REPUBLIC OF HUNGARY

NATIONAL REPORT

Third Report

prepared in the framework of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management

2008

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SECTION A. INTRODUCTION

The Republic of Hungary was among the first to sign the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (hereafter Convention), established under the auspices of the International Atomic Energy Agency, on 29 September 1997, and ratified it on 2 June 1998. *The Convention was promulgated by Act LXXVI of 2001 [I.11]. (Hereafter the references to legal instruments listed in Annex 4 are used by numbering in brackets.)* In order to fulfil the obligations of Article 32 of the Convention the present National Report has been prepared and submitted.

Apart from this Introduction (Section A), this National Report contains ten more sections and eight annexes in accordance with the Guidelines regarding the Form and Structure of National Reports (INFCIRC/604).

Section B describes the general policies and practices in Hungary. Generation of radioactive waste started simultaneously with the introduction of isotope technology in Hungary in the early 1960's. First, a low and intermediate level waste (LLW/ILW) storage was built. As the site proved to be inadequate for long-term disposal, it was closed and cleaned up, and a new site, which is still in operation, was commissioned in 1976.

After the commissioning of the four units of Paks Nuclear Power Plant between 1982 and 1987, spent fuel and an increased amount of waste have been generated.

A major part of the spent fuel of Paks Nuclear Power Plant was shipped back to the Soviet Union (later Russia) between 1989 and 1998. At present, a modular type interim spent fuel storage is in use and is being enlarged as necessary. The disposal of high level waste (HLW) is a long-term programme.

In 1993, Hungary launched a national programme to solve the problems of radioactive waste management. *A suitable site was identified in granite host rock in the vicinity of Bátaapáti where a below-surface repository would be able to accommodate the LLW/ILW waste of Paks Nuclear Power Plant. At present, the construction of the repository, the National Radioactive Waste Repository is in progress.*

It is declared in Section C (Scope of application) that there are no reprocessing facilities in Hungary and no spent fuel originates from military applications.

The inventories of waste stored or disposed of in the existing facilities and rates of waste generation are given in Section D.

Section E describes the legal background. The basic regulation in force at present, Act on Atomic Energy [I.6], expresses the national policy in the application of atomic energy. It regulates the various aspects of radioactive waste management. Among other items, this Act declares the priority of safety; defines the tasks of the national authorities; and prescribes the establishment of a Central Nuclear Financial Fund for financing the disposal of radioactive waste, the storage and disposal of spent fuel, and the decommissioning of nuclear installations.

Other aspects of the safe management of spent fuel and radioactive waste, the responsibilities of the licensees and authorities, issues of emergency planning, international relations, and questions of decommissioning are discussed in Section F.

Sections G and H discuss in detail the problems related to the safety of spent fuel/HLW and ILW/LLW management, respectively. The Act on Atomic Energy [I.6] formulates the safety philosophy of all existing and planned activities by stating that:
"The interim storage and final disposal of radioactive waste and spent fuel shall be considered safe if

a) the protection of the environment is ensured throughout the entire duration of these activities;
b) the impact on human health and the environment is not higher beyond the country borders than that accepted within the country."

Transboundary movement of radioactive waste, described in Section I, is regulated in accordance with the international rules.

In Hungary, in recent years a new unified computerised local and centralised accountancy system has been introduced that further strengthens and significantly enhances the efficiency of the management of spent radiation sources, as described in Section J.

Section K gives a summary of the current and planned activities aimed at further improving the safety of waste management.

Sections B, D, E, F and K are arranged in such a way that the part related to spent fuel (in Section B together with the part related to high level waste) is followed by discussion regarding radioactive waste.

Technical details are given in Annexes 1-8. Annexes 1-3 describe the existing facilities for spent fuel and radioactive waste management as well as the isotope composition of radioactive waste. Annex 4 contains a list of Hungarian laws and regulations relevant to the scope of the Convention. In Annexes 5 and 6 reference is made to official national and international reports related to safety and to reports on review missions that have been performed at the request of Hungary. Annex 7 deals with the remediation of the area of the closed uranium mine. Annex 8 deals with the spent fuel management and releases of nuclear facilities other than spent fuel management facilities.

This *third* National Report prepared in the framework of the Convention is a stand-alone document, demonstrating the fulfilment of our obligations undertaken under the Convention. It is based on the revised version of the second National Report, omitting some less important parts concerned with past problems and presenting the new developments *that are highlighted in the text in italics. Taking into account the lessons learnt in the earlier review conferences, the Report discusses in a more detailed way the ongoing activities and the experience gained.*

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The text of this report was finalised on 30 June 2008; most of the inventory data herein describe conditions as of 31 December 2007.

Declaration

The Republic of Hungary declares that

- *priority is given to the safety of spent fuel management and to the safety of radioactive waste management and both are achieved through legal regulation as well as the efforts of regulatory bodies and operators;*

- *appropriate measures are taken to ensure that during all stages of spent fuel management and radioactive waste management there are effective defences against potential hazards in accordance with the objectives of the Convention;*

- *appropriate measures are taken to prevent accidents with radiological consequences and to mitigate the consequences of such accidents should they occur during any stage of spent fuel management or radioactive waste management.*

Budapest, June 2008

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

SECTION B. POLICIES AND PRACTICES

Generation of radioactive waste started simultaneously with the introduction of the use of isotope technology in Hungary in the early 1960s. The commissioning of the four units of Paks Nuclear Power Plant (1982-1987) increased the generation of both LLW/ILW and HLW.

The basic regulation in force at present, viz. Act on Atomic Energy [I.6], expresses Hungary's national policy in the application of atomic energy. Among other aspects, it regulates the management of radioactive waste and authorises the Government and the competent Ministers to issue executive orders specifying the most important requirements in this field. In connection with radioactive waste repositories the Act prescribes that Parliament's preliminary approval in principle is required to initiate activities for preparing for their establishment.

In accordance with the basic rules laid down in the Act, radioactive waste management shall not impose any undue burden on future generations. To satisfy this requirement, the long-term costs of waste disposal and of decommissioning of the nuclear power plant shall be paid by the generations that enjoy the benefits of nuclear energy production and applications of isotopes. Accordingly, by the Act and its executive orders, a Central Nuclear Financial Fund was established on 1 January 1998 to finance radioactive waste disposal, interim storage and disposal of spent fuel, as well as the decommissioning of nuclear facilities.

The Minister supervising the Hungarian Atomic Energy Authority has jurisdiction over the Fund, the Hungarian Atomic Energy Authority itself is responsible for its administration. *On behalf of the Government the Hungarian Atomic Energy Authority is supervised by the Minister of Transport, Telecommunication and Energy.*

The Government authorised the Director General of the Hungarian Atomic Energy Authority to establish the Public Agency for Radioactive Waste Management; this agency has been in operation since 2 June 1998. *On 7 January 2008 the public agency was transformed into a non-profit, public limited company following the corporation forms in the European Union. The new name of the company is Public Limited Company for Radioactive Waste Management (Radioactive Waste Management Plc., hereafter PURAM).*

On the basis of the Act, PURAM shall design and carry out radioactive waste management in such a way that

- it shall be safe during the whole duration of the activity;
- it shall not affect to a greater extent human health and the environment abroad than that accepted within the country; and
- *it shall ensure the safe disposal of radioactive waste and spent fuel in accordance with the most recent, certified results of science, international expectations, as well as experience, in such a way that no unacceptable burden is passed on to future generations.*

The Act on Atomic Energy [I.6] pays particular attention to providing information to the public. For example, it provides the possibility for the licensee of a radioactive waste repository to promote the establishment of a public control and information association and to grant assistance to its activities in order to give regular information to the population of the communities in the vicinity of the facility. Such associations have been established, and have been operating successfully both around the existing and planned radioactive waste repositories and around the spent fuel storage facility.

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The following chapters describe the relevant Hungarian practices and policies. Classification of radioactive waste is given in Section D. To enhance the understanding, a map showing the locations of the former, present and planned facilities is given in Figure B-1.

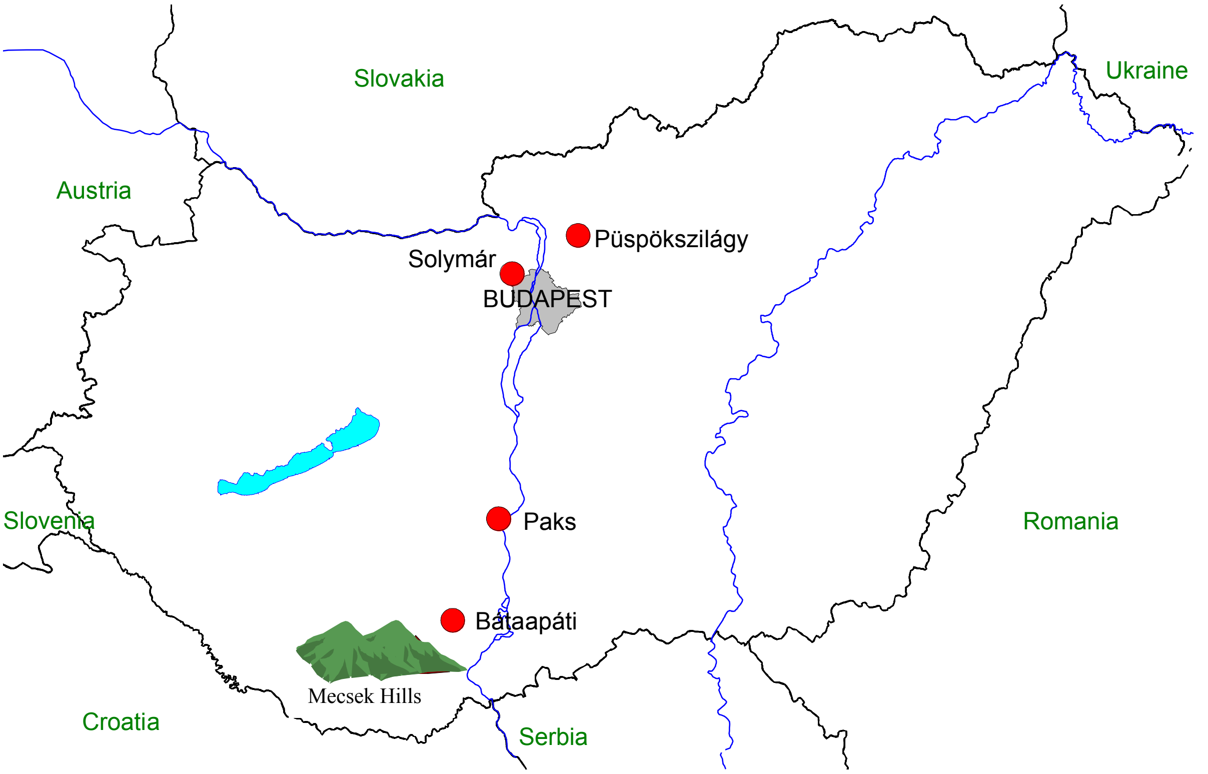

Figure B-1 Sites of importance in Hungary

B.1 Spent nuclear fuel and high level waste

B.1.1 Practice

Since all the feasible scenarios of the fuel cycle back-end lead to disposal of HLW, the issues of HLW and spent nuclear fuel are discussed together.

Hungary has three nuclear facilities producing spent fuel: Paks Nuclear Power Plant, the Budapest Research Reactor, and the training reactor of Budapest University of Technology and Economics.

HLW is generated during the operation of Paks Nuclear Power Plant and is temporarily stored in purpose-designed storage tubes (pits) at the plant. Inevitably, decommissioning of the power plant will also produce HLW in the future. The decommissioning of the other two nuclear facilities will also produce radioactive waste, but to a much smaller extent. These high level wastes can be disposed of together with the similar wastes of the nuclear power plant.

From the very beginning it was obvious that all the problems associated with the management of HLW would have to be solved by Hungary on its own, irrespective of whatever solution might be found for the issue of the fuel cycle back-end.

In 1995 a new programme was launched as a means of solving the disposal of high level and long lived radioactive wastes. Although this programme outlined long-term ideas, it mainly focused on the in-situ site investigations carried out by the Mecsek Ore Mining Company with the help of the Canadian AECL in the area of the Boda Claystone Formation at 1100 m depth (accessible from the former uranium mine) during 1996-98. The programme was limited to three years because of the closure of the mine in 1998; the reason for this was that the existing infrastructure of the mine could be economically maintained only during this time period.

The studies were completed by the end of 1998 and summarised in a documented form. According to the final report there were no circumstances questioning the suitability of the Boda Claystone Formation for HLW disposal purpose. In 2001, in order to support the step-wise decision-making, a preparatory study entitled "Determination and evaluation of handling strategies for spent fuel and HLW, establishing a working programme and time schedule" was elaborated. Its implementation, i.e. the forming of the strategy, is one of the tasks to be faced in the coming years.

In line with the development of the strategy, the investigations of the Boda Clay-stone Formation aimed at its exploration and the selection of a suitable site have continued since 2004. The primary objective of the re-started research has been to select the location of an underground research laboratory. The preparations, however, have continued more slowly than expected because of the preferential importance of the National Radioactive Waste Repository, hence the schedule of the project aiming at selection of site for an underground research laboratory should be revised.

At the beginning of 2008 a document entitled "Updated concept of the long term research programme of the Boda Clay-stone Formation including content, financial and schedule aspects" was prepared. A foreign expert has been also requested for the ongoing technical evaluation of this document.

On the level of a draft concept, the study discusses – taking into account the Hungarian law and licensing environment – the possible extent, expected costs and scheduling of the preparatory research activities aimed at the domestic disposal of the high level waste and spent nuclear fuel. The programme will inevitably need to be updated from time to time in the light of new knowledge.

The investigations have been supported by the adjacent nine municipalities.

Spent fuel from Paks NPP

A Hungarian-Soviet Inter-Governmental Agreement on Co-operation in the Construction and Operation of Paks Nuclear Power Plant was signed in 1966, and an Additional Protocol was added to it in 1994. In these agreements, still in force, the Russian party undertakes to accept delivery of the spent fuel and the Hungarian party undertakes to purchase the necessary new fuel assemblies exclusively from Russia for the whole life-time of the nuclear power plant.

After having shipped back the spent fuel, until now Hungary was not required to take back the radioactive waste and other residuals from the reprocessing of such fuel.

The major part of the spent fuel was shipped back to the Soviet Union (later Russia) between 1989 and 1998. However, in the 1990's, contrary to the terms of the original agreement though in accordance with international practice, the responsible Russian authorities wished to have Hungary take back the residual radioactive waste and other by-products created during reprocessing. At present Hungary does not have the capability to dispose of high-level or long lived radioactive waste.

It was for these reasons that the licensing and construction of an interim spent fuel storage were started in 1993. Paks Nuclear Power Plant commissioned the British company GEC Alsthom to build a dry storage facility of the MVDS (modular vault dry storage) type. One of the advantages of this type of construction and storage technology is that the number of storage modules can be increased in a modular system. *By the end of 2007 the first 16 modules (each with a capacity of 450 fuel assemblies) were completed.* The facility for the interim storage of spent fuel allows for the storage of the assemblies for a period of 50 years. The site of the Interim Spent Fuel Storage Facility is in the immediate vicinity of Paks Nuclear Power Plant. It is situated at a distance of 5 km south of Paks.

Further details of the facility are given in Annex 1, its safety is dealt with in Section G.

Spent fuel from the research reactor and from the training reactor

Spent fuel arises mostly as a consequence of the operation of Paks Nuclear Power Plant. In addition the operation of the 10 MWth Budapest Research Reactor at the KFKI Atomic Energy Research Institute, and that of the training reactor (100 kWth) at Budapest University of Technology and Economics contribute to spent fuel generation.

The spent fuel of the Budapest Research Reactor, in accordance with international practice, can be and up to now has been temporarily stored in wet storage facilities. However, for long-term storage, dry storage in an inert gas atmosphere is more advantageous. Therefore, the operator of the Budapest Research Reactor, in agreement with the Hungarian Atomic Energy Authority, decided to modify the storage conditions. Based on the new concept, the fuel elements will be encapsulated and stored in a nitrogen atmosphere. It is pointed out that the modified storage conditions do not exclude any possibilities of the spent fuel disposal as discussed below.

