accordance with the related effective stipulations of the National Labour Code. As this means a particularly strict limitation of overtime work, the Human Affairs Directorate keeps comprehensive records of the workload of employees.

The fact that within a given shift the proportion of those holding higher qualifications is constantly increasing is also a trend that tends to reduce work loads.

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 this social system's quality and standard are much higher than anywhere else in Hungary.

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 expert personnel can be preserved and the appropriate recruitment can be ensured.

Among the aspects of the human resource strategy of the NPP, performance planning and evaluation, career planning, and the opening of professional and management career possibilities play important roles. Emphasis is also placed on dealing with the employment of new specialists providing quality-based replacements and the systematic recruitment of young people.

12.5 Feedback of experience in order to enhance safety

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

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

12.6 Safe working conditions

Healthy working conditions (proper temperature, lighting, noise and vibration levels, clean air) in accordance with standard values are considered as 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 measures are taken. The proper use of personal protective equipment (the use of which depends on the given working conditions) is ensured by regular check-ups and the possibility of imposing sanctions.

It is 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 of those countries where an advanced nuclear industry exist in these areas are applied. It is important that the suppliers of the power plant have to be in possession of a valid qualification for the relevant activity.

13.2 Description of national quality management system

Subsection (2) of Article 11 of the Act on Atomic Energy prescribes 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 prescribes 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 shall be examined and certified.

On the basis of these legal requirements, the principles of the quality management system were 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 taking account of *ISO*

9001:2000 standard. Volume 2 on quality assurance and the 14 associated guidelines enforce the requirements of the law and define the quality management expectations not only towards the operator but also towards the suppliers. A *review of the Nuclear Safety Code is in progress. Concerning the quality management regulations the goal of the review is to include the new requirement system published by the International Atomic Energy Agency in 2006 (GS-R-3 The Management System for Facilities and Activities).*

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 according to the standard MSZ EN ISO 9001:2001 (ISO 9001:2000). *The continuous development of the quality management system and justification of its adequacy resulted in the second Certification granted by the firm Első Magyar Tanusító Kft. (First Hungarian Auditor Ltd.) as the Hungarian representative of NQA (National Quality Assurance Ltd.), after the audit conducted between March 6 and 9, 2006. According to the certificate, the quality management system of HAEA met the requirements of the international standard ISO 9001:2000 for the second time in relation to following activity: "Regulation and inspection of safe and peaceful use of nuclear energy".*

Validity of certificate:	*2006.03.21. - 2009.03.21.*
Identifier of certificate:	*100 – 0900*

After processing the accumulated experiences the IAEA, in the summer of 2006, published the new GS-R-3 and GS-R-3.1 documents. The structures of the new documents follow the structure ISO 9001:2000, their concepts and definitions are based on those of the ISO. It supplements the ISO with safety related requirements, such as graded requirements, independent inspection, safety culture, self-assessment, self-evaluation, etc. Elaboration of the documents for domestic introduction by both the regulatory bodies and those seeking a license has begun.

13.4 Quality management system of the nuclear power plant

13.4.1 Management

The plant operates a full-scope management system, which defines the requirements for all processes. Quality Policy unambiguously declares the general intention and direction of the plant management concerning quality.

All activities within the nuclear power plant are accomplished in a way laid down and regulated in procedural orders.

An indicator system is used to assess the correct functioning of the quality assurance system of the nuclear power 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.

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.

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.

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 Implementation

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 prescribed in regulations, process instructions, procedural orders, and in the Technical Specifications. Operations are performed on the basis of the 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 the procedural order. 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.

Control 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 Audits

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

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

Audits are performed by the quality assurance supervisory organization and generally regulated by the procedural order on the basis of an annual audit plan. Auditors receive special training or, when auditing certain professional areas, are assisted by experts familiar with the given area.

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 must 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 qualifications of staff,
- documentation,
- management of non-conformances;
- normal operation,
- maintenance and repair work,
- nuclear fuel management,
- selection of contractors,
- design,
- 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 Authority primarily expects the quality management organization of the Licensee to undertake 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 prescribe the improvement measures.

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 The system of safety analysis reports

The method of preparation and application of safety analysis reports is prescribed by legal regulation at Government Decree level. The official procedure related to a nuclear installation is based on the Preliminary Safety Analysis Report that is followed by the Final Safety Analysis Report necessary for the commencement of operation of a given nuclear installation.

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

Govt. Decree 89/2005. (V. 5.) Korm. stipulates that the Final Safety Analysis Report should be updated annually, so that the safety analysis report can serve as an authentic and continuous basis assessing the safety of the nuclear installation throughout its entire life-time.

The 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 Report on the results of this assessment to the Authority. In the Periodic Safety 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, which includes the establishment of deadlines, and it submits this programme 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 Report of the Licensee, in which it lays down the conditions for future operation.

14.2 In-service inspections and tests, material testing

The in-service inspections and tests as well as tests and periodical material testing associated with overhauls are painstakingly carried out at Paks NPP. A detailed description of these tests is given in *Annex 1*.

14.3 Ageing management of equipment

In the Nuclear Safety Code issued as an annex to *Govt. Decree 89/2005 (V. 5.) Korm.*, separate sub-sections are designated to the topics of ageing and lifetime management. Ageing management of equipment at Paks NPP is being performed according to the Nuclear Safety Regulations. Its detailed description can be found in *Annex 2*.

14.4 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 pieces are installed at different locations of the reactor building important from both structural and mechanical points of view. The earthquake monitoring system provides sufficient measurement data for the evaluation procedure.

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

14.5 Periodic Safety Review

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

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, entered into force in 1997, and the related regulations.

The upcoming Periodic Safety Review will be conducted together for all 4 units. The deadline for submitting the Periodic Safety Report is December 31, 2007. Based on the Periodic Safety Review that will have been submitted, the Authority will have until December 31, 2008 to decide on necessary safety improvement measures, on related deadlines, and on extending the operating license, all of which will also take into account the design lifetime of each unit.

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 (radiation protection directly affecting humans) belongs to the Ministry of Health, Social and Family Affairs; the technical side of plant radiation protection is the task of the Authority; the issue of releases and thus the protection of the environment belong to the Ministry of Environmental Protection and Water; tasks related to the radioactivity of the soil and the vegetation belong to the competence of the Ministry of Agriculture and Rural Development.

The Act on Atomic Energy allocates regulatory, official and professional administrative tasks to several ministries. 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 Public Health on the implementation of some decrees of the Act on Atomic Energy lays down the basis of radiation protection according to the recommendations of the ICRP 60 and the IAEA Safety Series-115. The decree stipulates that a radiation protection service should be set up in all installations applying nuclear energy. All users are obliged to prepare an internal radiation protection standard, which should be approved by the competent authority the National Public Health and Medical Officer Service in this case. The annexes of the Decree specify the limits of doses of workers and members of the public; the radiation safety principles of workplaces, methods of radiation protection training; dosimetry control; the treatment of those suffering from a radiation injury; the tasks of the radiation protection service, the management of accidents, and the special radiation protection requirements for nuclear power plants.

- Ministerial Decree 15/2001. (VI. 6.) KöM of the Minister of Environmental Protection on the radioactive release limits to waters and atmosphere and its inspection derives the annual release limits based on the dose constraints determined by Office of the Chief Medical Officer.

- *Govt. Decree 275/2002. (XII. 21.) Korm. on monitoring of national radiological conditions and radioactive material concentration aims at adjusting 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, prescribes monitoring the radioactivity of 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:*
  - *collection of measurement results on environmental dose-rates, on radioactive isotopes in environmental elements, in foodstuffs, in structural and base materials, on concentration of radon activity, on radioactive contamination of human bodies;*
  - *public information on monitoring results;*
  - *co-operation in information of the European Community's Commission;*
  - *publication of results in annual reports.*

- Ministerial Decree 47/2003. (VIII. 8.) ESZCSM prescribes 5 years of (renewable) service time for the interim storage of radioactive wastes, while regarding the operation of final disposal it prescribes 10 years (extendable). Concerning the final disposal, after closure, the public limit is set at 100 μSv/year effective dose, and the risk limit at 10^{-5} case/year.

- *Govt. decree 89/2005. (V. 5.) Korm. concerning the interim storage and final disposal of radioactive wastes, and concerning certain radiohygiene issues of naturally existing radioactive materials concentrating during industrial activity*, 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 that is the appendix 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 Safety Analysis Report necessary for the request of the installation and operating licenses and that of the same section of the Final Safety

Analysis Report. 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, 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	Subjects of exposures		
	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.
In 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 Rule of Paks Nuclear Power Plant, every worker employed in a radiation hazardous post (including both outside and plant employees) are monitored by a regulatory film dosemeter. The internal rules of Paks NPP prescribe full-scope operative dosimetry inspection. In accordance with these rules, every such worker has to wear an electronic dosemeter that performs the activity within the controlled area.