Based on the plans of the operator, the irradiated fuel elements of the training reactor are to be replaced with new fuel around 2012. As a part of the preparatory and licensing activities plans will be drawn up for the interim storage and final disposal of the spent fuel elements.

B.1.2 Policy

As a preparation for the disposal of the high level waste an underground research laboratory should be built in the above-mentioned Boda Claystone Formation. Should the results of the investigations be successful, the planned repository may well be able to serve for accommodating either directly the spent nuclear fuel or the residues resulting from the reprocessing of the irradiated fuel.

Spent fuel from Paks NPP

As yet, there is no decision on the back-end of the fuel cycle, but - in order to calculate the future costs of radioactive waste and spent fuel management, as well as to assure the necessary funding - some assumptions need to be made. As a reference scenario the postulation of direct disposal of the spent fuel assemblies in Hungary was accepted.

It is obvious that in the foreseeable future a strategy for the fuel cycle back-end should be elaborated. In the course of the elaboration of the strategy it is worth while to examine various possibilities, including the shipment of spent fuel abroad. In principle, this latter is a possible option due to the protocol on conditions concerning the reshipment to the Russian Federation of Russian-made spent fuel assemblies signed on 29 April 2004. That future decision should be based on technical, political, social considerations and also on achievable guarantees at intergovernmental level.

Spent fuel from the research reactor and from the training reactor

There are three possible options for the disposal of the research reactor fuel and later the training reactor fuel in Hungary. At present, since none of these options is definitely possible all three have to be kept open until a decision is due.

The first option is to return the fuel elements to the country of origin, i.e. to the Russian Federation. Negotiations on this option started in the 1980s, but due to vis maior (changes in the position of the partner stemming from the transformation of the Soviet Union) these discussions were not successful.

The arrangements for the reshipment into the Russian Federation within the IAEA programme RER/4/028 initiated and financially supported by the US Department of Energy were started two years ago. Although the technical activities are progressing satisfactorily, the conclusion of international agreements is a time-consuming process. Even so, one expects that these issues can be settled in the near future and the very first batch can soon be reshipped. This programme is in line with the international efforts to minimise the use of high enriched fuel assemblies in research reactors and substitute them with lower enriched ones that are less dangerous from the viewpoint of the proliferation of nuclear weapons. In the case of the Budapest Research Reactor this means that the present enrichment value of 36% will be reduced to 20%.

The second option is to transport the fuel elements to the Interim Spent Fuel Storage Facility and treat them together with the nuclear power plant fuel stored there. This option is less attractive than the first one because the difference in fuel characteristics would cause legal and technical problems.

The third option is to store the fuel elements on the site of the Budapest Research Reactor for a longer term. This option is the least attractive, especially as it was never foreseen that the site might be used for such purposes, and the licensing of a storage facility at the given location could be problematic. Nevertheless, since the realisation of the first option may not be quite certain and the second option may not necessarily be feasible, the operator of the Budapest Research Reactor has to consider this option as well. Preliminary discussions indicate that the fuel could be stored on-site in suitable containers (e.g. CASTOR type) placed into a building of light-weight construction. The costs of this option are the highest of the three. In the second and third options the spent fuel of the Budapest Research Reactor and the training reactor should be managed together with the spent fuel of the nuclear power plant from the viewpoint of final disposal. This possibility is ensured by the planned HLW repository.

B.2 Low and intermediate level waste

B.2.1 Practices

The solid and liquid radioactive wastes that are generated during the operation of the nuclear power plant are processed and temporarily stored in the plant. In addition to these wastes, radioactive wastes are generated in research institutes, in medical-, industrial-, and agricultural institutions and in laboratories.

Radioactive Waste Treatment and Disposal Facility

The repository for institutional low and intermediate level radioactive wastes, the Radioactive Waste Treatment and Disposal Facility, was commissioned in 1976. It is situated at Püspökszilágy some 40 km north-east of Budapest (see Figure B-1). The repository is a typical near-surface facility, composed of concrete trenches (vaults) and shallow wells for spent sealed sources.

At the moment, the Radioactive Waste Treatment and Disposal Facility is the only existing repository in Hungary.

The competent authority issued the final operational licence for the facility in 1980. In the absence of waste acceptance criteria, the repository has accepted almost all kinds of radioactive wastes generated during the utilisation of nuclear technology and isotope applications. Between 1979 and 1980, radioactive wastes stored up till then in a facility in Solymár were transferred for disposal to the Radioactive Waste Treatment and Disposal Facility. The Solymár site was cleaned up and closed as described in Section H.

Since 1 July 1998, the facility has been operated by PURAM.

Judging from the geological investigations, it is not possible to expand the Radioactive Waste Treatment and Disposal Facility for the disposal of the waste originating from the operation and decommissioning of Paks Nuclear Power Plant. The low-level, solid waste from Paks Nuclear Power Plant was transported to the repository in Püspökszilágy only as a provisional solution. At the same time the capacity of the Radioactive Waste Treatment and Disposal Facility was increased with the financial support of the power plant. The total capacity of the repository is now 5040 m^3. In the licensing procedure of the new part of the facility the Hungarian Geological Survey questioned the long-term suitability of the site in lack of results of detailed investigations*, thus the enlarged part of the repository received only temporary licence of operation. This licence expired on 31 December 2004.*

By then the results of detailed geological investigations had become available. Thus the licensing authority granted the new licence of operation – which can be renewed – for the longest possible period of time, i.e. ten years, based on the licensing documentation as required by the decree [III.16] of the minister responsible for health issued in 2003, newly *regulating this area, and on the position taken up by the 13 special authorities participating in the procedure.*

The results of the safety assessments, at the same time, unambiguously indicated that certain spent radiation sources may pose a risk in the far future, after the closure of the repository in case of human intrusion (see Section H). Therefore, with the aim of enhancing the long term safety of the repository (affecting on first place the future generations), a multi-year programme was launched in the framework of which the 'critical' waste types are segregated from the recovered waste and then the rest are – as far as possible – compacted before re-disposal in the vaults. By doing this, the repository – which became full in 2004 – can continue to accommodate the institutional radioactive waste from all over the country.

In April 2007, in the framework of the programme aiming at enhancing the safety of the repository and providing free disposal capacity, a demonstration programme was launched by opening four vaults. The objective of this ongoing trial programme is to test the applicable technologies.

The facility is described in detail in Annex 2, the safety aspects are dealt with in Section H.

New repository

Since the expansion of the Radioactive Waste Treatment and Disposal Facility to the extent that would satisfy the total needs of the nuclear power plant is impossible, after several attempts in early 1993 a national programme was launched with the aim of finding a solution for the final disposal of LLW/ILW of the plant.

In 1996, based on the final document resulting from the geological investigations as well as on safety and economic studies, further taking into account the willingness of host communities, a proposal was made to carry out further explorations for a geological disposal site in granite in the vicinity of Bátaapáti about 45 km south-west of Paks.

At the end of 1998, in the report finalising the geological investigations carried out in 1997-1998, the Geological Institute of Hungary made a recommendation to start the detailed site characterisation in the Bátaapáti research area as the preparatory step for the licensing procedure.

By 2003, as a result of the 4-year research programme, the surface-based geological investigations were completed.

The geological authority concluded that the site fulfils all the requirements formulated in the relevant decree [III.4]. Thus, from the geological point of view, it is suitable for the disposal of low and intermediate level radioactive waste. Further investigations with a below surface starting point are necessary to select the rock volume for the repository and its safety zone. The programming of these investigations was approved by the minister supervising the Hungarian Atomic Energy Authority in December 2004.

On the basis of the resolution on the preliminary approval in principle made by the Hungarian Parliament on 21 November 2005, and the favourable results of the local referendum held in July 2005 in Bátaapáti, preparation of the licensing and the investment of the repository started. At present the licensing procedure is in progress, the Environmental

Licence entered into legal force on 17 October 2007. The construction licence was also issued by the competent authority which entered into legal force on 18 June 2008.

Meanwhile the storage capacity for low-level solid radioactive waste has run short in Paks Nuclear Power Plant. Therefore the construction of the buildings on the surface was commenced at a rate which enables the temporary storage of a part of the solid waste from the nuclear power plant to take place later in 2008.

Further details about the establishment of the repository are given in Section H.

B.2.2 Policies

Radioactive Waste Treatment and Disposal Facility

It is expected that the repository will be able to accomodate the institutional waste for several more decades after its safety and capacity have been increased.

The complete reconstruction of the treatment building located on the repository site has provided a long–term solution for centralised interim storage of those long lived wastes and spent radiation sources as well as wastes containing nuclear material which are not suitable for near-surface disposal.

New repository

Low and intermediate level waste of nuclear power plant origin generated during the operation and decommissioning of the plant will be disposed of in the National Radioactive Waste Repository that is currently under construction. Closure of the repository is not planned prior to decommissioning the nuclear power plant. The repository – based on appropriate geological and geophysical measurements – can be expanded in order to accommodate the increased amount of waste stemming from the planned life-time extension of the nuclear power plant.

SECTION C. SCOPE OF APPLICATION

The Republic of Hungary ratified the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management on 2 June 1998 and promulgated it *by an act [I.11]* that requires the fulfilment of all the obligations of the Convention.

As to the scope of application - referred to in Article 3 of the Convention - Hungary declares the following:

- no decision has been taken on the back-end of the fuel cycle, so reprocessing is not part of the spent fuel management; there are no reprocessing facilities in Hungary;

- any waste that contains only naturally occurring radioactive material and does not originate from the nuclear fuel cycle is not radioactive waste from the viewpoint of the Convention;

- there is no spent fuel from military or defence programmes; the exclusively low and intermediate level radioactive wastes from the defence programmes of the Hungarian Ministry of Defence are disposed of with other institutional radioactive waste and they are included in the inventory of the radioactive wastes from civilian programmes.

SECTION D. INVENTORIES AND LISTS

D.1 Spent Fuel

Spent fuel arises mainly as a consequence of the operation of Paks Nuclear Power Plant. In addition, the Budapest Research Reactor and the training reactor (Budapest University of Technology and Economics) contribute to the generation of spent fuel.

In Hungary there is only one facility on the list of spent fuel management facilities, the Interim Spent Fuel Storage Facility. The main characteristics of this facility are described in Section B, its safety in Section G, further details are contained in Annex 1.

D.1.1 Inventory and rate of generation of NPP spent fuel

The four units of Paks Nuclear Power Plant are fuelled with fuel assemblies of VVER-440 type. The enrichment is between 2.4 and *3.82*%. Based on our present knowledge, the number of spent nuclear fuel assemblies that will have been generated by the end of the life-time of the nuclear power plant (2017) and may remain in Hungary will be about 11 000, with approximately 1286 t heavy metal content. Previously, between 1989 and 1998, altogether 2331 spent fuel assemblies with 273 t heavy metal content were shipped back to the Soviet Union (later to Russia).

The nuclear power plant is gradually increasing the burn-up level of the fuel and, accordingly, is decreasing the anticipated quantity of the spent nuclear fuel assemblies that will be generated during the planned life-time of the plant.

On 31 December 2007, 2034 and 5107 fuel assemblies were stored in the spent fuel (cooling) ponds of the nuclear power plant and in the Interim Spent Fuel Storage Facility, respectively.

At the end of 2007, the total capacity of the Interim Spent Fuel Storage Facility was 7200 assemblies in 16 vaults. By future extensions, the capacity of the storage facility can be increased to accommodate 33 vaults.

Besides the above mentioned inventory, 68 storage canisters containing damaged fuel elements are being stored in the cooling pond of Unit 2 of the nuclear power plant . These are the residues of those 30 fuel assemblies that were damaged during the cleaning process in April 2003. This method of storage is to be used until a solution suitable for the final disposal is found. Neutron- and gamma-spectroscopy methods were developed and measurements have started for quantitative and qualitative determination of the fission content of the residues.

At present, investigations and discussions are in progress on extending the planned 30-year life-time of the nuclear power plant by about 20 years and Paks Nuclear Power Plant has already submitted the corresponding Preliminary Environmental Study to the competent authority. The life-time extension will have an effect on both the amount and the management of radioactive waste and spent fuel. The present Report does not take into consideration the consequences of the life-time extension as no *regulatory* decision has yet been taken on this issue. *(See Section E.1.)*

D.1.2 Inventory and rate of generation of the spent fuel of non-nuclear power plant origin

The Budapest Research Reactor operates with 230 fuel assemblies of VVR-M2 and VVR-SM types (with an enrichment of 36*%). These assemblies are used partly grouped by threes and partly individually. In total, 1653 fuel assemblies are stored on the site with 150 kg heavy metal content. The reactor is scheduled to operate until 2023; thus, from the end of 2007 to the end of its operational life, a further 1100 VVR-M2 "single" spent assemblies (approximately equivalent to 110 kg heavy metal content) should be taken into account. From previous operations there are also 82 spent fuel assemblies of EK-10 type (with an enrichment of 10%) in the facility with a heavy metal content of about 100 kg.*

There are 24 - partly modified - assemblies of EK-10 type (with an enrichment of 10%) operating in the training reactor of the Budapest University of Technology and Economics, and no spent fuel is stored on site. There is fresh fuel on the site: 28 EK-10 type assemblies and 37 separate fuel rods. From the technological viewpoint, it is conceivable that during the reactor operation lasting up to 2027 the core might be refuelled once, thus the total amount of spent fuel may be maximum 48 assemblies, containing 59 kg heavy metal.

D.2 Radioactive Waste

In Hungary there is only one facility on the list of radioactive waste management facilities, this being the Radioactive Waste Treatment and Disposal Facility. The main characteristics of this facility are described in Section B, its safety in Section H, further details are contained in Annex 2.

D.2.1 Classification of radioactive waste

The relevant decree [III.16] of the minister responsible for health regulates the classification of radioactive wastes. That type of radioactive waste is qualified as low and intermediate level radioactive waste in which the heat production during the disposal (and storage) could be neglected. Further,

a) that low- and intermediate level radioactive waste is short-lived, in which the half-life of the radionuclides is 30 years or less, and it contains long-lived alpha emitter radionuclides only in limited concentration;
b) that low- and intermediate level radioactive waste is long-lived, in which the half-life of the radionuclides and/or the concentration of the alpha emitter radionuclides exceed the limits concerning short-lived radioactive waste.

That type of radioactive waste is high-level waste whose heat production shall be considered during the design and operation of storage and disposal.

Within the above classification the authority can prescribe more detailed classification for the low, intermediate and high level radioactive wastes.

Classification viewpoints for low and intermediate level radioactive wastes:

1. The classification of the radioactive waste into low and intermediate level classes shall be performed based on the activity-concentration and exemption activity-concentration (EAC) of the given radioisotope (Table D. 2.1-1).

Table D. 2.1-1 Classification of radioactive waste for one radioisotope

Radioactive waste class	Activity concentration (Bq/g)
Low level	1 EAC – 10^3 EAC
Intermediate level	> 10^3 EAC

2. If the radioactive waste contains more types radioisotopes, then the classification shall be performed accordingly as follows (Table D.2.1-2):

Table D.2.1-2 Classification of radioactive waste for more than one radioisotope

Radioactive waste class	Activity concentration ratio
Low level	$\sum_i \frac{AC_i}{EAC_i} \leq 10^3$
Intermediate level	$\sum_i \frac{AC_i}{EAC_i} > 10^3$

where AC_i is the activity-concentration of the i^{th} radioisotope existing in the radioactive waste, and the EAC_i is the exemption activity-concentration of the i^{th} radioisotope.

The regulations on exemption and clearance of radioactive materials also apply to radioactive waste. Exemption levels are regulated by a ministerial decree [III.7] in accordance with the regulations of the European Union. The procedure of clearance from regulatory control is regulated by another ministerial decree [III.10]. According to this latter decree, substances containing radionuclides can be released from regulatory control if the projected annual individual dose originating from its re-use, or its re-utilisation or handling as non-radioactive waste does not exceed 30 μSv effective dose, and analysis proves that clearance is the optimum solution.

D.2.2 Inventory and rate of generation of HLW from the nuclear power plant

In Hungary, high level waste is generated basically in Paks Nuclear Power Plant, in relatively small quantities. *It is stored in the reactor hall, in 1114 storage tubes (pits) designed for this purpose. At the end of 2007, approximately 84 m^3 of the total 222.8 m^3 storage capacity had been used.*

The rate of generation of high level radioactive waste is 3-5 m^3/year; thus the total volume expected to be generated till the end of the planned design life-time (30 years) of the nuclear power plant can be stored in the existing storage space.