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

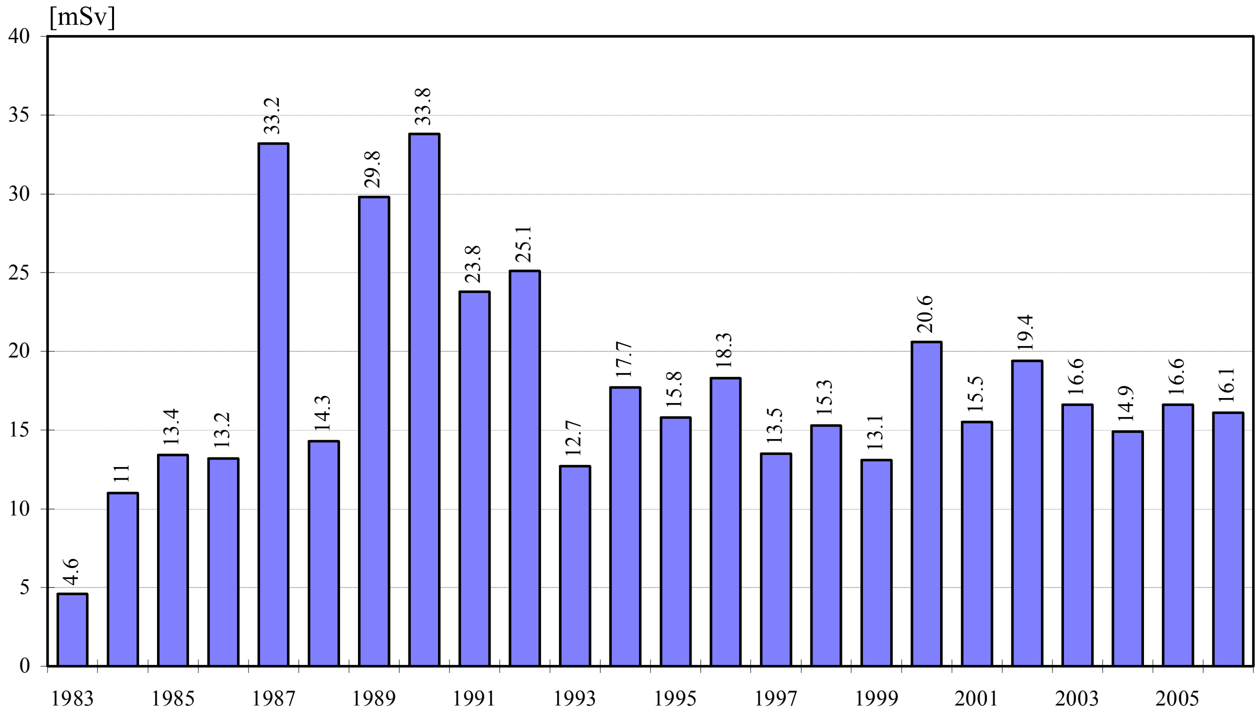

Figure 15.3.1-1 Maximum annual individual doses according to regulatory film-dosemeterreadings

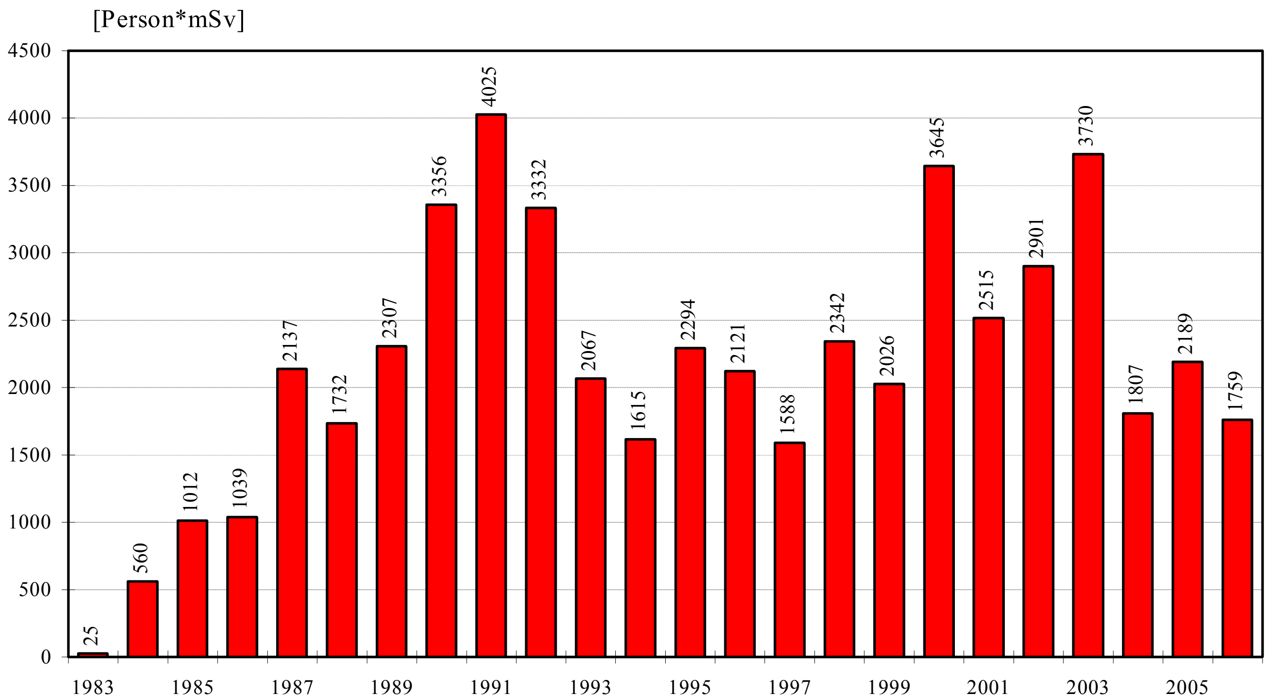

Figure 15.3.1-2 Annual collective doses according to regulatory film dosemeter readings

15.3.2 Radiation exposure during the overhaul period

At Paks NPP most radiation exposure of the 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 of 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 shutdown of the unit in the immediate surroundings of main components and in rooms involved in overhaul work. Data gathered on the radiation conditions could be used for dose planning for the coming years.

As for the personnel performing the maintenance and maintenance related activities, their dose values were determined on the basis of operative dose values received at the power plant. *Collective doses for the period 2004-2006 can be seen in the following table.*

Table 15.3.2-1: *Exposure of maintenance personnel between 2004 and 2006*

Unit/year	*Collective dose [person*mSv]*		
	2004	*2005*	*2006*
I	*444*	*292*	*253*
II	*297*	*598*	*211*
III	*270*	*759*	*169*
IV	*147*	*132*	*439*

The plant also regularly checks the patterns of internal exposure, by thyroid and tritium excretion measurements, and by whole body measurements. Internal exposure generally has a very low contribution to the annual exposure of workers. *Between 2004 and 2006, no internal exposure exceeding the recording level of 0.1 mSv was found. Concerning the tritium activity-concentration measurement in urine, values 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 2.5Bq/cm^3*

Year	*Number of cases*	*Max. concentration [Bq/cm3]*	*Max. committed effective dose [µSv]*
2006	*140*	*25*	*51*
2005	*102*	*43*	*87*
2004	*242*	*45*	*93*

The power plant itself performs the dosimetry control of employees engaged from outside companies.

Summing up, it can be stated 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, further upgrading and supplementary courses, along with the regular examination of knowledge comprises 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 shutdown cooling schedule, aimed at reducing the deposition of corrosion products during cool-down.

When making preparations for work with particularly enhanced exposures, 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). 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 of 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). *Since 2004, when Ministerial Decree 15/2001. (VI. 6.) KöM on the new release system came into force, the effluent and atmospheric releases are to be compared 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 limit usage of the last three years for Paks NPP and the Spent Fuel Interim Storage Facility are outlined in Tables 15.4.1 and 15.4.2.

Table 15.4.1.: *Releases from plant units*

Year	*Number of operating units [pc]*	*Release limit criterion*	*Limit usage [%]*
2004	*4*	*2.7×10^{-3}*	*0.27*
2005	*4*	*2.2×10^{-3}*	*0.22*
2006	*4*	*2.2×10^{-3}*	*0.22*

Table 15.4.2.: *Releases from the Spent Fuel Interim Storage Facility*

Year	*No. of Stored fuel assemblies at end of the year*	*Release limit criterion*	*Limit usage [%]*
2004	*3767*	*1.2×10^{-5}*	*0.0012*
2005	*4267*	*3.3×10^{-5}*	*0.0033*
2006	*4747*	*9.8×10^{-5}*	*0.0098*

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 500 measurement channels per twin-unit. Control includes gauging 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). The computerized display and archiving of measurement results also take place in this control room. 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, temperature, water flow measurement), at the meteorological tower, and at environmental monitoring stations set up at about 1.5 km from the power plant (air iodine activity, dose rate). Data are transmitted to the above mentioned Dosimetry Control Room;
- 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, dry-out, grass, soil, aerosol, ^{14}C, atmospheric tritium activities and doses.

In addition, sampling stations which measure dry-out activities and doses are situated within a 30 km radius of the nuclear power plant. Moreover, numerous samples are collected in the environment surrounding the power plant, e.g. mud, fish, plants, milk and soil. Measurements have so far shown 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 radioactive release control and environmental monitoring system took place between 2003 and 2005. The new system operates with a high degree of 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 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 Management. *The measurement system of authorities consists of several monitoring networks completing each other, which belong to departments in accordance with the task-sharing specified in the Act on Atomic Energy.*

The Tolna County 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. The Tolna county office representatives of the National Public Health and Medical Officer Service, in accordance with the above agreement, fortnightly consults the resident inspectors of the HAEA NSD. Exchange of the actual radiation protection inspection records and experience takes place during these consultations.

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

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

The Baja Section of the South-Transdanubia Environmental, Nature Conservation and Water Management Inspectorate enforces the fulfilment of requirements related to discharge limits and other environmental stipulations contained in resolutions and 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.

The various activity values of soil, veterinary and foodstuff are monitored by SPHMO, the National Research Institute for Radiobiology and Radiohygiene and the regionally competent County Veterinary Sanitary and Food Control Stations monitor the activities in soil, vegetation and foodstuff.

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 Collecting, Evaluating and Processing Center 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 Protection Control System (OKSER). The chairperson of the committee managing OKSER is one of the two deputy director generals of the HAEA.

The most important data gathered by the system in 2005, with a summary evaluation, was published in the first OKSER report in September 2006.

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 Regulatory framework

The Hungarian Nuclear Emergency Response System was established by the amended Ministerial Council decree 135/1989. (XII. 22.) MT on the establishment of the national emergency response system. Govt. Decree 248/1997. (XII. 20.) Korm., amended by Govt. Decree 40/2000. (III. 24.) Korm. regulates the organization and tasks of the National System for Nuclear Emergency Response as well as the scopes of duty and competence of the Hungarian Atomic Energy Authority 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 Council of the European Union directive 89/618/EURATOM on the topic of informing the general public about health protection measures to be applied and steps to be taken in the event of a radiological emergency.

16.2 Operation of the national nuclear emergency response system

The protection against disasters is managed by the Governmental Co-ordination Committee.

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

- president: Minister of Local Government and Regional Development;
- vice president in case of a nuclear emergency: Director General of the Hungarian Atomic Energy Authority;
- members: administrative state secretaries of the ministries involved in the emergency and a high-ranking officer appointed by the minister governing the national security services.

The bodies of the Governmental Co-ordination Committee are the Secretariat, the Operative Staff, the Emergency Centre, the Defence Working Committee and the Scientific Council.

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

The Secretariat of the Governmental Co-ordination Committee, and in the event of an emergency its Operative Staff, operates within the Ministry of Local Government and Regional Development, its Emergency Centre operates on the basis of the Directorate General for National Emergency Management. Chairpersons of the Secretariat and Operative Staff is nominated by the minister for local government and regional development.

A nuclear emergency is declared or withdrawn by the president 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 plant.

If a nuclear accident occurs, it is the task of the competent Defence Working Committee of the Governmental Co-ordination Committee to provide the decision-makers with decision support (until the Defence Working Committee is set up this task is performed by the Operative Staff). The Committee is activated by the Ministry of Local Government and Regional Development, its head is appointed by the state secretary of the Ministry of Local Government and Regional Development, members are appointed by high ranking officers of corresponding ministries and bodies of national competence. The Hungarian Atomic Energy Authority operates an expert panel within the Defence Working Committee in the case of a nuclear emergency. *In order to harmonize communications in the case of a nuclear emergency the Defence Committee operates a Public Information Working Group under the Directorate General for National Emergency Management that is directed by the minister for local government and regional development.*

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 Directorate General for National Emergency Management *that is directed by the minister for local government and regional development* and the corresponding ministries. The head of the Operative Staff is appointed by the Minister of Local Government and Regional Development.

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 handle the consequences of an emergency.

Within the nuclear installation, the person responsible for implementing tasks related to the response to an accident is the chief executive of the installation; in the counties and in the capital it is the chairman of the regionally competent County (Capital) Local Committee for Nuclear Emergency Response, while at national level it is the chairman of the Governmental Committee.

For a nuclear emergency, it is the task of the Hungarian Atomic Energy Authority to evaluate the current situation and then to forecast the likely nuclear and radiation situation and its propagation. Information to support the assessment and decision-making are provided by the following organizations:

- Centre for Emergency Response, Training and Analysis of the Hungarian Atomic Energy Authority, which is in direct data communication contact with Paks NPP;
- International Contact Point at the Authority;
- Nuclear Emergency Information and Evaluation Centre operated by the Directorate General for National Emergency Management;
- Emergency Information Centre of the Nation-Wide Environmental Radiological Monitoring System operated by the Ministry of Health.

16.2.1 Departmental and regional nuclear emergency response organizations

The management and operating structure of the sector-wide system is determined by the corresponding ministers and the heads of bodies of national competence. It is the responsibility of the County (Capital) Local Defence Committees to set-up nuclear emergency preparedness bodies for each sector, to designate the forces and equipment needed to implement protective actions and to prepare and continuously maintain the emergency response action plan.

16.3 The National Emergency Response Plan

As an up-date of the Nuclear Emergency Response Plan that was effective from 1994 the Governmental Coordination Committee approved the new National Nuclear Emergency Response Plan in 2002. This plan is intended to be a model for elaborating emergency response plans at various levels. The fundamental objectives of the documents are as follows:
- *reduction of the risk of a nuclear or radiological emergency, and mitigation of its consequences;*
- *prevention of severe deterministic health consequences;*
- *reduction of the probability of stochastic effects.*

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 being 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 (summary of accident scenario and processes resulting in nuclear emergency for facilities grouped to certain emergency categories);*
- *organizational responsibilities (role and duty of organizations participating in nuclear emergency response for mitigating the consequences and preventing harmful effects of an emergency);*
- *principles of operation during an emergency (description of operation of nuclear emergency response system in different phases of an emergency);*
- *preparatory tasks (tasks in connection with reviewing of plans and with preparatory training for nuclear emergency response).*

Additional information dealing with the National Emergency Response Plan is included in the appendices of the plan. The topics discussed there are as follows:
- *detailed description of departmental responsibilities and resources;*
- *nuclear facilities, special sources and their relevance in nuclear emergency response;*
- *national emergency response levels and emergency planning zones in Hungary;*
- *system of emergency response plans, content and structural requirements for emergency response plans;*
- *monitoring strategy during an emergency;*
- *alerting procedures applied by Paks Nuclear Power Plant;*
- *detailed description of emergencies taken into account at the design stage.*

The nuclear emergency response plans together with laws harmonized in accordance with EU requirements have been tested during national and international exercises held in recent years. The general lesson learned from exercises is that the National Emergency Response Plan fulfils its objectives, it is applicable for professional regulation of operation of the National Emergency Response System. In order to utilize the experience gained during exercises, a High-level Working Group was established at the end of 2005 aiming at continuous maintenance of the National Emergency Response Plan, at feedback of experiences, and at follow- up of changes of laws and international recommendations. The updating of the National Emergency Response Plan approved in 2002 is in progress, its most important objectives are as follows:

- *to be in harmony with the most up-to-date recommendations of the International Atomic Energy Agency (with the document entitled GS-R-2 Preparedness and Response for a Nuclear or Radiological Emergency, and publications of EPR series);*
- *to utilize experience gained from exercises and drills, and to update the operation of the National Emergency Response Plan;*
- *to update the legal background in harmony with its modifications.*

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

In case of 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 protective action planning zone", in which the measures to be introduced shall be implemented without undue delay with the necessary preliminary arrangements. This circle is surrounded by the next, 30 km, circle within which the "urgent protective action planning zone" can be found; and then the largest one, of 80 km, the "long term protective action planning zone" is located. Concerning the latter two, special laws determine the intervention levels, the taking into account of which shall be provided for determining the protective actions to be introduced.

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

16.4.1 Comprehensive Emergency Response Plan of Paks Nuclear Power Plant Ltd.

The emergency preparedness of the power plant is based on the Comprehensive Emergency Response Plan. The plan contains organizational and technical measures aimed at the assessment, limitation and management of nuclear, radiological and conventional emergencies. The structure of the plan is modular; besides regulation of the general emergency operation it contains different modules for different types 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 resources are specified in emergency response scenarios At the plant an alarm system ensures the rapid activation of the Emergency Response Organization.

The plan prescribes the order of internal and external alarms 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 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.

16.4.2 The system of providing the public with appropriate information in the event of a nuclear emergency; media relations

The protection of the public is the task of state-level and local governmental authorities, but in the early stages of an accident the power plant itself faces duties of this nature.

Should there be an actual emergency, the public is alerted by an acoustic alarm and information system installed within a 30 km radius of the power plant. In the event of an emergency, it is the duty of the national media to give 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 receive SMS notification as well, detailing the related events of the plant. The nuclear power plant is represented in the working group of the Governmental Co-ordination Committee.

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 emergency preparedness activities of Paks NPP based on links with national media.

16.4.3 Order of preparation and exercises

On-site and off-site exercises, including national and international exercises, are organized regularly in accordance with annual plans as defined in Emergency Response Plans.

The entire personnel of the power plant are in readiness for potential emergency tasks. Members of the emergency response organization receive regular training to handle their specific tasks. The power plant carries out its own exercises based on an annual exercise programme that is approved by the Authority; there may be exercises perhaps alerting exercises; there may be practices when different organs of the Emergency Response Organization are prepared for their tasks; or there may be system exercises when tasks are accomplished in co-operation with county-level or state-level bodies.

As a Member State of the OECD Nuclear Energy Agency, Hungary regularly takes part in international nuclear emergency exercises called INEX. Similarly, Hungary is a regular participant of the CONVEX nuclear emergency response exercises organized by the International Atomic Energy Agency. Since September 2003, Hungary - as a full member of ECURIE (the early notification arrangement of the EU in case of nuclear emergencies) - also participates in the exercises organized within the framework of the ECURIE system.