Taking into account the small amount of high level radioactive wastes generated, the issue of final disposal will have to be solved (also in accordance with the technical design of the plant) only during the decommissioning phase.

D.2.3 Inventory and rate of generation of LLW/ILW of non-nuclear power plant origin (institutional radioactive waste)

The small-scale, non-fuel-cycle producers such as hospitals, laboratories and industrial companies generate about 10-20 m^3 low and intermediate level waste and 1000-3000 disused radiation sources per year. To date, 3081 shipments were carried out from 550 different consignors. By the end of 2007, the low and intermediate level waste generated by the non-fuel-cycle producers occupied 2570 m^3 repository volume. Between 1983 and 1996 the nuclear power plant shipped 1580 m^3 low level solid waste to the facility, occupying about 2500 m^3 of the repository. The overall volume occupied by the waste is 5040 m^3. The repository has become full.

At the end of 2007 the total activity of the radioactive wastes in the repository was 680 TBq based on the available data.

Most radioactive wastes, including spent sealed sources, are generated in medical, industrial and research applications. The two most widely used radionuclides with significant inventories are ^{60}Co and ^{192}Ir, used in medical and industrial radiography. The isotope composition of the waste disposed of in the Radioactive Waste Treatment and Disposal Facility is described in Annex 3.

D.2.4 Inventory and rate of generation of LLW/ILW from the nuclear power plant

The main radioactive waste producer in Hungary is Paks Nuclear Power Plant. During the operation of the nuclear power plant, a certain fraction of the radionuclides that are produced by nuclear reactions in the reactor is taken up in the coolant. Some of these radionuclides, such as tritium and the noble gases, are released to the environment. Aerosols and volatile components, such as iodine, are effectively contained in filters while contaminants in water are contained by ion-exchange resins. Some LLW is produced from routine maintenance (overalls, gloves, etc.). The waste streams generated include solid and liquid wastes, spent ion-exchange resins, and contaminated oils. The small amount of radioactive waste generated in the Interim Spent Fuel Storage Facility is treated together with the waste of the nuclear power plant.

Gaseous wastes:

The discharging of gaseous radio-isotopes (tritium, radioactive noble gases, etc.) always takes place within the discharge limits, and under constant control. (See Annex 8.)

Liquid radioactive wastes:

Chemical waste waters containing radioactive isotopes are generated from various sources within the controlled zone of the power plant. These water solutions with low (3-5 g/dm^3) solid content contain all the dissolved chemicals that are used for maintaining the water regime of the primary coolant, reconditioning of the water purifiers, fine adjustment of the reactor power and decontamination purposes. After chemical treatment, the collected waste waters are evaporated to produce a concentrate containing about 200 g/dm^3 boric acid. *The total volume of evaporation wastes produced up to 31 December 2007 was 5346 m^3, of which*

255 m^3 was generated in 2007. During the period from the incident at Unit 2 in April 2003 to December 2007, 975 m^3 of evaporator bottom containing alpha radiants was produced, which is stored in special tanks separately from the other concentrates.

A special tank was provided for the storage of evaporator acid solution. A quantity of approximately 10 m^3 evaporator acid solution was generated in 2007. Thus, as at 31 December 2007, this tank contained a total volume of 260 m^3 evaporator acid solution. Bearing in mind the present 15 m^3/year generation rate for the evaporator acid solution the total volume till the end of the planned 30 year life-time will be 365 m^3.

After appropriate treatment, the ion exchange resins (low, middle and high level) are stored together in two tanks. *The total quantity of resins used up to 31 December 2007 was 150 m^3; 14 m^3 of this during the year 2007.* At present, there is no necessity for immediate processing of the ion exchange resins. *Bearing in mind the present 5 m^3/year generation rate for ion exchange resin, the total volume till the end of the planned 30 year life-time will be 335 m^3.*

With a future modification of the storage tanks for spent ion exchange resins the resulting storage capacity of 870 m^3 is expected to be sufficient not only till the end of the design life-time but also for the planned extended life-time of the power plant.

The decontamination solutions that arose during the elimination of the consequences originating from the serious incident at Unit 2 were collected in a separate tank. During the restoration activities a total of 220 m^3 decontamination solution was produced.

By the end of the planned life-time the total waste volume produced after liquid waste conditioning is estimated as 18 000 m^3. The waste volume to be disposed of will be significantly reduced if the liquid waste treatment system is put into operation. This is expected in 2009. In this case the disposal of only 7300 m^3 conditioned waste needs to be solved.

<u>Solid radioactive wastes:</u>

In accordance with the present practice, solid radioactive wastes are processed as follows:

- The compactable and non-compactable radioactive wastes are separated as early as during the collection in a way that non-compactable wastes are very rarely loaded into plastic bags. Worn mechanical parts, structural components, insulation materials, and contaminated tools, etc. which - due to their weight and dimensions - cannot be loaded into plastic bags, are put into drums. *The use of sorting equipment operating on the basis of surface dose rate measurements was terminated in July 2005, when a new isotope selective waste release method was introduced.*

- To reduce the volume of compactable radioactive waste, a 500 kN press is used, achieving an average reduction factor 5. In accordance with the experience gained so far, some 80-85% of the total solid radioactive wastes can be compacted.

- The active sludge removed from the primary waste water collectors, chemical treatment decanters, or interim storage facilities, was *solidified* with the addition of diatomaceous earth in a ratio of 1:1. (The ratio depends on the liquid content of the sludge.) *From March 2007, the solidification is performed by settling and then removing the liquid content with an industrial suction cleaner rather than by soaking with diatomaceous earth.*

Solid waste, including aerosol filters and solidified sludge, is loaded into special 200 l metal drums (internally coated with plastic). Some half of the waste is plastic, but it also includes textile, heat insulation material, wood, metal, rubber, glass and paper.

As of 31 December 2007, 8333 drums loaded with low and intermediate level solid radioactive wastes were stored in the interim stores. Bearing in mind the present rate of waste generation, the annual quantity will be some 850 drums of 200 l capacity. Taking into account the estimation for the annual quantity of waste for the presently considered 30-year design life-time, the total volume of solid wastes to be disposed of will be some 2900 m^3.

D.2.5 Waste from the decommissioning of Paks Nuclear Power Plant

The decommissioning of nuclear facilities will produce a large volume of radioactive waste only in the case of Paks Nuclear Power Plant.

It is planned that only relatively small amounts of waste be produced by the early stages of decommissioning, e.g. from the removal of fuel and the flushing out of the reactor coolant circuits. With regard to the waste generated by the dismantling of the reactor, in accordance with the general practice a storage phase is foreseen. This period may last several decades to allow for short lived radionuclides to decay significantly. Even so, much larger volumes of low and intermediate level waste will be produced from the decommissioning than from the operation of the plant. According to calculations, the total decommissioning LLW/ILW as conditioned will amount to some 17 900 m^3. The volume of HLW is estimated to be approximately 410 m^3.

SECTION E. LEGISLATIVE AND REGULATORY SYSTEM

E.1 Legislative and regulatory framework

The Hungarian Parliament approved the Act on Atomic Energy [I.6] in December 1996, it entered into force on 1 June 1997. The codes and guides of the International Atomic Energy Agency provided a basis for the establishment of the Act, and recommendations of the European Union and the OECD Nuclear Energy Agency were also considered.

The main characteristics of the Act on Atomic Energy [I.6] are that it:

- declares the priority of safety;
- *declares that the control and supervision of the safe use of nuclear energy are Government tasks; the Government fulfils its tasks through the Hungarian Atomic Energy Authority, and the responsible ministers;*
- *defines the regulatory competences of the Hungarian Atomic Energy Authority and of the minister responsible for health in the licensing procedures;*
- *defines and allocates the competences and tasks of other bodies of the public administration involved in the application of atomic energy;*
- declares the organisational and financial independence of the licensing and supervising authorities;
- outlines the general framework for the utilisation of human resources, education, research and development;
- defines the responsibility of the licensee for all nuclear damage, and fixes the sum of liability in accordance with the revised Vienna Convention;
- *entitles the Hungarian Atomic Energy Authority to impose a fine on a licensee for infringing a legal regulation or a safety code, or failing to comply with an obligatory standard or with the provisions set forth in an individual regulatory licence issued based on the above;*
- requires that the Government appoints - as it is in the national interest - an organisation responsible for the final disposal of radioactive waste, for the interim storage and final disposal of spent fuel, and for the decommissioning of nuclear installations;
- prescribes the establishment of a Central Nuclear Financial Fund intended solely for financing the final disposal of radioactive waste, the interim storage and final disposal of spent fuel elements, and for the decommissioning of nuclear installations.

There are two more or less specific issues in Hungary defined by the Act on Atomic Energy [I.6]:

- One of them is the definition of nuclear facilities. The definition in the Act is based on that applied in the safeguards agreement between Hungary and the International Atomic Energy Agency. It states that only those facilities are classified as nuclear facilities in which the amount of nuclear material used in the facility is above a certain limit. This means that radioactive waste management facilities (e.g. repositories) are not considered as nuclear facilities.

- The other specific issue is that the Act establishes a so-called divided authority and regulatory system. From the viewpoint of the Convention's aims it means that the principal licensing and supervising authority for spent fuel management is the Hungarian Atomic Energy Authority; *with regard to radioactive waste management it is an organisation appointed by the minister responsible for health* (at present, it is the National Public Health and Medical Officer Service).

As far as radiation protection is concerned, the Act on Atomic Energy [I.6] allocates regulatory tasks to several ministries. *The basic regulation of radiation protection belongs to the minister responsible for health. The technical side of radiation protection in nuclear facilities and spent fuel management belongs under the regulatory authority of the Hungarian Atomic Energy Authority. Protection of the environment - including the general regulation of releases - belongs to the minister responsible/for environmental protection. The Operation Limits and Conditions, approved by the Hungarian Atomic Energy Authority, include the derived limits of radioactive releases from the operation of Paks NPP. Tasks related to the radioactivity of the soil and flora belong to the scope of the minister responsible for agriculture.*

According to the Act on Atomic Energy [I.6] users of atomic energy shall ensure that the generation of radioactive waste through their activity is held to the lowest possible level. In the application of atomic energy, provisions shall be made for the safe storage or disposal of radioactive waste and spent fuel in accordance with the most recent, certified results of science, international expectations, as well as experience, in such a way that no unacceptable burden is passed on to future generations.

Considerations of environment protection issues concerning spent fuel and radioactive waste management are given in Act on Environmental Protection [I.5]. This Act applies to projects that may have significant environmental impacts. Construction of a new, spent fuel storage or a radioactive waste repository always requires an environmental licensing procedure based on an environmental impact assessment. The Act also calls for hearings of citizens in local and neighbouring municipalities and of other interested groups. *These issues are within the competence of the minister responsible for environmental protection.*

Hungary is also committed to the international agreements concerning environmental impact assessment. As a member of the European Union, Hungary also complies with the relevant Council Directive.

Life-time extension of the Paks NPP

Extension of the life-time of the Paks NPP by 20 more years is a subject of very serious discussion in Hungary. According to Hungarian legislation, in order to operate the units of a nuclear power plant beyond the original design life-time a new environmental and a new operational licence are necessary, to be acquired in an environmental protection procedure and in a nuclear safety procedure, respectively.

In the framework of the environmental licensing process a new environmental licence was issued by the environmental authority after public hearings and an appeal. In accordance with the government decree on nuclear safety regulatory activities [II.27] Paks NPP is required to submit a programme for establishing the conditions and demonstrating the operability of the units beyond the designed life-time in 2008 (at the latest four years prior to *the end of the designed life-time). The Hungarian Atomic Energy Authority is due to supervise the programme and its implementation. The licensee will be required to submit a licence application for operation beyond the designed life-time to the Authority one year before the end of the designed life-time at the latest (in the case of Unit 1, not later than 2011). This report does not take into consideration the effects of the life-time extension (see chapter D.1.1).*

E.1.1 Spent fuel management

The licensing and supervision activities of the spent fuel storage facilities had been carried out earlier in accordance with principles similar to those valid for nuclear power plants. Later, once the sixth annex of the governmental decree [II.27] of 2005 had entered into force, the nuclear safety code for spent fuel interim storage facilities was issued. This covers all of the safety aspects of dry spent fuel storage facilities. The application of the safety codes is supported by guidelines: eighteen guidelines are related to the spent fuel storage facilities with dry storage; a further three guidelines are being elaborated.

E.1.2 Radioactive waste management

The Act on Atomic Energy [I.6] authorises the minister responsible for health to determine in a decree the dose limits for employees engaged in the field of atomic energy applications and the limits of the population's radiation dose. *In this respect, the executive order of the Act on Atomic Energy [I.6] is the decree of the minister responsible for health [III.10]*. The decree requires that regulatory rules must be applied to all activities involving the use of atomic energy and ionising radiation, i.e. both for spent fuel management and radioactive waste management. The dose limits in the decree are in accordance with the values laid down in the IAEA's Basic Safety Standards and in the 96/29/Euratom Directive.

The radiation protection requirements of the final disposal of radioactive waste are also set down in a decree [III.16] *of the minister responsible for health.* This decree stipulates the following:

- Final disposal of radioactive waste can be licensed in a manner and on a site only if the disposal does not impose an unacceptable risk to society and does not harm human life, the health of present and future generations, the human environment, and goods.
- Members of the public living in the closest neighbourhood of the facility should not be exposed to a yearly effective dose above 100 μSv, and in the case of individual events involving damage to or destruction of the disposal system, the collective risk shall not exceed the value of 10^{-5} event/year.
- When designing a disposal facility, a design basis shall be set up, and the components of the planned disposal system shall be ranked in design safety classes.
- Disposal technology shall be designed in such way that the waste could be retrieved in the operational phase.
- Depending on the given operation stage a full-scale or partial safety report shall be prepared for the disposal system.
- Waste acceptance criteria shall be set up for the disposal facility.

- Commissioning licenses for final disposal are grantable for 10 years, and for interim storage for 5 years, but these licences could be extended on the basis of a periodic safety review.
- In the post-closure period the operator is required to provide supervision of the facility for the monitoring of radiation in the environment and the prevention of the intrusion of persons and animals for at least 50 years, and after that date for as long as the authority requires it.

Regarding the geological aspects in radioactive waste management, a ministerial decree [III.4] prescribes the methodology and geological requirements of site selection and characterisation, the essential elements of quality assurance and control, the general geological and mining requirements, as well as details of the licensing procedure. Annex 1 of this decree – with the title: General Research Aspects for Geological Site Suitability of Nuclear Facilities and Radioactive Waste Disposal Facilities – contains a table of facilities in relation to geological aspects with the proposed rankings for evaluating the geological characteristics. Three other annexes prescribe the special geological requirements.

E.2 Regulatory body

E.2.1 The Hungarian Atomic Energy Authority

According to the Act on Atomic Energy [I.6], the relevant authority regarding nuclear facilities and thus regarding, among others, the spent fuel management facilities is the Hungarian Atomic Energy Authority (see governmental decree [II.22]).

The Hungarian Atomic Energy Authority is a *government office*, dealing with the peaceful use of nuclear energy under the supervision of the Government. It is independent both organisationally and financially from all organisations interested in promoting the application of atomic energy.

Its scope of competence comprises, among others, nuclear safety supervision (licensing, inspection and assessment) of nuclear installations in each phase of their lifecycle, involving systems and structures/components important to safety.

In 2002 a quality management system based on international standard ISO 9001:2000 was introduced. After the IAEA mission following the serious incident in the Unit 2 of Paks NPP in April 2003 the structure of the HAEA was modified in the autumn of 2004. The present structure is illustrated in the organisational chart (Fig. E.2.1-1).