16.5 International relations

16.5.1 International conventions

The Republic of Hungary was among the first nations to sign the following multilateral conventions concluded in 1986:

- the Convention on early notification in the case of a nuclear emergency;
- the Convention on providing assistance in the event of a nuclear or radiological emergency.

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.

16.5.2 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).

16.5.3 RESPEC support

The Hungarian Atomic Energy Authority signed the RESPEC contract at the end of 2006, in the framework of which the Hungarian Atomic Energy Authority will provide the European Commission with professional support for three years in the case of nuclear and radiological emergencies which have an effect within the European Union. The RESPEC tender was announced in July, 2006 by the European Commission, and the bid of the Hungarian Atomic Energy Authority won the tender. The duties contracted will be effective as of April 1, 2007. Based on the contract the Emergency Response Organization of the Hungarian Atomic Energy Authority, at the request of the European Commission, will provide professional support in nuclear and radiological evaluation of an emergency, and in public communication. The European Commission may request this professional support primarily if an emergency occurs in the territory of the European Union or of neighbouring countries, or if an emergency jeopardizes the civilians of the European Union.

D. THE SAFETY OF INSTALLATIONS

17. Siting

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. Location and surroundings of the site

Paks NPP is situated about 115 km south of Budapest. The nuclear power plant is situated 5 km to the south of the town of Paks, 1 km to the west of the River Danube and 1.5 km to the east of National Main Road No. 6. Its geographical co-ordinates are 46°34'24" (northern latitude) and 18°54'53" (eastern longitude). The 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 reach the power plant by road, rail or by water.

17.2 External man-made hazards

The region is mainly characterized by cultivated land. There is no significant industrial activity in the immediate vicinity of the site. There is no airport (neither civil nor military) there are no take-off or landing safety zones or military establishments either in the near or wider vicinity of the power plant. According to regulations related to airspace usage, flights are permitted to cross the area in a radar-controlled airspace only above an altitude of 2,400 m above sea-level; however, flying is completely prohibited within a 3-km-zone around the power plant. Based on conservative estimates the probability of military aircraft crashing and falling on the most sensitive 100,000 m^2 area of the nuclear power plant is $3.2*10^{-7}$/year.

Analysis of road and waterway accidents during the transport of hazardous substances, indicates that the probability of the release of hazardous substances by road accidents is $4.8*10^{-7}$, that of a poisoning is $3.1*10^{-7}$, while that of an explosion is $2.6*10^{-7}$ events/year. In the case of transport by water, a conservative analysis regarding the probability of water-related accidents and release of substances resulted in less than 10^{-7} events/year.

17.3 Population

The population within a 30 km radius of the nuclear power plant numbers approximately 200,000.

Detailed meteorological, hydrological and geological study of the site can be found in Annex 3.

18. Design and construction

Nuclear Safety Convention, Article 18

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

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

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

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

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

Volume 3 of the Nuclear Safety Code issued as an appendix to Govt. Decree 89/2005. (V. 5.) Korm. (as amended by Govt. Decree of 249/2005. (XI.18.) Korm.) contains general nuclear safety-related requirements concerning the design of nuclear power plants. The requirements lay down in detail the following principles and rules well known from international practice. The most important requirements are summarized below.

18.1.1 Multilevel protection

The principle of defence-in-depth should be applied to all activities related to safety in such a way that any failure can be compensated for or corrected, and the occurrence of serious accident situations can be prevented. Levels of protection are aimed at maintaining the normal state of operation, preventing the development of accidents, and to mitigate the consequences of design basis accidents. Moreover, specific auxiliary systems and components shall be installed - for further protection of the public and the operating staff - the task of which is to mitigate the consequences of occurrences and accidents beyond the design basis.

18.1.2 Application of technologies proven by experience and qualified by testing or analysis

Equipment for proven and verified technologies shall be available for the following cases:

- to shut down the reactor safely and to maintain it in a safe shutdown condition in each state of operation;
- to remove residual heat after shutdown;
- to reduce the emission of radioactive substances and to ensure prescribed limits of emissions.

Safety functions and systems and components executing these functions should be categorized into safety classes according to their influence on safety. The classified safety systems 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.

It is required that the scope to be determined of those safety-related systems and components which should be designed to be inherently safe should also - as far as possible - be insensitive to any human error.

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 and components during normal operation, anticipated operational transients, and design basis accidents.
- An adequate communication system shall be established between different locations.
- The constant 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 prescribe the establishment of a unit control room, a reserve 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

18.2.1 Design principles applied when the nuclear power plant was constructed

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

18.2.2 Fulfilment of up-to-date safety requirements

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 must not be breached (thus the fourth barrier 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. 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 limits. Management of severe accidents that are more severe than design basis accidents but the probability of which are minimal 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.

From experience gained from deterministic accident analyses, probabilistic safety analyses (level one), severe accident analyses, and from 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 increased; this is clearly revealed by the core damage probability data in chapter 6.1.3 and figure 6.1.3.

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 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 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.

A comparison was made between the Preliminary Safety Analysis Report and the results of the analyses of off-normal events in the framework of the AGNES project. The AGNES project finally concluded that the power plant could be safely operated.

Analyses of the Periodic Safety Review performed for four 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 (containment, bubble condensers) of the WWER-440/213 type units came to an end. The containment 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. The bubble condensers, with minor structural modifications, were also proved to be adequate. Details of the containment analysis are described in Annex 3 of the 3rd National Report.

Within the framework of level-1 PSA analyses, event trees and fault trees have been prepared concerning technological initiating events characteristic for full power and shutdown states, and also those concerning internal flooding, fire, high energy pipe ruptures and seismic initiating events. The value of core-damage probability was calculated and sensitivity and uncertainty analyses were performed. All probable external effects jeopardizing safety were assessed.

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 capability 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; *later, all these cases were re-calculated to substantiate the increased thermal power of the units.* 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 initiating events considered to be globally important plus the cases especially characteristic for WWER reactors. The most sophisticated and up to date computer programs were used for analyses.

Based on the deterministic analysis of basic accident scenario performed within the framework of severe accident analyses, conclusions were drawn about processes inside the reactor and phenomena inside the containment, including the distribution of radioactive substances. The document contains the strategy of accident management procedures to be elaborated.

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 Nuclear Safety Directorate, on repealing the Preliminary Safety Analysis Report, approved the first version of the Final Safety Analysis Report and accepted it as the valid 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's Nuclear Safety Directorate.

Paks Nuclear Power Plant Ltd. had started to review the Final Safety Analysis Report in 2002, which work was completed in 2005. The aim was to prepare such an advanced basic document which would serve as the basis for the licensing process for extending the lifetime of Paks Nuclear Power Plant. This document is due to be updated annually in line with the regulatory prescriptions.

The latest up-dated Final Safety Analysis Report was submitted to the regulatory body by Paks NPP in 2006.

19.2 Operational limits and conditions

In 1988, Paks Nuclear Power Plant Ltd. elaborated the Technical Specifications on the basis of the then effective operating instructions, available design, operational and maintenance documentation, statements of the major constructor, safety analyses of professional institutes, and of operating experience. The Technical Specifications contain the operational limits and conditions of safe operation; this document is a key element of the operating documentation.

The operator is obliged to maintain the specification in a fully up-to-date condition. Content modifications that may become necessary due to technical modifications of the plant, the implementation of safety improvement measures, and technical modernization and scientific development may be introduced after regulatory approval.

19.3 Documents regulating operation

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

The requirements of the Company Quality Management Code (CQMC) specify the expectations to be met regarding the management of documents.

In accordance with the CQMC's requirements the associated regulations govern the processes of preparation, harmonization, checking, approval, issuing, up-loading to INTRANET, distribution of paper versions, promulgation, review, archiving time and of repealing.

Special emphasis is placed on ensuring that all personnel are acquainted with the regulations prior to their being put into force.

The valid version of each element of the regulation system is available in printed form for those participating in direct operation, and it is also downloadable from the INTRANET of the company.

19.4 Emergency operating procedures

In order to replace the earlier-used event-based emergency operating procedures, Paks Nuclear Power Plant Ltd. introduced the symptom-based emergency operating procedure system in 2003, after its validation on the plant simulator and after full training of the personnel. *The symptom-based operating instruction was elaborated on the basis of analyses of design basis accidents made in advance. Its main advantage compared to the formerly used event-based approach is that the possibility of human errors during emergency management is decreased, since all analyses and evaluations necessary for operator decision making in different operating states have been made in advance, during the elaboration of the instruction package.*

19.5 Maintenance

The maintenance of a power plant is an integral part of its operation, and this is always a task of vital importance to be accomplished by the operator. Maintenance affects safety, availability, operational safety, efficiency, lifetime and the economic viability of the plant.

The maintenance body of the nuclear power plant is divided into professional divisions (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 5.

19.6 Technical support

19.6.1 Technical and preparatory bodies

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

- *System analysis, condition monitoring, and establishment and execution of technical tasks for safe and economical operation of the nuclear power plant based on the assessment of operational and maintenance events.*
- *Provisions ensuring that the units meet the actual technical and safety requirements by utilizing international nuclear energetic 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 fields of technical engineering, electrical, instrumentation and control engineering, architecture and chemical engineering, and execution of tasks and assessments serving for preserving the qualified state of equipment.*
- *Execution of technical and closely related safety and economical calculations, analyses and reviews.*
- *Technical design, preparation of technical applications to the Authority, maintenance of relevant technical documentation.*
- *Preparation for archiving of technical documentation, and delivery of archive material for storage.*
- *Justification and preparation of technical developments (e.g. operation beyond design lifetime, 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 managerial 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.*
- *Elaboration and development of medium- and long-term fuel consumption strategies.*
- *Planning of nuclear fuel loads, fuel supply, stocking, and coordination of associated tasks. Supervision of safe operation of fuel loads.*
- *Elaboration of medium- and long-term and annual maintenance programmes of the company.*
- *Keeping and updating the cyclic plan for the maintenance of equipment.*
- *Elaboration of company-level development and investment programme.*

19.6.2 Decision support committees

Standing or ad hoc committees may be set up to make recommendations concerning emerging tasks. The tasks and operation of such committees are prescribed by the entity establishing them. The major committees of a technical nature are the Technical Committee, the Maintenance Working Committee, and the Safety and Quality Management Committee.

19.6.3 Domestic and foreign support institutions

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

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 ETV-ERŐTERV Zrt.; the principal consultant is the KFKI Atomic Energy Research Institute.

19.7 Reports to the Authority

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

19.7.1 Regular reports

- quarterly report: notifying the Authority of the state of operational characteristics, current issues of operation and factors affecting operation;
- annual report: based on the quarterly reports, but as more information is available due to longer periods of time elapsed, a more comprehensive description, evaluation and analysis is available;
- annual safety report: the final safety analysis report should be updated by the Licensee according to the changes relating to nuclear safety having 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 such as minutes of meetings, etc.

19.7.2 Event reports

- events under the obligation of instant reporting are required to be reported within two hours following their occurrence; the INES classification of all events subject to reporting should be performed, and the relevant recommendation should 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.

19.8 Feedback

19.8.1 Own operational experience

As operation and maintenance tend to be profession-specific so far as equipment and activities are concerned within the various professional areas (mechanical, instrumentation and control, electrical engineering), data collection and processing are separated as well. 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 professional areas has been developed in order to ensure a uniform system of data acquisition and processing.

Analysis of reliability and availability indicators should be the basis of replacement, modernization or modification of components or equipment. These data are used in safety analyses as well. The power plant shows good indicators even by international comparison, as far as safety systems are concerned. 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, other events are investigated at professional 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 of 1992-2006 the safety related events that occurred at Paks Nuclear Power Plant were classified to INES as seen in figure 19.8.1. *No event classified on the INES scale as being higher than 1 occurred in the subject period (2004-2006).*

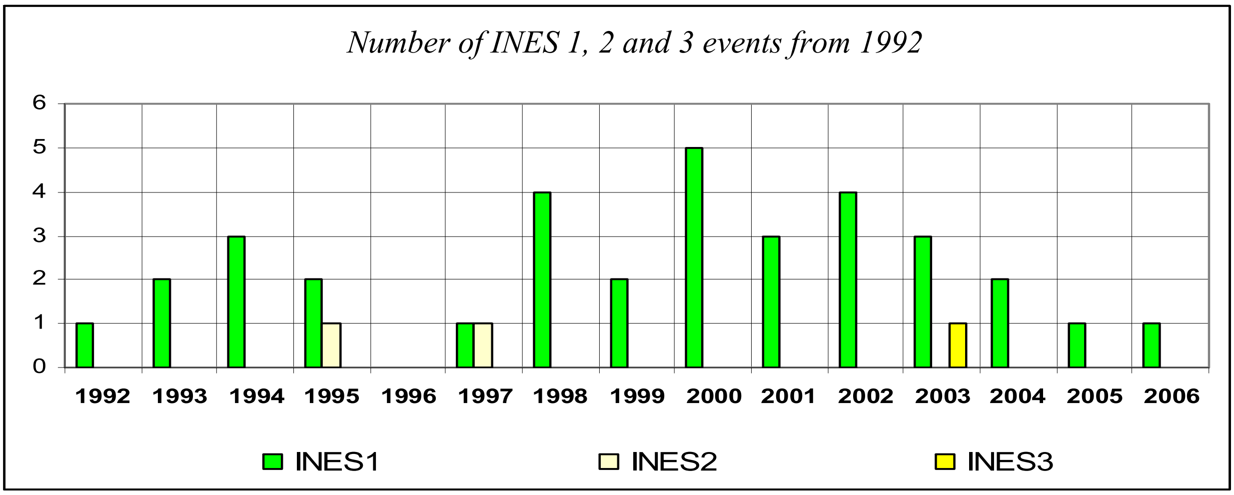

Figure 19.8.1: *Number of INES 1, 2 and 3 events from 1992*

The results of investigations and the corrective measures are widely presented. In that responsible personnel and deadlines related to corrective measures are always indicated and known, such measures are always traceable. Not only single events but also trends are monitored as well, including changes occurring in 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 through simulator training. The constant 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 experience of 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.

19.8.2 Utilization 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 NPP takes part in the work of large international nuclear organizations (e.g. the International Atomic Energy Agency, the 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. 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. Good examples of recent years are the co-operation with the Loviisa power plant (Finland) in the framework of the fuel diversification project, or the exchanges of maintenance experience with other WWER plants.

19.8.3 Reviews of external entities

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

Table 19.8.3. 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*

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 2 or 3 years.

19.8.4 Radioactive waste

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, which was promulgated by Act LXXVI. of 2001. A detailed discussion of the issues related to radioactive wastes and spent fuels can be found in the report submitted within the framework of the Convention; here, only the most important characteristics are cited.

The classification of radioactive wastes takes place in accordance with Decree 47/2003. (VIII. 8.) ESZCSM of the Minister 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 NPP 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 Agency 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 investigations. 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 waste from the power plant

From 1983 to 1997 low level solid wastes generated by the power plant were transported to Püspökszilágy, within the framework of a contract concluded with the approval of the Authority. Since 1997, solid radioactive wastes from the power plant are not transported to the above-mentioned site. Therefore, until the establishment of a new storage facility for final disposal, safe interim storage will be accomplished at the nuclear power plant itself.

Disposal of a power plant's radioactive waste is of national concern, its safe solution is a government task for which an inter-ministerial project was initiated. Relying on the results of preliminary surveys and safety analyses, a subsurface repository, in granite (at Bátaapáti) turned out to be the safest solution; so it was decided to launch the necessary detailed research there.

Since February, 2005 the formation of two inclined exploration shafts is in progress as well as the related preparatory research work. Based on the currently available research results the facility can be built at a depth of 250-280 m below the surface and at heights of 0-30 m above sea level.

The population of Bátaapáti and its neighbourhood supported the research activity from the beginning, then - on July 10, 2005 - by virtue of a local referendum (participation of 75%) more than 90% voted for building the waste disposal facility. The local governments of neighbouring villages assured their support in a resolution.

On November 21, 2005 Parliament granted preliminary consent in principle with its resolution 85/2005. (XI.23.) OGY to launch the preparatory activities for establishing the radioactive waste disposal facility to be used for the disposal of low and intermediate level wastes. This Parliamentary resolution made it possible to start preparations for the facility in 2006.

The final disposal facility will be available only for solid or solidified waste of appropriate quality. For this reason a waste acceptance criteria system was elaborated that specifies those parameters (physical and chemical characteristics, packaging, etc.) and inspection methods for each waste type and waste package, which can guarantee the safety of final disposal. This criteria system was approved by the competent authorities in 2006.

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 programme was elaborated for further investigations of the region; this programme was approved by the minister disposing the Central Nuclear Financial Fund at that time.

20. Plans concerning safety improvement

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

Corrective measures prescribed during the first Periodic Safety Review of Paks Nuclear Power Plant have already been carried out; preparation of the second Periodic Safety Review is in progress. This common review for the four units will be conducted in 2007.

The following measures among the already commenced safety improvement measures will be implemented in the forthcoming years:

- *technical modifications necessary for severe accident management, elaboration of accident management guidelines;*
- *qualification or reinforcement of relays and switch-boxes that have not yet been qualified to earthquake;*
- *management of leakage from the primary to the secondary circuit by back-feeding of the radioactive medium into the hermetic zone.*

Besides the technological modifications a significant element of safety improvement derives from the increased commitment, awareness and initiatives of the staff.

Within the framework of the Organization and Operation Development Programme the implementation of a three-year action package was begun whose goal is also the improvement of the safety and operational culture of Paks NPP.

ANNEX 1:
DETAILED DESCRIPTION OF IN-SERVICE INSPECTIONS

Types of operational tests

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

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

- in-service technological test - this is a function for testing systems in standby state of operation while taking the lowest risk possible;
- unit shutdown technological test - this checks the operability of components and systems taking part in the shutdown, 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 minutes evaluating the tests are the basic documents for verifying suitability. Evaluation is done by the organization responsible for the performance of the test. As a result of the evaluation, 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 processed in detail.

Over a period of time the in-service tests performed have verified the adequate availability of components, systems and 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 a given unit, tests are scheduled to check the systems necessary for shutdown and cooling;
- during the overhaul of a given 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 a given 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;
- 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.

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.

Periodic material testing

The scope of periodic testing is defined by material testing programmes, which specify the testing area, the method of testing, the scope and frequency of testing, reference to the corresponding item of the list of criteria, 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 block;
- reactor internals;
- main circulating pipeline;
- steam generators;
- pressurizer;
- hydro-accumulators
- primary circuit components and piping;
- local sealings;
- 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 List of Criteria for Non-Destructive Material Testing".