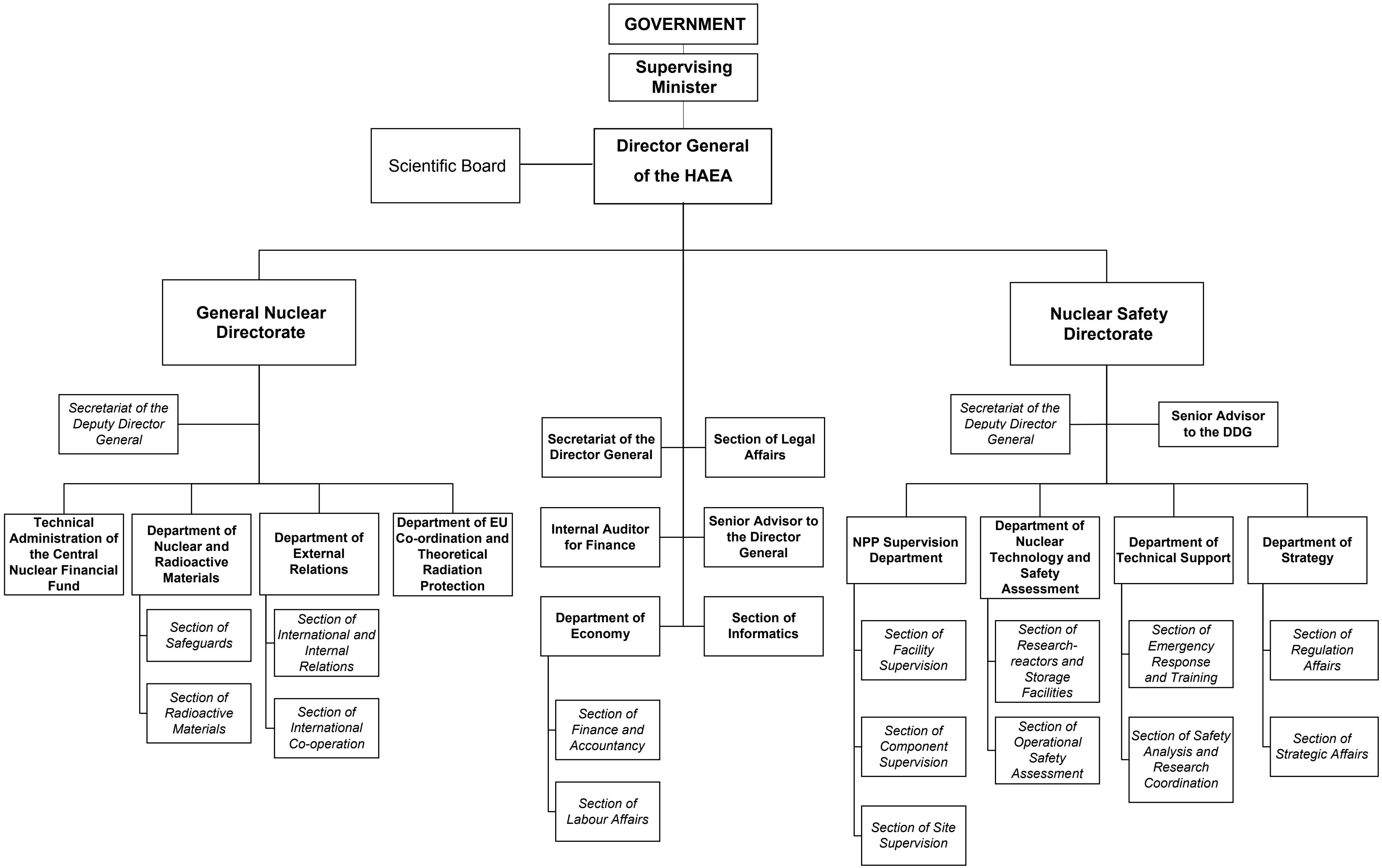

Fig. E.2.1-1 Organisational structure of the Hungarian Atomic Energy Authority

Regulations allow the involvement of professional experts (both institutions and individuals) in all cases when the Authority itself does not possess the necessary expertise.

In order to provide an appropriate scientific background for its activities, the Authority has concluded agreements with several scientific institutions. Such an agreement seals its co-operation with the KFKI Atomic Energy Research Institute, the Institute of Nuclear Techniques at the Budapest University of Technology and Economics, the Department of Physical Chemistry at Veszprém University, the Electrical Power Research Institute Ltd., and the Institute of Isotopes of the Hungarian Academy of Sciences.

In accordance with the Act on Atomic Energy [I.6], the work of the Authority is also supported by a Scientific Council that is composed of members of national reputation. The Council's main function is to deal with major issues of principles as well as to consider those areas of research and development that are related to nuclear safety and the prevention of nuclear accidents.

E.2.2 The National Public Health and Medical Officer Service

With regard to issues concerning radiation protection (radiation protection of employees and of the public, performance of tasks related to public health and radiation health matters) the related tasks are dealt with by regionally competent institutes (regional radiological centres, RC) of the National Public Health and Medical Officer Service *according to the relevant governmental decree [II.30]*. This applies to spent fuel management facilities as well.

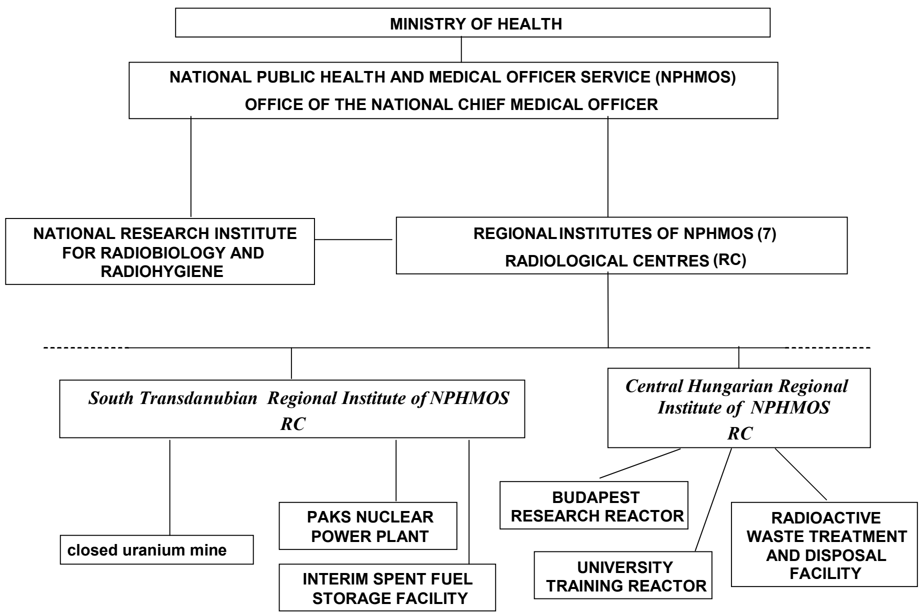

Figure E.2.2-1 Structure of the radiological health authority and the main supervisory authorities in Hungary

The national-level body, the Office of the National Chief Medical Officer, is the licensing authority for radiation protection regulation, the health physics service section of the facilities, and it also participates in the nuclear safety licensing procedures as a special authority on radiation protection questions having the right of consent. An institute of the National Public Health and Medical Officer Service, the National Research Institute for Radiobiology and Radiohygiene, maintains the personal dosimetry services (evaluation of the compulsory authority personal dosimeters and operation of the national personal dosimetry register).

The South Transdanubian Regional Institute of the National Public Health and Medical Officer Service (regional radiological centre) is empowered to supervise (including inspections) the adherence to radiation protection rules and prescriptions in spent fuel management activities.

E.3 Licensing procedure

E.3.1 Spent Fuel Management

The basic principles of the licensing procedure for spent fuel management facilities are analogous to those of all other nuclear facilities.

In concordance with the regulations in force, a nuclear safety licence should be obtained from the authorities for all periods during the lifecycle of an *interim* spent fuel storage facility (*siting*, construction, commissioning, operation; *within and beyond the planned life-time*, respectively), decommissioning (final shutdown and dismantling). Moreover, separate licences must be obtained for all changes of construction to a given facility or *modifications* to its components/constructions should they belong to safety classes. *In addition to this, the Authority grants building and occupancy licences for buildings and structures.*

Within the licensing procedures, the specific aspects are dealt with by the special authorities designated by law (see also E.3.2). The Hungarian Atomic Energy Authority has to take into consideration the additional requirements *(stipulations and conditions)* of these specialised authorities. Before applying for a construction or decommissioning licence an environmental protection licence is a prerequisite.

Licences are valid for a given period of time, and may be extended upon request *of the licensee* if all requirements are met.

Any nuclear installation that operates without a licence, or operates contrary to a valid licence falls under the Penal Code [I.2]; among the consequences for an operator of an installation found guilty in these respects is a severe sentence of imprisonment.

E.3.2 Radioactive Waste Management

The Minister of Health, through the National Public Health and Medical Officer Service, with expert advice and technical assistance provided by the National Research Institute for Radiobiology and Radiohygiene performs the licensing procedures.

In the licensing procedure all the other relevant public administration organisations participate as so-called special authorities. These special authorities designated in the decree of the Minister responsible for health [III.16] have jurisdiction in the following cases:

- the regionally competent Inspectorate for Environment, Nature and Water enforces aspects relating to environment protection, nature conservation, protection of water quality, water utilisation and protection of water bases;

- the building authority competent for the area enforces aspects relating to regional planning and building;
- the Hungarian Atomic Energy Authority enforces aspects relating to general nuclear safety;
- the Minister of Defence enforces aspects relating to national defence;
- *the Foodchain-Safety and Animal Health Directorate and the Plant Protection and Soil Conservation Directorate of the competent County/Capital Agricultural Office enforce aspects relating to animal hygiene, food protection as well as plant hygiene and soil protection;*
- *the competent Regional Directorate of the National Transport Authority enforces aspects relating to traffic and transport;*
- the Hungarian Police Headquarters Department of Administration enforces aspects relating to public security and police administration;
- the competent County Directorate for Emergency Management and the Capital Directorate for Civil Defence as well as the Capital Headquarters of the Fire Service enforce aspects relating to civil defence and fire protection;
- *the Hungarian Office for Mining and Geology enforces aspects relating to mining technology, mining safety and geology.*

E.4 Inspection

The Act on Atomic Energy [I.6] 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 applications of nuclear energy.

The authority is entitled to perform inspections both with advance notice, or without notice should the latter be considered justified. Inspections may also be performed by associated external 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 or giving their separate licenses may also carry out separate official inspections.

In order to ensure the controlled deployment of atomic energy and to evaluate the activity of the licensee, the authorities operate a reporting system. Reports prepared for the authorities are detailed so as to enable independent review, evaluation and assessment of operating activities, and any noteworthy events that may have taken place.

The investigation and assessment of any events affecting safety that have occurred during operation and the identification of the causes and the taking of corrective actions and measures in order to prevent their repeated occurrence is primarily the task of the licensee.

The Hungarian Atomic Energy Authority evaluates annually the safety performance of all licensees based on the results of a Safety Performance Indicator System. The aim of this evaluation is the regulatory assessment of the activities and safety performance of a licensee, and thus monitoring and assessing the safety indicators of the operation as well as identifying probable safety gaps in a timely manner.

The periodic reassessment of the nuclear safety of nuclear facilities is performed every ten years on the basis of a comprehensive, predefined programme (taking into consideration the present international practice). This is the Periodic Safety Review process required by the various legal provisions. Decisions on the further validity of the operation license, and – *if necessary* – on the possible prescription of further safety enhancement measures as a precondition of that are taken within the framework of this programme by the Authority.

In the field of radioactive waste management, the competent institutes (regional radiological centres) of the National Public Health and Medical Officer Service carry out regular inspection and surveillance of licensees. Furthermore, they check the licensed modifications and any extraordinary events. The objectives of inspection and surveillance are to:

- check compliance with radiation safety;
- check compliance with the prescribed conditions;
- perform in situ radiation surveys;
- take samples for laboratory measurements;
- make a protocol or take a decision in the case of any abnormal situation.

From the legal viewpoint, the radioactive waste disposal facility is regarded as a special institution, and it is required to undergo a full-scale annual inspection by the competent authority. In practice, the competent authority *(Central Hungarian Regional Institute of the National Public Health and Medical Officer Service: regional radiological centre),* with expert advice and technical assistance provided by the National Research Institute for Radiobiology and Radio hygiene inspects the Radioactive Waste Treatment and Disposal Facility at Püspökszilágy twice a year. During this inspection the authority supervises the site and carries out environmental sampling in the vicinity. *The results of the environment monitoring are published also in the annual reports of the National Environmental Radiation Protection Monitoring System (OKSER) set up by governmental decree [II.21]. (These annual reports are accessible on the internet: http://www.okser.hu.)*

E.5 Enforcement of the regulatory requirements

The conditions for enforcing legal mandates of the authorities are included in the Act on the general rules of regulatory procedures and services in the public administration [I.12], in the Penal Code [I.2], and in governmental decrees [II.22] and [II.27].

In order to enforce the requirements of the regulations the authority is entitled to initiate an administrative procedure and, within the framework of this, may - if the situation arises - oblige the licensee to eliminate any deviations from the regulations that may be detected.

The authority can oblige the licensee to pay a fine if there is an infringement of any requirement of law, safety regulations or if the licensee fails to meet the stipulations of any decision/resolution *being in force*. In cases falling under the Penal Code [I.2] the authority has a reporting obligation.

With regard to spent fuel management, the discharging of legal authority is facilitated by the enforcement policy of the Hungarian Atomic Energy Authority introduced in 2001. *The enforcement policy summarises the objectives and expectations along with the legal resources.*

SECTION F. OTHER GENERAL SAFETY PROVISIONS

F.1 Responsibility of the licence holder

In general, the Act on Atomic Energy [I.6] and its executive orders make the licensee responsible for the safe use of atomic energy and the fulfilment of safety related requirements. In the context of the Convention it means that prime responsibility for the safety of spent fuel management and radioactive waste management rests with the holder of the relevant operational licences of spent fuel management facilities and radioactive waste management facilities, the PURAM.

PURAM is responsible for the following activities:

- elaboration of *its* medium- and long-term plans (strategies);
- e*laborating* cost estimates to identify the necessary payments into the Central Nuclear Financial Fund (see F.2.2.2) each year;
- preparation of technical and financial reports for the activities financed from the Fund;
- *preparation for the construction of facilities for the storage and disposal of radioactive wastes and their establishment;*
- construction (extension) and operation of the storage facility for interim storage of spent nuclear fuel, viz. the Interim Spent Fuel Storage Facility;
- completion of work required for decommissioning of nuclear installations;
- operation of the existing low- and intermediate level waste repository, i.e. the Radioactive Waste Treatment and Disposal Facility;
- *provision of information and maintaining public relations.*

The basic tasks of PURAM as a licensee are – *within its field of activities* – as follows:

- to establish the technical, technological, financial and human conditions for the safe operation of the facilities;
- to elaborate a safety policy which reflects implementation of the principle that safety prevails over all other considerations;
- to elaborate, introduce and maintain an appropriate management system;
- to prevent the occurrence of any supercritical nuclear chain reaction;
- to prevent the evolution of any unacceptable damage affecting employees, the public, the environment, material assets, caused by ionising radiation or any other factor;
- to keep the exposures of the personnel and the public as low as reasonably achievable (taking into account the social and economic factors);
- to take into account, from the aspect of safety, the limits of human performance;
- to establish and operate a radiation protection (health physics) service which plans and controls all actions and measurements necessary to adhere to the basic principles of radiation protection;
- to maintain (regulatory and/or its own) dosimetry control;

- to derive the estimated annual discharge limits from the dose constraint specified by the *radiohygiene authority* and to submit them for approval to the environmental protection authority and to *the nuclear safety authority;*
- to determine the planned (airborne and liquid) discharges for normal operation;
- to ensure compliance with the annual discharge limits;
- to monitor/control continuously radiation levels and concentrations of the radionuclides in the environment and provide the local public with relevant information;
- to maintain an appropriate organisation which is capable of accomplishing in due time each and every prescribed periodic and event reporting obligation (including categorisation of all events according to the International Nuclear Event Scale (INES));
- to ensure that the qualifications, professional education, and health of the employees are in line with the prescribed requirements;
- to carry out continuous activities in order to maintain the highest possible level of safety including evaluation of all relevant operation experience, and to finance the costs of related research and development activities;
- to regularly revise and upgrade the licensee's own management system in order to fulfil the safety-related requirements;
- to qualify subcontractors and suppliers for the task, taking into account that their *quality management system* prescribed by law is a prerequisite;
- to maintain an emergency preparedness organisation, to have ready emergency plans as required to handle all possible emergency situations on-site, and to co-operate with the local, regional and national level emergency forces;
- to ensure the physical protection of the site by armed guards, and to prevent unauthorised persons from access to nuclear materials and equipment;
- to ensure the financial coverage of indemnity (insurance);
- to maintain the necessary records prescribed for the inventories of nuclear and radioactive materials, and the operational data necessary for the evaluation of safety and the planning of decommissioning;
- to participate in the fulfilment of obligations of the Republic of Hungary arising from international treaties, conventions, and multilateral and bilateral agreements.

As a means of regulating responsibilities and measures for all orphan or confiscated radioactive/nuclear materials (spent fuel and radioactive wastes included) a governmental decree [II.9] is in force.

The licensee should, according to the governmental decree [II.15] on the National Nuclear Emergency Response System

- fulfil tasks related to consequences of events occurring during transportation of nuclear and radioactive materials and of violent intrusions;
- fulfil obligations to supply data necessary to alarm, notify and inform the public whenever the discharge limits are or may be exceeded and assure the conditions thereof;
- supply data on the activity and composition of airborne and liquid discharges in the case of a severe, rapidly developing event; estimate the consequences and give advice for the introduction of countermeasures.

F.2 Human and Financial Resources

F.2.1 Human and financial resources of the authorities

F.2.1.1 The Hungarian Atomic Energy Authority

The number of employees of the authority for spent fuel management, the Hungarian Atomic Energy Authority, *decreased to 80 people* of whom more than 2/3 hold a higher education degree (university or college), most of them have two degrees (the second degree usually being in the area of nuclear techniques). In addition, many of the staff have scientific degrees, and most of them are fluent in one or more foreign languages.

A systematic education plan has been prepared by the Authority for training their inspectors. The plan is based on individual training profiles and consists of three basic training types: introductory training, re-training, and advanced courses. The accident prevention preparatory programme is an independent and permanent part of the education plan.

In order to ensure stable working conditions for the Hungarian Atomic Energy Authority, the Act on Atomic Energy [I.6] provides two financial sources:

- a specific sum should be provided annually from the state budget to cover:
  - the costs of R&D activities necessary for supporting the regulatory work of the Authority,
  - the costs necessary for activities of the Authority related to the prevention and handling of nuclear accidents,
  - the costs of the Authority covering its international obligations;
- the licensees of nuclear installations are obliged to pay a supervision fee to the Authority in the way and to the extent defined in the Act on Atomic Energy [I.6], and prescribed also in the Act on the annual central budget.

The Hungarian Atomic Energy Authority performs its regulatory activities impartially, independently of the nuclear installations, and its funding is sufficient to carry out its duties efficiently.

F.2.1.2 The National Public Health and Medical Officer Service

In Hungary, the licensing of radioactive waste management belongs to the National Public Health and Medical Officer Service.

The National Public Health and Medical Officer Service, as the competent authority, is independent from the sphere of the licensees. In 7 regional radiological centres some *60* well-qualified experts are employed in the field of radiation protection. Each centre is supplied by appropriate radiation measurement instruments and well-equipped laboratories. In special cases, the tasks for the authority undertaken by the regional radiological centres of the National Public Health and Medical Officer Service are supported by the National Research Institute for Radiobiology and Radio hygiene (with about *80* highly qualified employees). The National Radiation Hygiene Preparedness Service with its appropriately equipped vehicle provides a 24-hour service every day.

The National Public Health and Medical Officer Service is a central public administration office financed from the state budget.

F.2.2 Human and financial resources of the licensee

F.2.2.1 Human resources

The Act on Atomic Energy [I.6] states that the performance of tasks related to the final disposal of radioactive waste, as well as to the interim storage and final disposal of spent fuel, and to the decommissioning of a nuclear facility is of national interest, therefore it shall be the responsibility of an organisation designated by the Government. In view of this, the Government commissioned with a decree [II.14] the Director General of the Hungarian Atomic Energy Authority with the task of establishing this organisation (See Section B). The financial resources for the operation of this organisation, PURAM, are provided from the Central Nuclear Financial Fund (see F.2.2.2) established in accordance with the Act on Atomic Energy [I.6]. The status and operational conditions of PURAM as a public utility are defined by the Act on business organisations [I.13] and the Act on non-profit organisations [I.8].

The organisational scheme of PURAM is shown in Figure F.2.2.1-1.

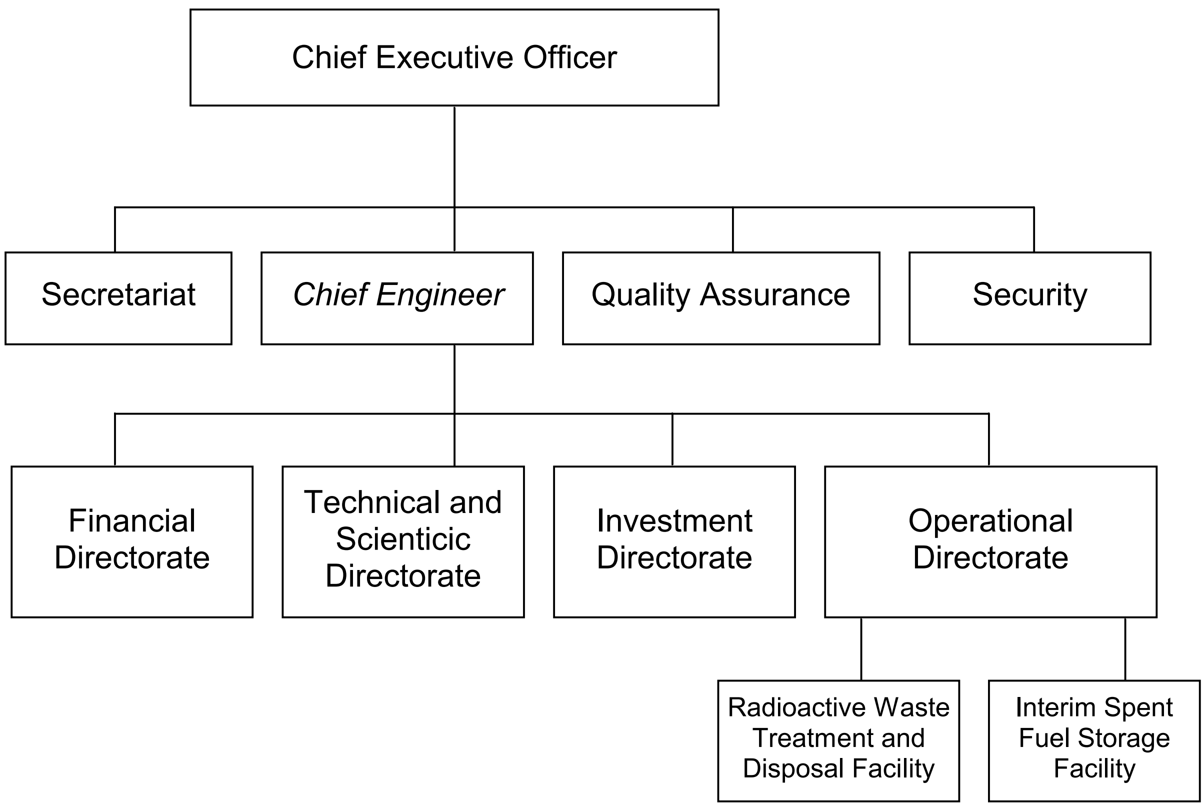

Figure F.2.2.1-1 Organizational scheme of PURAM

The central offices of PURAM are in Budaörs, close to Budapest. The management and administrative activities within each directorate are performed at Paks, on the site of the Interim Spent Fuel Storage Facility. The Radioactive Waste Treatment and Disposal Facility is situated in Püspökszilágy. Altogether *160* people work at these three sites, *including 78 security guards.* This number of staff does not include those responsible for the Interim Spent Fuel Storage Facility's operation and maintenance, which functions are performed on a contractual basis by the personnel of Paks Nuclear Power Plant.

In accordance with the legal regulations, the professional and health physics qualification requirements of the employees of PURAM are the same as for the employees of Paks Nuclear Power Plant.

F.2.2.2 Financial resources

The Minister supervising the Hungarian Atomic Energy Authority disposes of the Central Nuclear Financial Fund, while the Hungarian Atomic Energy Authority is responsible for its management. The Fund is a separate state fund pursuant to the Act on public finance [I.4], exclusively earmarked for financing the construction and operation of disposal facilities for the final disposal of radioactive waste, as well as for the interim storage and final disposal of spent fuel, and the decommissioning of nuclear facilities.

A long-term plan (lasting up to the decommissioning of the various nuclear facilities), a medium-term plan (for five years), and an annual work schedule on the use of the Fund are being prepared by PURAM. The long- and medium-term plans are to be reviewed annually and revised as required.

The long- and medium-term plans and the annual work schedule are to be approved by the minister supervising the Hungarian Atomic Energy Authority.

The payments into the Fund are defined in accordance with these plans. The annual payments into the Fund by Paks Nuclear Power Plant are proposed by the minister supervising the Hungarian Atomic Energy Authority, in the course of the preparation of the Act on the Central Budget of the next year. Payments are based upon submittals prepared by PURAM and approved by the Hungarian Atomic Energy Authority and by the Hungarian Energy Office. Payments by Paks Nuclear Power Plant are taken into account when the price of electric energy is being determined.

The institutes disposing radioactive waste in the Radioactive Waste Treatment and Disposal Facility are also liable to contribute to the Fund in accordance with the official price list contained in a ministerial decree.

For nuclear installations financed from the central budget (research reactor and training reactor), the sources required to cover payments into the Fund are provided by the central budget, when they arise.

The rate of payments into the Fund shall be specified in such a way as to provide appropriate sources for all costs of radioactive waste and spent fuel management and the decommissioning of nuclear facilities. These sources also provide coverage for public control and information activities as well as for the operational expenses of the existing repository.

In order to ensure that the Fund maintains its value, the Government contributes to the Fund with a sum that is calculated on the average assets of the Fund in the previous year using the average base interest rate of the central bank in the previous year. This practice was interrupted for 2001-2002, but it is now restored again as of 2003.

Table F.2.2.2-1 Financial data of the Fund between 1998 and 2007

M HUF

	Income	*Expenditure*	*Increase of assets*
1998	*7 777.4*	*3 941.1*	*3 836.3*
1999	*9 399.0*	*3 634.6*	*5 764.4*
2000	*10 449.0*	*2 094.1*	*8 354.9*
2001	*14 886.9*	*6 084.0*	*8 802.9*
2002	*17 205.8*	*11 239.4*	*5 966.4*
2003	*23 703.2*	*9 183.5*	*14 519.7*
2004	*27 577.0*	*9 705.9*	*17 871.1*
2005	*30 497.1*	*11 026.9*	*19 470.2*
2006	*28 445.9*	*14 680.4*	*13 765.5*
2007	*29 184.9*	*13 068.6*	*16 116.3*

The assets of the Fund amounted to HUF 114.5 milliard as of 31 December 2007.

F.3 Quality Management

All facilities dealing with spent fuel management, in line with all other nuclear facilities, are obliged by the Act on Atomic Energy [I.6] and the relevant governmental decree [II.27] to operate under an appropriate *quality management* system. The system shall be presented to the Hungarian Atomic Energy Authority as a constituent part of the safety analysis report prescribed in the safety code. *Nuclear Safety Code, Vol. 6 of the governmental decree [II.27] also contains prescriptions on the functioning of the licensee's quality management system.* The Hungarian Atomic Energy Authority is empowered by law to inspect the effectiveness of the quality management system of the licensee.

All organisations contracted by the licensee and working on safety-classified systems/structures/components are obliged to maintain a quality management system. *Prior to concluding a contract with the suppliers, the licensee shall qualify them in the selection process to decide whether they are suitable for the assigned task, and also whether the proposed quality management system is appropriate.*

PURAM introduced a Quality Management System based on ISO 9001:2000 and an Environmental Management System based on ISO 14001:1996 standards. These systems were certified officially. Furthermore it is worth mentioning that the Hungarian Atomic Energy Authority itself has established its own quality management system based on the ISO 9001:2000 standard. This quality management system was certified in December 2002 and the Authority has a valid certificate since that time.

The regulatory tasks, including measurements, of the National Public Health and Medical Officer Service are also carried out under a *quality management programme*. Most of the laboratories are accredited.

F.4 Operational radiation protection

As demonstrated in Section E, the Hungarian legal regulations require that the radiation exposure of the workers and the public shall be kept as low as reasonably achievable, and no individual shall be exposed, in normal situations, to radiation doses beyond the dose limitation set by the relevant ministerial decree. The implementation of these requirements as well as the measures taken to prevent unplanned and uncontrolled releases of radioactive materials into the environment are described in Annexes 1 and 2 respectively for spent fuel management and radioactive waste management facilities.

Based on the authorisation of Act [I.6], decree [III.13] of the minister responsible for environment protection regulates the radioactive releases to the atmosphere and into waters in the course of using atomic energy, together with the monitoring of the releases and of the environment. According to the decree, the licensees of nuclear facilities and radioactive waste repositories have to derive the annual release limits as well as the planned release levels from the dose constraint specified by the Office of the National Chief Medical Officer. For example, the dose constraint for Paks Nuclear Power Plant is 90 μSv/year, for the Interim Spent Fuel Storage Facility 10 μSv/year, for the Radioactive Waste Treatment and Disposal Facility 100 μSv/year, for the Budapest Research Reactor 50 μSv/year, for the Training Reactor of Budapest University of Technology and Economics 50 μSv/year and for the remediation of the closed uranium mine area 300 μSv/year. The release limits as well as the planned release levels shall be submitted for approval to the regionally competent Inspectorate of the Environment, Nature and Water. The licensees have to measure and determine the releases, monitor the environment in compliance with the requirements of the decree, and to prepare regular reports on the results to the authority. They are required to enable the authority to carry out sampling and on-site measurements for monitoring radioactive releases and supply the authority with samples if required.

In accordance with the legal regulation and confirmed by the regulatory authority, the actual discharges from nuclear facilities are well below the release limits.

F.5 Emergency Preparedness

F.5.1 Emergency response organization

The National Nuclear Emergency Response System established in accordance with the former regulations has been reorganized by the government decree [II.15] issued for the implementation of the Act on Atomic Energy [I.6]. On completion of the legal harmonization tasks the Government issued a decree [II.23] which regulates the dissemination of public information to be performed in any nuclear and radiological emergency in accordance with the 89/618/EURATOM Council Directive. The so-called Disaster Act [I.10] was issued in 1999. This Act addresses the prevention and mitigation of consequences of each type of disaster including nuclear emergency situations. The Act specifies that the emergency response is led by the Governmental Coordination Committee.

The Governmental Coordination Committee comprises the following organisations: Secretariat, Operative Staff, Defence Working Committee, and the Scientific Council.

In normal periods the organizations of the National Emergency Response System carry out preparatory and exercising tasks. Some of the organizations, beyond their own preparations, fulfil data collection-, planning-, information- and cooperation-related tasks.

In a nuclear emergency the professional decision-support is the task of the Defence Working Committee. The Hungarian Atomic Energy Authority operates an Expert Panel within the Defence Working Committee, and there is also a Public Information Working Group within the Committee to coordinate their approach to the media.

The head of the Operative Staff may recommend the application of intervening forces. The Operative Staff consists of the personnel of the ministries concerned and of the National Directorate General for Disaster Management as well as of experts, designated by the Director General of the Hungarian Atomic Energy Authority. Its head is designated by the minister responsible for local governments.

The main tasks of the Scientific Council are to provide scientific support in the development process of emergency preparedness, to provide support in decision-making, and to seek the most appropriate means of mitigating the consequences of any accident.

The head of a facility is responsible for the implementation of emergency response tasks within the nuclear facility, the presidents of county (capital) Defence Committees are responsible at local level, and the President of the Governmental Coordination Committee at national level.

In a nuclear emergency, evaluation of the nuclear safety and radiological situation is the task of the Hungarian Atomic Energy Authority: this Authority provides data and information for decision-support.

F.5.2 Sectoral and local nuclear emergency response organisations

The order of direction and operation of the sectoral system are determined by heads of the concerned ministries and authorities of national competence. Establishment of special organisations for nuclear emergency, designation of forces and tools to be applied in the response, local emergency planning and maintenance of the plan are the tasks of the county (capital) Defence Committees.