ANNEX 2:
AGEING MANAGEMENT

Basic concepts of ageing management

The nuclear power plant meets the official requirements related to ageing management in such a way that it enables the possibility of maintaining safe conditions of 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 constant development of scientific and technical knowledge.

Paks Nuclear Power Plant Co. conducts a systematic ageing management activity for components categorized to safety classes 1-3, and for those categorized to 4 and 4T which do not belong to safety classes but may jeopardize the operation of components providing a safety function. In the framework of this project:
- *the preservation of technical conditions of the required safety level for components providing an active function is ensured by utilizing the maintenance efficiency monitoring system that is currently in the introductory phase;*
- *environmental qualification is made for electrical and control components operating under harsh environments, and the qualified status is maintained;*
- *systematic ageing management is conducted for components providing a passive function: (1) individually for critical components, (2) in groups for non-critical components (component groups).*

The systematic ageing management for components providing a passive function includes the following:
- *specification of postulated degradation mechanisms and ageing sensitive structural 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 conditions (ageing monitoring system), status evaluation;*
- *elaboration of acceptance criteria used for status evaluation;*
- *in case of non-compliance, development of corrective measures and their implementation (e.g. repair, replacement, administrative measures);*
- *improvement of efficiency of component ageing management programme (feedback of condition information into the programme);*
- *possibility of administrative inspection regarding ageing management (quality assurance, coordination, documentation);*
- *operational experience feedback.*

The activities above are in harmony with the requirements derived from the following guidelines issued by the HAEA NSD:
- 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;
- Consideration of ageing effects 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 shutdown of the reactor core, and of structures inhibiting the release of radioactive substances (principle of defence-in-depth). During the selection procedure, the document 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, and the list included in *Guideline 1.26* of the Hungarian Atomic Energy Authority Nuclear Safety Directorate played an important role.

Accordingly, only those items were included in the list of critical components that demand long term ageing management because of their unique characteristics, or the replacement of which would constitute a serious financial and technical challenge. The components considered to be critical are as follows:

- *reactor equipment (vessel, internals, control and safety);*
- *pipelines connecting to main circulating pipe;*
- pressurizer;
- pressurizer surge line;
- pipelines of the main cooling loop;
- steam generators;
- main circulating pumps;
- main closing valves;
- feed-water pipeline;
- auxiliary emergency feed-water pipeline;
- ECCS hydro-accumulators;
- ECCS pneumatic valve;
- high pressure ECCS pumps;
- safety cooling water tank;
- *hermetic zone lining;*
- *piping penetrations;*
- *cable penetrations;*
- *sealings;*
- *surface coatings;*
- pneumatic valves at the hermetic zone boundary;
- low pressure ECCS pumps;
- spray system pumps;
- safety cooling water pump;
- emergency feed-water pump;
- feed-water pump;
- power supplies for safety equipment (cables and connections);
- *seismic re-inforcement of major equipment;*
- *high pressure concentrated boron pump;*
- *booster pump of make-up water;*
- *make-up water pump;*
- *safety relevant pipeline assemblies;*

- *piping supports;*
- *covered pipelines;*
- *venting system components providing a safety function;*
- *heat exchangers;*
- *seismic reinforcements;*
- *shafts;*
- *equipment suspensions;*
- *machines bases;*
- *metal supports.*

Procedure

In accordance with the procedure the main tasks of responsible organizational units of the power plant are as follows: to ensure the safe operation of units during their scheduled lifetime, to ensure the availability of units, to examine technical problems related to the ageing of components of distinct importance, to allocate tasks related to ageing management and co-ordinate the accomplishment thereof.

Cycle numbers

One of the administrative limitations for operating a critical component comes from the cycle numbers defined in the Technical Specifications. The cycle numbers of certain stressors were determined at design, thus both their rate of decrease and the actual load may be different from those scheduled. It should also be taken into account that such loads may arise that were not considered at design (e.g. thermal stratification due to stagnating flow).

Fatigue monitoring is an important task and it also provides the possibility to reassess the administrative limitations defined during design, which may be an important factor for potential lifetime extension.

ANNEX 3:
EVALUATION OF THE SITE OF PAKS NUCLEAR POWER PLANT

Meteorology

Judging from the measurements performed at Paks, the annual mean temperature is slightly increasing. The length of extremely cold periods (25 ^{o}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 variations, 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) 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, that of the water speed is 1m/s, and that of the 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 plume of hot water returned to the river completely mixes on its way to the border of the country (some 80 km), but no obvious temperature rise can be measured after the midway of this section. According to the water use license issued jointly for the four units, the warming of the cooling water returned to the river may not exceed 11 ^{o}C, or 14 ^{o}C if the temperature of the water is below 4 ^{o}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 ^{o}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 paleozoic-mezozoic basin basement.

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

The characteristics of an SL-2 earthquake (maximum horizontal acceleration, uniform hazard response spectra) were determined by calculation using probabilistic seismic hazard analysis based on a 10000 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 seen in the Pannon layer, which suggest movements 6 million years ago. Based on the data obtained it can be presumed that the fault lines generally follow the W-SW – E-NE direction, while a few of them follow the SW-NE direction. At the same time none of the profiles of the minimum 45,000 year old Quaternary upper layer had fault lines. Detailed geological and geophysical analyses performed at the site and its surroundings show that there is no obvious sign of a Quaternary fault. No Pannon structure can be related to measurable activity. No Quaternary faults can be found in the loess to the west of the site either. Deterministic analyses showed no faults reaching the surface. In spite of this, low-probability activity of structures within the Pannon layers around the Paks site was taken into consideration in the probabilistic risk analysis.

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

Soil liquefaction

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

Manufacture, acceptance, installation, and testing of technological equipment

The Preliminary Safety Analysis Report contains detailed technical data of 28 nuclear power plant components of distinct importance. It also features the technical requirements of manufacture, quality assurance, characteristics, manufacturing tolerances; the conditions of transportation, storage and conservation; the requirements of before-use inspection and super-inspection and the non-conformances revealed by these; the requirements, accomplishment and non-conformances of installation; and the manufacture and delivery documentation. It lays down the consequences of non-conformance in all cases. This is followed by a description of 37 systems of distinct importance, and 7 additional systems. Finally, it deals with the quality assurance of the fuel.

Start-up, commissioning acceptance tests and the commissioning programme

Commissioning plans laid down the objective, prerequisites, implementation, completion criteria, documentation and licensing requirements of certain steps. After the work was completed, all evaluations and statements had to be attached to the documents. Tests and commissioning took place in the following major stages:

- commissioning of the fresh fuel storage and the technological transportation system;
- commissioning of electrical components and systems;
- commissioning of control system equipment and radiation protection systems that directly serve the technology;
- cleaning of technological systems (primary, secondary, and ventilation systems);
- operational testing of technological systems;
- pressure testing and circulation washing of the primary circuit, along with functional tests scheduled for this phase;
- start-up tests on the secondary side using auxiliary-steam taken from the temporary boiler for the first unit and from the operating unit in the case of consecutive units;
- first revision, which included the dismantling and inspection of the reactor, the steam generators and other primary circuit components; the inspection of the cleanliness of the equipment after the pressure tests and circulation washing; installation practices for the maintenance staff under inactive circumstances;
- low-power test of the primary circuit;
- the second revision: status inspection requiring repeated dismantling;
- the integral pressure test, tightness test and the exact assessment of leakage values - with a comparison of these with the limit value for the hermetic zone including the primary circuit;
- physical start-up;
- the first connection of the given unit to the grid, followed by the tests of power start-up at different power levels: loading of the reactor up to around 20, 35 and 55% of its rated capacity, followed by the shutdown of the unit for scheduled preventive maintenance; further loading of up to 75% of rated power, then to 100%; and finally a 72-hour complex testing of the unit in its rated operational state;
- guarantee performance tests and certifying the unit as operational equipment.

ANNEX 5: MAINTENANCE

The maintenance of the power plant aims to ensure 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 bearing sufficient reserves 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 a 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;

- small overhauls:
  - only such work can be scheduled for this 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:
  - shutdown, reactor dismantling, refuelling, reactor assembly, restarting.

The order of executing maintenance activities

The activities of maintenance as a main process are regulated at the plant 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;
- 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 related to civil, electrical, instrumentation and control and mechanical engineering maintenance of the power plant are of adequate quality. Several kinds of supervising methods and regulation guarantee were introduced at Paks NPP.

Compliance with quality requirements is inspected during maintenance supervision and quality control activities, in some cases this involves the HAEA NSD staff.

The basic document of maintenance work is 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 and 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 the 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 outside contractors in maintenance is also regulated in detail. Outside 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 6:
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 prescriptions and requirements; compliance with its actions - in harmony with international practice, assessment of the problems based on their 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 prescriptions. The HAEA`s enforcement activities relate to those cases not following this approach.
- To support the efficient prevention and the introduction of the possible earliest actions, with enforcement, if necessary. Detailed aspects and are given in the 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 avoidance activities.
- Enforcement measures are necessary only on ascertaining the infringement of prescriptions when without them compliance with the prescriptions could not be achieved, or would be subject to delay, or the severity of occurrences demands express sanctions to prevent any recurrence.
- When the urgency and severity of regulatory enforcement actions are ascertained, at first the direct impact of prescription-infringements on safety are assessed, and secondly their potential future impact on safety shall be assessed.