F.5.3 National Nuclear Emergency Response Plan

In 2002 the Governmental Coordination Committee approved the National Nuclear Emergency Response Plan as a sample plan for the preparation of different level nuclear emergency response plans. The plan was an upgrade of the former plan that had been effective since 1994.

The new nuclear emergency response plans and the new legal documents harmonized with the EU requirements were tested during national and international exercises in recent years. The overall general experience drawn from the exercises was that the National Nuclear Emergency Response Plan fulfils its objectives and is applicable for the professional level regulation of the operation of the National Nuclear Emergency Response System. Based on the experience gained during the exercises, at the end of 2005 a working group was established to ensure feedback of experience gained from exercises, to follow up legal *changes, and to take into account any international recommendations. The review of the National Nuclear Emergency Response Plan of 2002 was finished and the new plan enters into force in 2008.*

F.5.4 Emergency preparedness in the facilities

F.5.4.1 Interim Spent Fuel Storage Facility

The Paks Nuclear Power Plant and the Interim Spent Fuel Storage Facility have an integrated emergency preparedness system and response organization, as their sites are neighbouring. The emergency situations included in the planning cover all types of nuclear emergencies that could occur in the nuclear power plant or in the storage facility. As the storage facility is based completely on passive air-cooling, the possible accidents are much less dangerous than those of the nuclear power plant. Therefore the emergency management system established at the nuclear power plant is capable of managing all spent fuel management related and radioactive waste management related accidents in both facilities. The emergency preparedness activities are specified by the Emergency Response Plan valid for the given facility.

The Emergency Response Plan of the Interim Spent Fuel Storage Facility shall be reviewed and approved biannually by the Hungarian Atomic Energy Authority.

F.5.4.2 Radioactive Waste Treatment and Disposal Facility

In 2007 the Radioactive Waste Treatment and Disposal Facility introduced a new Emergency Response Plan which is harmonized with the Hungarian legal background and with international expectations. The new plan has been approved by the National Public Health and Medical Officer Service.

F.5.5 Preparation and exercises

On-site and off-site exercises, including national and international exercises, are organised based on annual plans, *with a frequency regulated in the National Nuclear Emergency Response Plan.*

Members of the emergency response organization take part in basic and regular refreshing training. Training and exercises are performed based on annual plans approved by the authority. There are alerting tests, limited, and full scope exercises, to all of which the various regional and national level emergency organizations may combine with their own exercises. Beyond this the facilities hold regular communication tests. Some exercises are observed by the HAEA.

Hungary, as a member of the OECD Nuclear Energy Agency regularly takes part in the INEX international nuclear emergency response exercises, and in the various CONVEX exercises of the International Atomic Energy Agency. Since 2003 Hungary has been a member of the ECURIE, the early notification system of the European Union and as such it takes part in the exercises organized in the framework of ECURIE.

F.5.6 International cooperation

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

- the Convention on early notification of a nuclear accident;
- the Convention on assistance in the case of a nuclear accident or radiological emergencies.

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

The Republic of Hungary agreed, in 1991, to utilize INES, introduced by the International Atomic Energy Agency.

Hungary has been a member of the harmonization project of the International Atomic Energy Agency on nuclear accident prevention and emergency response since its beginning. This project significantly contributed to the review and renewal of the National Nuclear Emergency Response Plan.

Hungary has concluded bilateral agreements with the following countries in the areas of early notification, mutual provision of information, and co-operation in nuclear emergency matters: Austria(1987), the Czech Republic and the Slovak Republic (1991), the Federal Republic of Germany (1991), Slovenia (1995), Romania (1997), Ukraine (1997) and Croatia (2000).

F.5.7 RESPEC support

The Hungarian Atomic Energy Authority signed the RESPEC (Radiological Emergency Support Project for the European Commission) contract at the end of 2006, in the framework of which the Hungarian Atomic Energy Authority provides the European Commission with professional support for three years in the case of nuclear and radiological emergencies which have an effect on the European Union. The duties contracted entered into effect as of 1 April 2007. Based on the contract the Emergency Response Organisation of the Hungarian Atomic Energy Authority, at the request of the European Commission, provides professional support in nuclear and radiological evaluation of an emergency, and in public communication.

F.6 Decommissioning

Decommissioning is not a current issue for the Hungarian nuclear facilities. Nevertheless this question has been covered in regulations, as the final phase of the life-cycle of the installations. As for all other phases, it requires a nuclear safety licence. For decommissioning, a multi-step licensing procedure is established, where the first step is to obtain the authorities' consent to terminate operation. A further requirement is a valid environmental protection licence based on environmental impact assessment and public hearing. As in all phases of the life-cycle of a facility, radiation protection authorities are involved in these licensing processes, and they license separately the appropriate radiation protection programme and radiation protection organisation. During the dismantling, decontamination and other steps, an ongoing task of the authority is the control of the radiation situation within the facility and around it, and the monitoring of personal doses and the discharges and the radiation in the environment. Emergency plans have to be updated with new or likely scenarios and any necessary organisational changes required must be adjusted accordingly.

With regard to the nuclear power plant, the research reactor, the training reactor, and the Interim Spent Fuel Storage Facility, the safety codes contain provisions that decommissioning shall be taken into account at the design stage, and a preliminary decommissioning plan constitutes an obligatory part of the documentation prior to commissioning as well as of the final safety assessment. The decommissioning plan is required to be regularly revised in accordance with the regulations in force; revision results are required to be submitted to the Hungarian Atomic Energy Authority. The finalised decommissioning plan is a prerequisite for granting the operating licence. All decommissioning plans have to cover organisational and qualification questions together with the technical issues.

In the framework of the Revision Project of the Nuclear Safety Codes (currently being carried out), the Hungarian Atomic Energy Authority is compiling a separate volume containing requirements on the decommissioning of the nuclear installations.

In the case of Paks NPP no preliminary decommissioning plan was originally made. This situation was corrected in the early 1990s and since that time it has been updated regularly. *The third revision of the plan is carried out in 2008.*

The Periodic Safety Review (2003) of the Budapest Research Reactor prescribed that a Preliminary Decommissioning Plan be prepared for the facility with the deadline of 2005. In the case of the Training Reactor, the same problem has been arranged similarly, during the Periodic Safety Review in 2007. The IAEA effectively supports these activities in the form of expert missions. *Now the Hungarian research reactors have Preliminary Decommissioning Plans, approved by the Hungarian Atomic Energy Authority.*

The Interim Spent Fuel Storage Facility was already designed by taking into account all relevant requirements of decommissioning and it has an adequate preliminary decommissioning plan.

SECTION G. SAFETY OF SPENT FUEL MANAGEMENT

The safety of spent fuel in Paks NPP and in the Budapest Research Reactor is dealt with in Annex 8.

G.1 Interim Spent Fuel Storage Facility

Siting

The facilities of the Interim Spent Fuel Storage Facility are located 500 m south of the geometric centre of the power plant units. The foundation of the Interim Spent Fuel Storage Facility was designed at an elevation such that the facility would not be flooded even taking into account the Danube's maximum flood level that had occurred in 100 years. The structure of the basement prevents the release of radionuclides into the ground and groundwater. The Interim Spent Fuel Storage Facility is sited within a flight exclusion zone of 3 km diameter and 7000 feet (2133 m) altitude around Paks Nuclear Power Plant.

The design-basis earthquake levels used, following a conservative approach, for the seismic assessments are:

- 0.08 g *horizontal acceleration* for a design earthquake;
- 0.35 g *horizontal acceleration* for a maximum design earthquake.

Re-evaluation of the seismic hazard of the site defined a maximum horizontal seismic ground acceleration value of 0.25 g at an earthquake recurrence frequency of one in 10 000 years; this value was accepted by the licensing authority.

In the absence of site-specific response spectra values, data from the US NRC Reg. Guide 1.60 were used for the assessments. The actual site-specific response spectra data were included in the approved seismic risk assessment report prepared after completion of the licensing process.

Design and construction

The reception building of the modular interim storage system and the first three vaults – with storage tubes for 450 spent fuel assemblies in each vault – was completed in 1996. The facility started operating in 1997. In 2007 the facility already contained 16 vaults.

Taking into account the planned life time of the nuclear power plant, the annual generation of spent fuel assemblies and that of the volume currently being stored, until 2017 – the originally planned life time of the Paks nuclear power plant – 25 vaults are planned to be constructed. The arrangement of the storage tubes in the vaults to be constructed in the future will be quadrangular as opposed to the triangular arrangement currently used. By this modification instead of 450 storage tubes 527 can be installed in each vault.

The first 16 vaults constructed so far can accommodate 7200 spent fuel assemblies; in the 9 vaults planned to be built an additional 4743 spent fuel assemblies can be emplaced; in this way a facility with 25 vaults will provide the possibility to store 11943 assemblies.

The design makes it possible to expand the facility to 33 vaults in order to ensure the storage of most of the spent fuel assemblies that are generated during the planned life time of the nuclear power plant as well as during the possible life time extension. Given the full establishment of the storage facility, up to 16159 spent fuel assemblies can be emplaced in the 33 vaults.

A description of the Interim Spent Fuel Storage Facility is given in Annex 1.

Design specifications related to the decay heat and cooling time of fuel:

- minimum 3-year cooling time after discharge from the reactor;
- highest initial enrichment: *3.82*%;
- average burnup: 42 GWday/tU;
- highest burnup: 50 GWday/tU;
- 478 W/assembly remanent heat power for average burnup;
- 717 W/assembly remanent heat power for highest burnup;
- hermetic (intact) assemblies.

The cooling of the spent fuel assemblies is provided by a self-regulating passive cooling system, by a natural draft-induced airflow around the fuel storage tubes. No mixing can take place between the outside cooling air and the gas within the storage tube.

Safety Assessment

The safety assessment reported in the Final Safety Assessment Report of the Interim Spent Fuel Storage Facility was performed by AEA Consultancy Services, Risley, commissioned by GEC Alsthom. The assessment was performed to demonstrate that appropriate means are available for controlling criticality both in normal operational and in off-normal conditions within a specified range, and that nuclear safety is not jeopardised by any potential events.

Although the Interim Spent Fuel Storage Facility was designed expressly for storing spent nuclear fuels, the criticality calculations conservatively do not account for the reactivity reduction from the fuel burn-up. The data provided by NRC Standard Review Plan, NUREG 0800, Section 9.1.1, "New Fuel Storage Facility", were used as design criteria for the assessment. Accordingly, the criticality calculations of the Interim Spent Fuel Storage Facility are based on the following criteria:

- With the assumption of total flooding by a potential moderator, e.g. boric acid free water of various densities, the neutron multiplication factor, k_{eff}, as defined by ANSI/ANS-8.17-1984, shall not exceed 0.95.
- The Interim Spent Fuel Storage Facility shall provide a sufficient safety margin which takes into account the simultaneous occurrence of at least two unlikely and independent condition changes, with respect to the occurrence of criticality accidents.

Calculations were performed to assess the criticality conditions of fuel assemblies being handled in the fuel-handling machine, fuel drying tube, and the storage module. Additional calculations were carried out for those cases where the storage modules or the inside parts of the storage tubes are flooded with water. The criticality conditions were also assessed for various accident situations, e.g. dropping of fuel within the fuel-handling machine, the fuel drying tube, or the fuel storage tube.

The nuclear safety assessment of the Interim Spent Fuel Storage Facility demonstrated that appropriate control of criticality is provided for under all normal operational and all assumed off-normal conditions*, and the facility meets the regulatory safety requirements.*

In addition to the safety assessment, in 2002 the licensee launched a programme on aging management. This programme includes the regular inspection and testing of all safety-related systems and system components, beyond the normal maintenance work, and the establishment of a computer database for recording the operational safety parameters of the systems of the facility.

Within the scope of aging management the status supervision activity of the Interim Spent Fuel Storage Facility's systems and system elements important from the safety point of view is carried out as defined by the material-, structure- or status investigation programmes. Aging management also covers the periodic control of the functional suitability of the systems. In each programme the requirements for investigation and evaluation are previously determined with due consideration of the design bases. The applied methods are able to identify the failure symptoms and forecast the life time of the system element. Based on the evaluations it can be concluded that no such differences were explored by the analyses carried out that would affect the safety indicators of the Interim Spent Fuel Storage Facility.

Operation of the facility

The holder of the operation licence of the Interim Spent Fuel Storage Facility is PURAM. The operational and maintenance activities are performed by the staff of Paks Nuclear Power Plant in the framework of a contract. PURAM controls the operation and maintenance work.

The operation licence issued by the Hungarian Atomic Energy Authority is valid until 31 August 2008. The approval provided by the licence relates to the storage of spent nuclear fuel assemblies (of defined parameters) unloaded from Paks Nuclear Power Plant. The loading rate shall not be higher than 500 spent fuel assemblies per calendar year. The *conditions for extending the licence are discussed in Section K.1.*

In accordance with the operation licence, for safety related matters, the Safety Standards for Interim Storage Facilities of Spent Nuclear Fuel Elements; Dry Storage Facilities (Nuclear Safety Codes Vol. 6) issued as an attachment to the relevant governmental decree [II.27] shall be applied.

The operation limits and conditions are included in the technical specification of the Interim Spent Fuel Storage Facility. These were also approved by the licensing authority (the Hungarian Atomic Energy Authority) in *accordance with the legal rules.*

The design, the 'as-built' and the operational documents of the Interim Spent Fuel Storage Facility are all stored at the Paks office of PURAM. The operational staff of PURAM is responsible for the handling and maintenance of the documents.

The safety related information required for licensing *the operation* of the Interim Spent Fuel Storage Facility was presented in the Final Safety Analysis Report. Based on operational experience and the safety enhancing measures, the Final Safety Analysis Report *is required to be revised by the licensee* every year.

The safety criteria applied to the Interim Spent Fuel Storage Facility are in full accordance with internationally accepted principles, *because the limits and conditions prescribed in the national regulations were derived from these principles.* All real hazards associated with normal operation, anticipated operational occurrences and design basis accidents were assessed in the process of granting the *operation licence* and the results were accepted by every competent authority.

During the long term dry storage of spent fuel in nitrogen *gas* medium at low temperatures the appropriate cooling is ensured while at the same time the mechanical and isolation properties of the assemblies are maintained. During storage, the level of radioactivity decreases thereby excluding any increase of impact on future generations – meaning that the operation of the Interim Spent Fuel Storage Facility will not impose an undue burden on future generations.

G.2 Disposal of spent fuel

With respect to the disposal of high level waste and spent nuclear fuel, the policies and practices followed by Hungary are described in Section B. As mentioned there, it is a strategic target that preparations should be made to construct a waste repository for the disposal of the country's high level radioactive wastes in a deep, geological formation to provide long-term isolation. In accordance with international viewpoints, such a repository can be used for the direct disposal of spent nuclear fuels and would also be suitable for the reception of wastes from fuel reprocessing. No decision has yet been taken on the back-end of the fuel cycle. Thanks to the existence of the Interim Spent Fuel Storage Facility, there is sufficient time to elaborate the national policy and strategy.

SECTION H. SAFETY OF RADIOACTIVE WASTE MANAGEMENT

The general safety requirements of radioactive waste management are described in Section E. This present section deals with the past practice of radioactive waste management as well as with the safety of the only repository in operation in Hungary, the Radioactive Waste Treatment and Disposal Facility. Finally, the safety aspects of the establishment of a new LLW/ILW repository are discussed.

H.1 Past practice

In Hungary, the significant use of open- and sealed sources of radioactivity began during the second half of the 1950s. Simultaneously with the domestic use of artificial radionuclides the disposal of the radioactive waste produced was regulated. In 1960 a temporary waste repository was set up just outside of Budapest at Solymár. Low level waste was stored in wells made of prefabricated concrete rings without backfilling. After the wells had become full they were covered with concrete.

As the site proved to be inadequate for long-term disposal (due to the unfavourable impermeable properties of the soil, the disadvantageous hydrogeology of the site, etc.), the waste was removed and the Solymár site was cleaned up and closed between 1979 and 1980. After that, environmental monitoring took place, and the authority then cleared the territory for limited utilisation.

Uranium mining started in Hungary in 1957 and was terminated in 1997. This past practice led to short-term remediation tasks and long-term tasks of environment protection and monitoring (for details, see Annex 7). The remediation of the uranium mine is in progress on the basis of a detailed and comprehensive plan, under the supervision of the regulatory authorities. The human and financial resources are assured by the Government for the long term.