Implementation of the enforcement policy is regulated by a procedural document. The procedure relies on the general rules of public administration procedures. The procedural document also addresses the situation when the violation of more prescriptions exists; when are they 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 prescription breached. Before its introduction in October 2002 the opinion of Paks Nuclear Power Plant Ltd., as the largest Licensee, was sought in connection with the elaborated procedure.

The enforcement administration procedure was initiated in the case of three infringements of acts, 24 infringements of safety regulations, and 1 infringement of a legally binding, public administration regulatory decision. The HAEA NSD has not assessed two infringements of safety regulations as justified; it therefore closed the procedure without censure. It took no further action concerning the situation of one infringement of the prescription of the Act, and 17 infringements of the nuclear safety regulations because the conditions determining the reason for proceeding with the public administration procedure ceased, consequently it terminated the procedure. In the case of the remaining prescriptions (two cases relating to the Act, five cases relating to safety regulations, and one case relating to a legally binding, public administration regulatory decision) the infringements were proven and, based on that, a fine of HUF 5 million was imposed on Paks Nuclear Power Plant Ltd. The company paid the fine, but appealed against the decision referring to there being no infringements of law in connection with the incident since the laws and regulations referred to by the Authority relate to systems of normal operation and do not relate to the eventually applied cleaning system.

ANNEX 7:
ACTIVITY AIMED AT EXTENDING PAKS NPP OPERATION

Preliminaries

The most important element of future objectives of Paks NPP, as 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 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 maintenance of environmental qualification of plant equipment, monitoring of maintenance effectiveness, renewal and continuous updating of the final safety analysis report.

In accordance with currently effective legal requirements, in order to extend the plant's operation, a programme to create the conditions for operation beyond the design lifetime shall be submitted to the Authority 4 years before the expiry of the operating license. The following tasks shall be implemented for this purpose:

- *To determine the scope of SSCs that are necessary for safe operation beyond the design lifetime, as well as to justify the adequacy of the selection.*

- *To determine and describe those ageing mechanisms which have to be managed for operation beyond the design lifetime as well as to demonstrate the adequacy of the procedure.*

- *To survey the conditions of SSCs included into the scope of licensing the operation beyond the design lifetime, to evaluate the existing ageing management programmes and to modify these if necessary and/or to elaborate and launch new programmes.*

- *To determine the necessary scope of time limited ageing analyses (TLAAs) concerned in the operation beyond the design lifetime.*

- *To evaluate the TLAAs, their validity and extendibility taking account of the planned operating period beyond the design lifetime. Qualified status shall be maintained.*

Table A-7: *Progression of lifetime extension preparatory works, status of tasks*

	Main task groups	***Status of implementation***
1	*Specification of licensing scope, elaboration of methodology*	*Implemented. Review is necessary before submitting the programme due to changes in the meantime.*
2	*Comprehensive review of ageing management programmes*	*The following tasks are completed: review of material testing framework programmes, development of Inspection Plan according to ASME, determination of qualification criteria for cracks found, review of erosion and corrosion analyses and water management.* *The following tasks are in progress: review of maintenance technologies, ageing management reviews related to heavy equipment and mechanical components and structures, increasing efficiency of the steam generator blow down system.*
3	*Highlighted tasks in relation to lifetime management*	*Surveys of steam generators are in progress. Review of grout injection for units 1-4 is in the preparatory phase. Corrosion analysis of insert elements and analysis of condenser is in progress.*
4	*Lifetime limit analysis: highlighted activities – Time Limited Ageing Analyses (TLAA), extension of validity*	*Load catalogue is complete. Strength calculation and fatigue analysis are in progress. Re-analysis of pressurized thermal shock events, thermal-hydraulic modelling of PTS events of frequency higher than 10^{-5}/year, reactor pressure vessel fluence assessment have been completed. Further analysis related to the reactor pressure vessel is in progress.*
5	*Other TLAA tasks*	*Specification of scope, extension of TLAA analyses, crack propagation analyses are in progress.*
6	*Preparation, implementation of already determined ageing management measures*	*The following tasks are in progress: review of reinforced concrete structures, machine bases, penetrations, increase of Emergency Core Cooling System temperature*
7	*Tasks related to implementation of new maintenance requirements*	*The following tasks are completed: elaboration of methodological guidelines for different areas, elaboration of risk analysis guideline.*
8	*Tasks related to equipment qualification*	*The following tasks have bee completed: qualification of valve motors, hermetic penetrations and I&C boards, hot spot survey of environmental parameters of cables.* *Other qualification related tasks are in progress*
9	*Elaboration of condition maintenance programmes*	*Elaboration of the programmes is in progress.*
10	*Activities originating from the review of ageing management related programmes*	*Under preparation.*
11	*Compilation of lifetime extension programme, environmental licensing*	*The environmental license has already been granted, however, an appeal has been made against it. The Espoo Convention related activities are completed.*
12	*Support activities*	*Operation of expert panels, technical support organizations and co-operation within the technical support project of the International Atomic Energy Agency are ongoing activities.*

Environmental licensing

The environmental licensing procedure of lifetime extension was initiated by the NPP in 2003, in accordance with the requirements of Govt. Decree 20/2001. (II. 14.) Korm. on environmental impact study. The preliminary environmental impact study was prepared in concert with the legal and regulatory requirements and was submitted to the Lower Danube Valley Environmental Inspectorate for assessment. The Inspectorate issued its decision (registration number: K5K3742/05) on terminating the preparatory procedure in May, 2005 and prescribed the elaboration of the detailed impact study.

The law governing environmental impact study changed during the preparation of the detailed environmental impact study; thus, at the second step of the procedure (beyond the stipulations of the regulatory decision) the requirements of Govt. Decree 314/2005. (XII. 25) Korm. on unified environment usage licensing procedure had to be re-considered. It meant that the law addressing the documentation had also been changed during the procedure.

Based on all these prescriptions the following documents were prepared: "Environmental impact study for units 1-4 of Paks NPP to the lifetime extension of Paks Nuclear Power Plant" and an "Easy to understand summary". These documents were submitted in March, 2006 to the Lower Danube Valley Environmental, Nature Conservation and Water Management Inspectorate to apply for issuing the environmental license necessary for lifetime extension. In the framework of public debate of the licensing process, public hearings were held on April 28, 2006, in Paks and on May 18, 2006, in Kalocsa.

Espoo procedure

In the preliminary impact study phase the Licensee and the Authority came to the conclusion that the lifetime extension does not cause a significant transboundary impact. Despite this, during the procedure greater international concern was experienced than had been expected. International law, the directive of European Union on environmental impact study and the Espoo Convention, maintain strict conditions for the procedures related to the possible transboundary environmental impact. According to the guidelines, independently of the judgement of the investor state, any state indicating its concern has the right to participate in the impact study procedure. Thus, this is true for states belonging to the European Union. According to the Espoo Convention, the investor state and any other state indicating its intention to participate may agree that the other state might participate in the procedure, even if the investor state considers that no significant, transboundary, harmful impact is expected. If the intention to participate is rejected then the other state may turn to the examining committee under the convention. Based on the directive Austria wished to take part in the licensing procedure and, taking neighbourliness into account, Croatia and Romania were invited to take part in the licensing procedure.

According to the requirements of the Espoo Convention consultations had taken place with all three states, and experts of Paks NPP had participated in public hearings held in the territory of these states. Finally the Espoo Convention procedure was successfully terminated with all three of these states. This was placed on record by the participants.

Subsequent to the domestic and international occurrences of the above outlined process, the competent authority granted the environmental license on October 25, 2006, for the units of Paks NPP to operate 20 years further beyond the original design lifetime.

The Energy Club Environmental Protection Union, as a client to the procedure, appealed against the decision on November 17, 2006. The appeal was examined by the authority of first instance, it elaborated its standpoint and - in accordance with legal requirements - by supplementing the application with necessary documents forwarded it to the authority of second instance, i.e. to the Directorate-General for National Environment, Nature Conservation and Water Management. The procedure at second instance is currently in progress.

ANNEX 8: DAMAGED FUEL ELIMINATION PROJECT

On April 10, 2003, due to a cooling deficiency, 30 fuel assemblies being chemically cleaned were significantly damaged in a cleaning tank installed in service shaft No.1 of Unit 2 of Paks Nuclear Power Plant. Although the consequences were not manageable by tools generally used at the power plant, the technological systems of the unit were not damaged during the incident. The damaged fuel assemblies meant on the one hand a safety hazard; on the other hand they hindered the normal operation of the shaft that also serves for transporting fresh and spent fuel.