H.2 Radioactive Waste Treatment and Disposal Facility

Assessment of safety and safety upgrading

In the course of the establishment of the Radioactive Waste Treatment and Disposal Facility, no comprehensive safety evaluation was carried out. Therefore, in the licensing process for extending the capacity of the repository, on the initiation of the Hungarian Geological Survey, only temporary operation licences were issued *and safety assessments were to be carried out as required by the authority.*

Although the Facility has been reliably operating for over 30 years, some waste types that were emplaced in it earlier raised questions from the long term viewpoint of safety. The results of the safety assessments clearly indicate that certain disused sealed sources could impose high doses – exceeding the limit – to individuals who intrude into the facility, and they could also lead to doses greater than the limit following any future disruption of the repository by natural processes.

Based on the findings of the safety assessments, consideration had to be given to the following:

- *the retrieval of* 'critical' *types of waste from the site and their emplacement in an interim store or a geological repository;*
- the introduction of corrective measures to enhance he safety of the waste already disposed of.

It was an additional aspect that since the free disposal capacity has run out the possibility to emplace additional wastes has had to be ensured since the repository was envisaged to be further used for the emplacement of institutional wastes. It is also justified by the fact that Hungary has exported sealed radiation sources on a large scale and the new licences cover the return of the disused sources of Hungarian origin.

The basis for optimisation from the point of view of radiation protection is the balancing between the actual doses associated with intervention activities and the reduction of the potential dose in the future. The future decisions on the Radioactive Waste Treatment and Disposal Facility will be based on feasibility/optimisation studies.

Based on the aspects mentioned above, in 2002 a programme of four stages was launched with the aim at enhancing the safety and carrying out refurbishments. The first stage of the safety enhancement programme, approved in August 2002 by the minister disposing over the Central Nuclear Financial Fund, was terminated in 2005. At the same time the second stage – built on the results of the first, so-called preparatory stage – planned to be carried out between 2006 and 2010 was endorsed.

The objectives of the safety enhancement programme are still as follows:

- *to make the repository safe for the period after institutional control;*
- *to carry out the refurbishments that are necessary to maintain safety;*
- *to make the repository suitable for the disposal of additional institutional waste.*

The second stage of the safety enhancement programme started with a demonstration programme in the framework of which four vaults are opened, the waste is recovered and processed prior to re-disposal. Opening of the first vault took place on 16 April2007. The condition of the bagged wastes in the opened vault was relatively good and the wall of the vault required no repair. Segregation of the long-lived components was performed without any problem. The personal doses of the workers were in all cases below the time proportional dose limit pertaining to radiation workers. Based on the favourable experiences the programme has been continuing by processing the wastes recovered from the selected vaults.

Refurbishment

Since its commissioning the repository has been operated without any accident or significant release of radioactivity to the environment. However, up till 2001 no investments for upgrading had been made in view of which the equipment has become obsolete and the physical condition of the operating systems has become impaired. One of the objectives regarding the development of the Radioactive Waste Treatment and Disposal Facility has been to upgrade the physical state of the facility and to provide better conditions for its further operation. Between 2001 and 2004 the main areas of the upgrading activities were the following:

- physical protection (new fence system, new access control, new equipment for the security guards);
- radiation protection (replacement of obsolete measurement devices, enhancement of environmental monitoring);
- data acquisition (new data recording system, waste characterisation capability, new meteorological station);
- transportation (new transport vehicles and containers).

The list of repairs, improvements, and modernisation activities that have been and are being carried out include: repair and refurbishment of the buildings; entire refurbishment of the electrical supply and the reserve electrical supply, of the water supply, the specialised sump water collection system, the ventilation system, and the decontamination facility; upgrading of the fire-fighting system.

The other main objective of development at the repository site was to convert *the technology building into a centralised interim store* for institutional radioactive wastes which are not suitable for near-surface disposal *(description of the repository is given in Annex 2).*

During the preparation for the capping of vault row No. III, it was discovered that in the previous few years certain of the structures (gutters, asphalt surface, and concrete support) in the near vicinity of the vaults had deteriorated to a considerable extent *thereby possibly jeopardising the long term safety of the repository. In order to maintain safety on the long term a decision was made on the restoration of the vicinity of rows Nos. III and IV, which restoration was successfully completed without opening the vaults containing radioactive wastes (soil compacting, modernisation of rain water drainage system). Further consideration should be given to the eventual erosion of the surface, though it does not endanger at present and in the near future the safety of waste disposal. The extent of surface erosion is monitored continuously by measurements because, when closing down the repository, the safe capping method to be used will be selected based, among other factors, on the results of these measurements.*

Between 2005 and 2008 the refurbishment of the repository was continued:

- *a hot cell was installed in which radiation sources of up to 1 TBq Co-60 equivalent activity can be handled;*
- *a compactor with the capacity of 2-3 drums per hour was put into operation; the volume reduction – depending on the waste composition – is 2-5;*
- *a sorting box destined for segregating the compactible and non-compactible waste was commissioned;*
- *purchasing and licensing of cementation equipment for the processing of liquid waste started in 2006, commissioning of the system is planned at the end of 2008;*
- *the firewater system and the rainwater drainage system were renewed;*
- *a cross-country vehicle was purchased to facilitate environmental sample-taking ;*
- *a personal dosimeter system was developed to measure and record the neutron doses received by the workers.*

H.3 Construction of a new LLW/ILW repository

After the development of an increased new disposal capacity, the Radioactive Waste Treatment and Disposal Facility will be able to receive the radioactive wastes produced in research, medical and industrial institutions for several years, but for low and intermediate level waste coming from the operation and decommissioning of the nuclear power plant a new facility needs to be built. During the planned 30 years of NPP operation and decommissioning the production of altogether about 40 000 m^3 LLW/ILW can be anticipated.

In 1993, on the initiative of the then operative Hungarian Atomic Energy Commission, the Government launched a national programme aimed at selecting a site for the disposal of LLW/ILW arising during the operation and decommissioning of the nuclear power plant.

According to the principles that had earlier been set out, alternative solutions had to be examined both in terms of location and the mode of disposal. Thus both near-surface and underground repositories at up to 300 m depth were considered. Bearing in mind the international recommendations, the principle was adopted that safety of the repository should be guaranteed by a combination of waste form and packaging, engineered barriers, and the geological environment.

Site selection process

The site selection process was directed by the Geological Institute of Hungary. Initially, *in 1993*, numerous potential locations were identified: 128 for near-surface and 193 for subsurface disposal. At this stage, another very important issue arose - namely the opinion of the population in the areas under consideration. Public approval was given to just a few dozen out of the potential areas.

Of these, four prospective areas (three for near-surface and one for underground disposal) were investigated by field reconnaissance. Boreholes were drilled at two near-surface (loess) sites and one underground (granitic) site. On comparison, the granite site proved to be more suitable. Based on series of investigations *in 1996*, a granite formation in the village of Bátaapáti in south-west Hungary was selected as a potential site for an underground repository.

Safety analyses of the planned repository

Up till now, the Hungarian radioactive waste disposal regulations have not adopted risk-based standards. However, in making preliminary judgement on the suitability of sites under consideration - with different repository designs and in different geological settings - probabilistic performance assessment was used. As in other radioactive waste programmes world-wide, the applied health risk (corresponding to stochastic effects) was 10^{-6}/year risk increment for potentially exposed people.

A preliminary safety assessment for the Bátaapáti site has been prepared in co-operation with Belgian and Finnish institutions within the framework of a PHARE project initiated in 1998. Concentrations of radioactive isotopes calculated for the vicinity of the disposal areas do not exceed significantly the concentrations existing in the natural environment. To calculate the concentrations in the biosphere one has to investigate the effects of transport (delay, dilution and dispersion) through the geological formation. Results of the hydrodynamic modelling show*ed* that groundwater velocities at depths of 250-280 m are a few centimetres per year. Results of the preliminary safety assessment of the Bátaapáti subsurface disposal facility illustrat*ed* that radiological risk to the public is negligible for the post-closure phase (doses to the public are several orders of magnitude lower than the authorised limits for every case considered). This statement is valid for the normal and altered evolution scenarios. By virtue of the deep location and the hydrogeological conditions at the site, the proposed concept of subsurface disposal is not affected significantly by changes in the environment.

In 2003 the geological investigations from the surface were completed. The geological authority stated that the site fulfilled all the requirements formulated in the relevant decree, and that from the geological point of view, it is suitable for the disposal of low and intermediate level radioactive waste. Further investigations with a below-surface starting point *were* necessary to select the rock volume for the repository and its safety zone.

In 2004 a summarising safety assessment was completed with the goal of assessing the suitability of the Bátaapáti site utilising the most up-to-date techniques. The results verified the preliminary calculations with regard to the suitability of the site. Judging from the summarising safety assessment, the dose to the public caused by the planned repository will be by two – three orders of magnitude less than the dose constraint (100 µSv/year) for the public.

In terms of the Environmental Impact Study, the environmental monitoring of the site has been continued.

By October 2004, the special authorities had issued every important license necessary for the excavation of inclined tunnels to carry out underground geological research activities. The goal of these research activities (within the granite formation declared as suitable) were aimed at defining the precise location of the repository. This research work has been in progress since February 2005. By the end of May 2008, these shafts had reached the planned depth (0 m above Baltic sea level), and their lengths were 1723.5 m and 1772.5 m.

In July 2005, on the initiative of the local government of Bátaapáti a referendum was held in the village where – with a 75% participation rate – 90.7% of the eligible citizens were supportive concerning the implementation of the repository in the area of the village.

On 21 November 2005, the Hungarian Parliament approved a resolution on the preliminary approval in principle to initiate activities to prepare for establishing a radioactive waste repository.

In line with the underground activities the documents and plans necessary for licensing the repository were prepared. Based on these the competent authority issued the environmental licence, which – after an appeal – entered into force on 17 October 2007.

On the basis of the pre-commissioning safety assessment – prepared based on the design documents and the environmental impact assessment – the competent authority issued the construction licence, which entered into force on 18 June 2008.

Ongoing activities

The licensing process for commissioning and for taking into use can be started in the possession of the construction licence on the basis of the facilities built and licensing documents developed so far.

The repository is due to be put into operation in two phases: in the first phase only the surface facilities will be in operation. Temporary storage of the waste shipped from Paks NPP will be realised in the technology building. By accepting3000 drums of solid waste the problem of the storage capacity at Paks NPP having run low will be solved.

The underground facilities are planned to be constructed in the second phase. First (envisaged by the year 2010) four disposal galleries in symmetrical arrangement are planned to be commissioned. For technological reasons this requires the construction of 6 galleries in that the further construction necessitates one empty chamber both sides between the chambers in use and the construction area. This arrangement ensures seismic protection. On completion of the construction of the underground facilities, the repository will consist of 17 disposal galleries which will suffice to accommodate the waste generated during the originally planned life-time of the NPP.

The staged implementation of the repository ensures adequate flexibility to meet the demands of the nuclear power plant. During the technical design phase, consideration was given to the possible expansion of the repository should the life-time of the nuclear power plant be extended or significant changes in the Hungarian nuclear programme take place.

Repository concept and safety aspects

Construction and operation of the underground facility (including the transport of the radioactive waste to the disposal area) will make use of the two parallel inclined shafts used for underground geological research activities.

These shafts with a slope of -10% ensure access to the planned disposal depth (the "base" point). The two shafts are connected at each 220-270 m long section (by so called cross drifts), thereby ensuring the run through ventilation and the necessary escape routes.

Waste disposal will utilise a chamber- (gallery) type solution. The excavation of the one-exit chambers is executed from the connecting tunnel in a systematic arrangement, parallel to each other, and arranged in chamber-fields. For safety reasons the chambers are constructed in a single-level arrangement: this means that neither the chambers nor the chamber-fields integrating them into a unified system can cover each other.

Disposal of the various types of waste in the chambers will be performed in a segregated manner (mixed solid wastes, cemented sludge, cemented evaporation residues, cemented ion-exchange resins, special waste forms). National regulations require the retrievability of the waste packages during the operational period of the facility.

SECTION I. TRANSBOUNDARY MOVEMENT

With regard to the transboundary movement of radioactive waste, Hungary promulgated in 2004 a governmental decree [II.24] on the licensing of shipments of radioactive waste across the national border.

The replacement of this decree, based on the Council Directive 92/3/Euratom of 3 February 1992 on the supervision and control of shipments of radioactive waste between Member States of the European Union and into and out of the Community by a decree, based on the Council Directive 2006/117/Euratom of 20 November 2006 on the supervision and control of shipments of radioactive waste and spent fuel, is currently in progress. The new decree is due to enter into force by 25 December 2008. One of the most important changes is the extension of the scope to spent fuels.

The Hungarian Atomic Energy Authority is the competent body for licensing shipments out of Hungary and giving consent to shipments into Hungary. In these undertakings it is supported by the National Office of the Chief Medical Officer of the National Public Health and Medical Officer Service and the Headquarters of the Police, as special authorities.

The decree prohibits shipments from Hungary to any destination south of latitude 60° south and to any state being a contracting party of the African, Caribbean, Pacific country-group to the Agreement of Cotonou. No shipment shall be licensed if the country of destination does not have the technical, legal, or administrative resources to safely manage radioactive waste.

In compliance with Article 27 of the Convention, the Hungarian regulation does not prejudice or affect the rights of a contracting party as provided by international law, or with respect to the return of radioactive waste or other products from processing radioactive waste or reprocessing spent fuel.

SECTION J. DISUSED SEALED SOURCES

All practices involving radioactive materials, including sealed radioactive sources, are subject to licensing as required by the decree [III.10] of the minister responsible for health in order to ensure safety. All radioactive sources are recorded in a central registry, handled by the Institute of Isotope of the Hungarian Academy of Sciences on behalf of the Hungarian Atomic Energy Authority. The central registry system has been in operation since the end of the 1960s and it provides for the regulatory control of radioactive sources throughout their full life-time. This registration system was recently upgraded on the basis of the new decree [III.17] of the minister responsible for internal affairs. The recent, unified computerised local and central registry system is based on regular electronic reports of inventory changes and annual inventories, and a passport identifying each sealed source that contains all relevant technical data as well as details of the legal owner of the source. The new system has strengthened the regulatory control, and greatly improved its efficiency.

Modification of the accountancy system is currently in progress. One of the substantial modifications is the introduction of specific provisions for radioactive waste.

Legislation requires that unused radioactive sources be disposed of. The reporting system prescribed by the new regulation enables the regulatory authority to identify sources that have not been used for a longer period of time. Spent sources are disposed of at the Radioactive Waste Treatment and Disposal Facility at Püspökszilágy. The facility has sufficient space and infrastructure to handle the spent sources safely. The fees charged for disposal are sufficiently low in order to ensure that the lack of financial resources on the side of users should not be an obstacle to safe disposal. *The accuracy of the regulatory accountancy for nuclear materials was enhanced by the elaboration of a method for determining the fissionable content of PuBe sources and by carrying out the measurements of about 100 such sources.*

If requested, Hungarian manufacturers take back radioactive sources produced by them from users within the country or abroad. These sources are either re-manufactured or disposed of in the Radioactive Waste Treatment and Disposal Facility at Püspökszilágy. The legislative system does not prevent Hungarian manufacturers from fulfilling such obligations. In recent practice, numerous such obligations have been undertaken, and re-shipments take place regularly.

SECTION K. PLANNED ACTIVITIES TO IMPROVE SAFETY

K.1 Interim Spent Fuel Storage Facility

The design work of the Interim Spent Fuel Storage Facility was performed in the 1990s, thus the facility is considered to be up to date. In view of this, safety enhancement measures affecting the operation of important systems are not required. With regard to the modifications of the *existing systems* of the facility, mention is made of the improvements to the physical protection, *modernisation of the nitrogen gas supply system and leak-detection of the storage tubes,* and the updated monitoring of the discharges and the environment. The container service reception building, *the seismic support components* of the refuelling machine and the radiation protection control system have been improved, too. The modifications facilitated the operation of the installation, thus they improved the operational safety.