Stages of recovery

The elimination activity included the following, partly overlapping, stages:

A. *Stabilization. Guaranteeing the subcriticality inside the cleaning tank, establishment of its cooling and heat removal on the basis of existing systems, installation of filtered air sucked from the environment of the shaft, radiation safety, water chemistry and waste management measures, installation of auxiliary measurements (e.g. neutron flux, temperatures, water level, radiation protection parameters, measurements by sampling).*

B. *Status survey and improvement. Visual inspection of the condition of the damaged fuel by underwater video camera, inspection of mechanical strength by grip-tests, measurement of subcriticality, measurement of gamma radiation, thermohydraulic analyses. Further development of measuring instruments installed during the stabilization activity (establishment of new, more accurate and more reliable solutions, increasing the number of redundant trains, providing independence of the emergency boron, cooling and cleaning systems of the unit).*

C. *Preparation of personnel and establishing the technical conditions for dealing with the elimination of damaged fuel. Design in principle, then establishment of preparatory engineering work, tools (working platform, tools, canisters, vessels) and procedures. Technical and executive planning, licensing, manufacturing, inspections during manufacturing. Training and exercises on a model.*

D. *On-scene preparation for eliminating damaged fuel. Acceptance and installation of delivered tools. Training and exercises on Unit 1 using both real tools and models.*

E. *Elimination of damaged fuel. Provision of access to assemblies and debris, their removal, their deposition into canisters, and their transport to a storage place.*

F. *Returning the shaft to normal service. Decontamination and removal of equipment and tools, then of the empty cleaning tank; decontamination of the shaft and returning it to its normal state.*

A special task was to restart, in August, 2005, at the intact Unit 2. The incident affected the unit only because subsequent to the incident the water of the reactor and two loops (out of six) was in contact with the water of the service shaft, consequently the primary coolant was slightly contaminated. Additionally, during the stabilization activity certain emergency boron, cooling and water cleaning systems of this unit were utilized for a short time.

Elements and major features of elimination technology

Paks Nuclear Power Plant Ltd. commissioned the consortium headed by TVEL to carry out the procedure for eliminating the damaged fuel. In accordance with the work-plan elaborated by the Russian partner, fragments of the damaged assemblies were collected, lifted from the cleaning tank and then placed in canisters and vessels located in holes of the protection flange through openings of the shielded working platform and above the lifting platform (which also served for fast and safe evacuation) with the help of manipulators and other tools moved by small cranes of the platform.

The larger assembly fragments were placed in wider canisters, the debris in narrower ones. The cut head and leg parts of the fuel assemblies, which contained no fissile materials, were placed in radioactive waste vessels. The dimensions of canisters and vessels fitted the existing refuelling machine and the storage shelves of the spent fuel pond.

When the canisters and vessels became full, the platform was temporarily removed and were transported to the unit's spent fuel pond. They may be stored there for at least five years in a wet state, in vented canisters (the radioactive gases are able to disperse through the gas-lock, while the highly radioactive water is retained by spiral a compensator). This period will be sufficient for elaborating the technical details of the requirements (water discharge, drying, installing a new catalytic lid with hermetic metal sealing) for medium and long term management of nuclear materials.

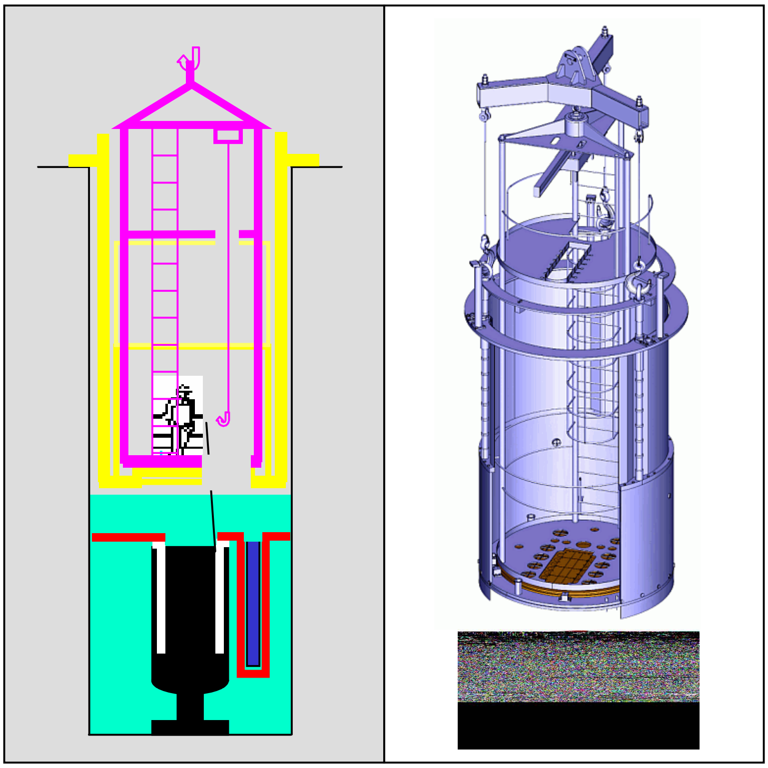

Figure A-8: *Under- and above water technological arrangement, spatial layout of assembled platform, and protecting flange*

The fixed position interim flange (white) and the protecting flange (red) were installed in the underwater part of the shaft. Three tubes went down from the interim flange on the inner side of the cleaning tank, their purpose was to hold neutron detectors and temperature sensors. The

protecting flange is a centrally opened horizontal disk touching the shaft wall, it has 17 fillable canister and vessel (blue) positions and places for storing tools.
The radiation shielded working platform (yellow) and the inner lifting platform (violet) were installed above water level. The working platform was suspended on a bearing ring, it could be set at several heights, its lower plate could be rotated. The base of the lifting platform rested on the lower plate of the working platform.

An information panel was connected to the platform, where the measurements, error signals and video images were displayed.

Design and construction, support organizations

Following the approval of the technology of principle and the design of tools, the main (TVEL, Russian) contractor formulated the construction document. The documentation of licensing in principle, and the applications for import and manufacturing license were elaborated on the basis of the design of the principle and construction documents.

The given elements were designed and manufactured by sub-contractors.

Table A-8: *Designers and manufacturers*

Technological element	*Designer*	*Constructor*
platform	*Hidropress (Podolsk)*	*OZNO (Azjorszk)*
tools and auxiliary systems	*Sosny (Dimitrovgrad)*	*NIIAR (Dimitrovgrad)*
canisters and vessels	*VNIPIET (St. Petersburg)*	*MSzZ (Elektrostal)*

Besides the Russian made equipment, other equipment was manufactured by Hungarian companies (e.g. autonomous cooling circuit, emergency boron system, air sucking system) and by other countries (French neutron detectors, German-Dutch electrospark machine, Czech boron acid measurement, Slovakian decontamination technique). The Hungarian scientific and engineering background (universities, competent research institutes) was widely involved, but expert support was received from the IAEA and other countries (e.g. USA in the management of damaged fuel, UK application of metal sealings).

Safety assessment

The possibility and consequences of the following event-groups were assessed:
- *Reactivity accidents: events entailing reduction of boron acid concentration.*
- *Cooling deficiencies: loss of cooling and loss of coolant.*
- *Violation of elimination technology: falling of fuel fragments and tools into the tank, uncontrolled sinking of the working platform.*
- *Violation of transport technology: fall-down, collision of canisters.*
- *Incidents leading to increase of radiation exposure could occur as secondary consequences of the above events.*
- *Events taking place on the unit or on the twin unit.*
- *External events.*

Acceptance criteria for assessment of events were as follows:
- *Subcriticality of the fuel had to be ensured, $k_{eff} \leq 0,95$.*
- *Coolant should not boil.*

- *Personal effective dose of any person in the controlled zone should not exceed 50 mSv at one time.*
- *Geometry of the canister had to be intact.*

It was stated as a result of the analyses the criteria were not violated even if the postulated events did occur, provided that:

- *Passive and active emergency boron systems were available.*
- *Boron acid concentration was high enough to prevent dilution transients.*
- *Water inlet level of the autonomous cooling circuit was limited.*
- *Inspection measurements were operating.*
- *Alarm systems were installed.*

Execution stage: fuel removal, major steps of encapsulation

The fuel was removed going from the top to the bottom, and outwards from the centre; the major steps of removal and encapsulation were as follows:

1: *Collection of debris from the upper spacer plate of the cleaning tank, removal of assembly heads, cutting and encapsulation of the connecting fuel part.*
2: *Division of the upper plate by drilling, cutting and core drilling, removal of plate parts.*
3: *Removal of debris from the centre of the tank either by pincer-like manipulators for larger size fuel parts (fuel pin parts), or by grab for medium sized debris (fuel pellets, smaller pin parts).*
4: *Removal of assemblies from the inner and centre circle, cutting off their legs, encapsulation of their parts containing fuel.*
5: *Cutting off the lower plate of the cleaning tank by core drilling.*
6: *Collection of medium sized debris under the lower plate by grab.*
7: *Removal of assemblies from the outer circle, cutting off their legs, encapsulation of their parts containing fuel.*
8: *Pumping up of small debris from the lower plate and the tank bottom.*
9: *Further division of the lower plate by core drilling in order to reveal the cooling water nozzles connected to the tank from below.*
10: *Cleaning of inlet nozzles by vacuum pump.*
11: *Removal of fuel spilled outside the tank.*

Lessons learned

Subsequent to a three-and-a-half year long thorough preparation the removal and encapsulation of the fuel was executed safely during the originally planned three months without any major problems.

*The three-shift work of 40 people resulted in slightly more than 30 man*mSv collective dose. The typical dose-rate on the working platform was only 3-5 μSv/h; this was made possible by well-designed shielding, low water activity and adequate administrative measures. The quantity of radioactive waste did not reach even half of the forecasted quantity. Some of the more than 70 different types of tools (consisting of altogether around 170 units) went wrong or broke down several times, but the manufacturing and maintenance capacity of the nuclear power plant, together with the help of the Russian designers who were on site enabled the situation to be controlled.*

The licensing practice of the Hungarian nuclear regulatory body was rigorous but just. It followed the elimination activity during on-site inspections, and it intervened expeditiously even in the case of minor deviations.