The Interim Spent Fuel Storage Facility is being built up gradually and 11 modules were licensed for storage (operational licence) in 2004. After the fuel cleaning incident at Unit 2 of Paks NPP in 2003, the storage *of hermetic, but surface contaminated fuel assemblies* had to be solved. *Based on the relevant safety evaluations, a licence was issued to store these fuel assemblies in the Interim Spent Fuel Storage Facility.*

The construction of modules 12-16 was started in 2005. Compared with the existing modules, significant modifications have been made by strengthening the sealing of the storage tubes and in the construction of the leakage monitoring system as well as in the nitrogen gas supply system. The commissioning licence for the new modules 12-16 was issued by the authority by the end of 2007. In 2008, as a consequence of the successfully performed Periodic Safety Review, the validity of the operational licence of modules 1-11 could be extended and, based on a unified Final Safety Analysis Report compiled for the entire 16 modules facility, PURAM applied for the operational licence of the facility as a whole.

The newly-built module 16, having a slightly modified layout for the storage places, may be capable of storing the encapsulated broken fuel elements or debris of the incident at Unit 2 of Paks NPP in 2003. Nevertheless the licensee shall make an extra application for this option, presenting an appropriate safety assessment to the competent authorities.

K.2 Radioactive Waste Treatment and Disposal Facility

From the results of the safety analysis it can be stated that operational and environmental safety up to the end of the passive institutional control of the Radioactive Waste Treatment and Disposal Facility at Püspökszilágy is appropriately guaranteed. The facility as a whole is suitable for the safe disposal of low and intermediate level short lived wastes.

Beyond passive institutional control, however, mostly because of the significant amount of long lived components already disposed of, inadvertent human intrusion - or any other scenario resulting in waste reaching the surface after the deterioration of the concrete barriers - could cause not only the dose constraint to be exceeded but even the dose limit.

On the basis of the investigations carried out until 2006 in the framework of the safety enhancing programme – as referred to in Section H.2 – the possible development areas for the repository could be as follows:

- *Certain long-lived or high activity disused radiation sources as well as waste packages containing long-lived radionuclides should be recovered from the 'A-type' vaults and placed in an interim store pending disposal in a geological repository. Recovery of the long-lived disused radiation sources can primarily reduce the probability of receiving high doses after the institutional control period.*
- *Corrective measures for enhancing the safety of the repository; One of the modifications planned to be carried out is the complete filling of the vaults with backfilling material aiming at providing a better physical and chemical barrier against radionuclide migration as well as against any possible inadvertent intrusion.*

Reconditioning and repacking of the recovered waste may improve the local retention capability, may act as a chemical barrier, and may provide a possibility for volume reduction.

In the case of the wastes that were not backfilled with cement, retrieval is relatively easy compared with the backfilled wastes where safe retrieval of the disused sealed radiation sources would be considerably more onerous and risky. It is a separate task in the safety enhancement programme to recover the disused radiation sources from the 6 m deep wells.

In the demonstration programme described in Section H.2, four vaults were to be opened. The work started with opening of the first vault in April 2007. At the beginning of October 2007 the second vault was opened and processing of the retrieved waste packages started; the work on this vault was finished by the middle of March 2008.

In these two not backfilled vaults – except for 3 drums – there were only wastes packed in plastic bags. The bagged wastes were in good condition and remained intact during movement, thus their hoisting did not cause any problem. During sorting, the waste packages – based on the content of long-lived, alpha emitting nuclides – were separated into different categories and were treated and emplaced in different ways.

Special attention was given to waste packages containing tritium or tritium sources. These latter were treated separately from the other wastes and they were encapsulated.

By analysing the external and internal exposure data measured during recovery and processing of the waste, it can be concluded that the results are very favourable: the doses received by the workers were less than the initially estimated values , and the personal doses of the employees did not reach the time-proportional value of the limit set for the radiation workers.

The waste recovery operations have been executed under a double tent from where the air may be released after filtering. During the other operations carried out in the technological building, releases can take place only in a controlled manner. Discharges of those substances containing radioactive materials (air, water) only slightly increased but were much below the authorized limit and remained in the order of magnitude of normal operation; hence the public was not affected by excess radiation. The radiation protection and environmental monitoring systems were continually operating during the safety enhancement programme and did not register any significant difference compared to the normal operational data.

The demonstration programme is due to be completed by the end of 2008. After that, the experience gained during recovery and treatment of the waste, the impact of the measures taken on the safety of the repository, the efficiency of providing free disposal capacity, and the cost implications need to be evaluated. On the basis of these factors,, a decision can be made about which other vaults are worth opening, and whether any modifications are needed in the technologies used, as well as which method is the most practical for re-disposing of the segregated and reconditioned waste.

ANNEX 1: THE INTERIM SPENT FUEL STORAGE FACILITY

An1.1 Description of the facility

The Interim Spent Fuel Storage Facility is a modular dry storage that can be functionally divided into three major structural units: the reception building, the charge hall, and the storage modules.

An1.1.1 The reception building

The first unit is the reception building in which the reception, preparation, and unloading of the spent fuel transfer casks takes place. This building comprises a reinforced concrete structure with a basement and a steel structure forming a hall. The fuel handling systems and the various auxiliary systems are installed in this building.

The reception building is a separate unit adjacent to the first module. It houses the equipment necessary to handle and position the transfer cask prior to fuel assembly removal/drying operations. The reception building also houses service and plant rooms, as well as ventilation systems and monitoring systems.

An1.1.2 The charge hall

The fuel handling machine performs the fuel transfer operations in the charge hall. The hall is bordered by the reinforced concrete wall of the ventilation stack on one side and by a steel structure with steel plate sheeting on the other side. The basic function of the sheeting is to protect the fuel handling machine against climatic stresses.

An1.1.3 The storage modules

The storage modules serve for the storage of the spent fuel. These modules are enclosed by thick reinforced concrete walls and shell structures filled with concrete; the basic function of these structures is to provide radiation shielding. Each module is capable of accommodating 450 spent fuel assemblies. They provide for the vertical dry storage of irradiated fuel assemblies, housing an array of steel fuel storage tubes each with a removable steel shield plug. Each fuel storage tube houses a single fuel assembly. Nitrogen *gas* is used in the tubes to provide an inert atmosphere. The reinforced concrete structure of the module is covered by a structural steel building to form the charge hall.

In the case of modules Nos. 1-11 the lifetime of the storing tube O-rings (until effective sealing is ensured) is expected to be longer than 25 years. In service the effectiveness of the sealing is checked by the monitoring system of the gas supply. Should gas from the nitrogen supply system of any of the modules escape due to corrosion or other reasons, an alarm will be set off. The threshold for the alarm is a gas leakage rate of 1.75 l/min.

Measurements utilising He-leak tests are carried out when filling the tubes with fuel assemblies as well as when leakage is observed.

In the case of the filled modules Nos. 1-11, every 5th year the sealing of 8 randomly selected closure plugs are removed and investigated by destructive material testing. As far as modules Nos. 12-16 are concerned, periodic checking of the plugs is not needed as the sealing unit was redesigned by changing the rubber sealing to a metal one.

During the construction of the modules metal 'corrosion' samples were inserted into the modules in order to investigate the appropriateness of the surface protection – metal vaporization against corrosion – utilized for the storage tubes of the Interim Spent Fuel Storage Facility.

An1.2 Handling of fuel assemblies

A fuel handling machine moves the fuel assembly from a water-filled transfer cask to the fuel storage tube via a drying tube. The fuel handling machine operates in the charge hall.

An1.3 Cooling

The fuel stored in the metal tubes is cooled by the passage of air between the tubes, using the heat emitted from the stored fuel as the driving force. It is a self-regulating system in that as more heat is given up to the cooling air which rises up through the discharge stack, more air is drawn into the module by the thermosyphoning effect, thereby ensuring adequate cooling without the need for any active mechanical systems or human intervention.

Maximum temperature values:

fuel cladding:	*410 °C*
concrete:	*100 °C*
storage tube:	*300 °C*

During storage the temperature of the fuel cladding is not measured.

An1.4 Guarding

The site of the Interim Spent Fuel Storage Facility is situated in the immediate vicinity of Paks Nuclear Power Plant. Since 2004, the physical protection of nuclear facilities is ensured by an independent security organization (independent here means that it is not connected with the security body of the NPP) and by using state-of–the-art security systems meeting today's requirements.

The access system is designed to prevent uncontrolled access of persons and/or vehicles and to warn the security staff of any attempt to trespass. The system's computer registers all entries of persons and vehicles to the site. Vehicle access by road to the Interim Spent Fuel Storage Facility from the nuclear power plant site is not possible. This can only be done through the access point of the security system. Transport of the spent fuel assemblies is carried out under strict control from one facility to the other.

An1.5 Radiation protection and environmental protection

Operational monitoring, sampling and the subsequent laboratory assessment of samples, and personal health physics monitoring are included in the radiation protection system of the Interim Spent Fuel Storage Facility.

The radiation protection monitoring system includes fixed dose rate measuring detectors and an aerosol monitoring network. In addition, various portable radiation protection devices are available for the operational staff. Personal radiation monitoring is performed with the use of film dosimeters, as required by the authorities, supplemented with thermo-luminescent detectors and electronic dosimeters.

The airborne discharge of the Interim Spent Fuel Storage Facility is monitored by an isokinetic sampling system and continuous aerosol monitoring equipment installed in the outlet stack of the ventilation system. The samples taken by the above equipment are subjected to total beta counting and gamma spectrometry analysis and, in addition, are assessed for ^{3}H, ^{14}C, ^{90}Sr *and alpha activity-concentration. After assessing the samples taken from the tanks the liquid discharges of the storage are drained into the waste water system of the nuclear power plant. Most of the laboratory inspections are performed by the health physics laboratory of the Interim Spent Fuel Storage Facility. The discharges from the storage are very small: in 2006 the amount of discharges was only 0.00976% of the derived limits.*

Since the site of the Interim Spent Fuel Storage Facility and that of the nuclear power plant are adjacent to each other, the environment monitoring system of the storage is integrated with that of the nuclear power plant. A sampling station, equipped with telemetric devices installed next to the site, has been integrated into the similar system of the power plant. Environmental dose rate monitoring, aerosol activity concentration measuring and aerosol/fall-out sampling functions are fulfilled by this station. The entire network, together with the meteorological data obtained by the power plant's meteorological monitoring system, enables dispersion model calculations to be completed for various discharges. The samples taken by the sampling station of the Interim Spent Fuel Storage Facility are processed and assessed in the environmental monitoring laboratory of the nuclear power plant.

Up till now, the environmental monitoring system has not shown any increment of the dose to the population living in the vicinity of the site. The impact can be estimated only if based on calculations using discharge data. Up to now, the excess dose calculated for the critical group of the population from emission data was less than $3x10^{-5}$ *μSv/y annually; in other words, orders of magnitude less than the dose constraint (10 μSv/y).*

ANNEX 2: THE RADIOACTIVE WASTE TREATMENT AND DISPOSAL FACILITY

The Radioactive Waste Treatment and Disposal Facility is located at Püspökszilágy, on the ridge of a hill at an altitude of 200-250 m above sea level. One side of the hill is steep with a slope length of 200-250 m, whereas the other side is longer and slopes more gently.. The groundwater depth is 14 to 16 metres measured from below the bottom of the storage vaults and wells. The facility occupies a surface area of 10 hectares.

An2.1 Description of the facility

The repository is of a near-surface type which consists of reinforced concrete vaults and storage wells.

The vaults and the storage wells are located above the water table in the unsaturated zone within Quaternary clayey loess, which is approximately 30 m thick at the repository location and overlies a thick Tertiary (Upper Oligocene) sequence.

The repository is divided into four areas in order that different types of wastes can be stored or disposed of separately. *Vaults designated as 'A-type' serve for disposal of radioactive waste; vaults designated as 'C'-type' and the storage wells (designated as 'B' and 'D') are used for storage.*

The 'A-type' vault system contains 60 vaults each of 70 m^3 and 6 vaults each of 140 m^3 . The vaults are arranged in four rows. *At the beginning of the repository operation both the conditioned and the non-conditioned wastes were emplaced in plastic bags or metal drums. There were vaults where no backfilling was used and where the voids between the packages were filled with a grout made with low activity waste water or concrete. Most of the vaults are only partially backfilled. After reaching capacity, two vault rows were temporarily covered. The final cap is to be produced only after the safety enhancement measures have been completed.*

In 2004 the 'A-type' vaults containing the solid wastes reached capacity, therefore further waste shipments can only be placed in the interim storage area in the cellar of the technology building. This temporary solution – by which the continuity of reception of institutional radioactive wastes from all over the country can be secured – is to be applied until free storage capacity is provided by recovery of the waste from the designated vaults followed by segregation and, if possible, volume reduction.

The 'C-type' vaults were used to store contaminated organic solvents whose activities were higher than the limit acceptable for incineration. Prior to emplacement the liquid wastes were solidified or soaked up by zeolite at the place of generation. These wastes were usually placed in the storage position in metal cans or metal drums.

This storage system consists of 8 vaults, each of 1.5 m^3, sunk into the ground. The inner walls of the vaults are covered by a waterproof layer.

There are 16 wells of ‘B’ type with a diameter of 40 mm, and 16 wells with diameters of 100 mm. The wells are made from stainless steel, they are 6 m deep, located inside a monolithic concrete structure. The wells of greater diameter accommodate the by-products from the production of ^{60}Co sources. *The radiation sources containing* ^{192}Ir *are separated from other sealed sources.*

The type ‘D’ storage unit consists of four carbon-steel wells, each one is 6 m deep and has a diameter of 200 mm. They can be locked and are provided with a protective cap. These wells were utilised for storing spent radiation sources with a half-life of greater than 5 years.

An2.2 Handling and Storage

Spent gamma sources are not conditioned prior to emplacement into the stainless steel wells. *The 6 m long storage wells have an active depth of 5 m because the 1 m part at the top remains unfilled to provide the necessary radiation protection at the surface. During the operational phase the wells are protected by lead plugs.*

Spent alpha and beta radiation sources are embedded into cement before being disposed of with the other low and intermediate level waste in type ‘A’ disposal units provided the waste acceptance criteria are met.

Reconstruction of the operational building was accomplished in 2003. The basement of the building serves as storage for long-lived radioactive wastes that are not suitable for disposal at the site. In the basement 50 storage wells were constructed for emplacing long-lived disused sealed radiation sources, and space was also provided for eight hundred 200 l drums. Furthermore, a separate room (nuclear material store) is designated for storing nuclear materials. Repacking of the radioactive materials and preparation for disposal is carried out at the base level of the operational building.

At one time, the radium sources used for medical purposes were collected and stored at the National Oncology Institute. In 2001 these radium sources were encapsulated and transferred to the Radioactive Waste Treatment and Disposal Facility for interim storage.

Since 2005, those radioactive wastes containing thorium, uranium and plutonium isotopes as well as disused neutron sources collected from the country’s institutions have been stored in the nuclear material store.

In one of the halls of the building (so called No.2) those wastes are stored having a half life longer than 30 years together with those in which the decay products are volatile or gaseous under normal circumstances (^{14}C, ^{3}H, ^{232}Th, ^{226}Ra*, etc.). The other wastes are being stored in the hall of No. 1.*

An2.3 Transport, disposal and record keeping

The transport of radioactive waste from waste generator to site and on-site is organised by PURAM under its own responsibility, using its own work force and equipment (transport vehicles, containers).

Large gamma sources are usually sealed into a special disposal container by the Institute of Isotopes Ltd. Gamma sources with no surface contamination are not packaged. For their safe transportation lead containers are used. Alpha and beta sources are packed into polyethylene casings. For neutron sources paraffin protection is used, as necessary. Other types of waste are shipped to the facility in drums.

If treatment is required prior to disposal, then the waste is temporarily stored. The types of waste needing treatment include organic solvents, biological waste, contaminated water, damaged or damageable spent sources. Treatment may be by solidification, sponging up of liquid by absorbing material, or by repackaging.

At present only waste packed in metal drums or containers is disposed of in the type 'A' disposal unit.

The Hungarian regulatory system requires all licensees working with radioactive materials to maintain local registries of all radioactive materials in their possession. As one of the licensees, the Radioactive Waste Treatment and Disposal Facility has a waste inventory record keeping system. Originally the record keeping system was based on paper documents, but during the 1980s the old system was replaced by a computerised database. The record keeping system was recently upgraded (1999). The new waste inventory record keeping system was designed in accordance with international recommendations (IAEA-TECDOC-1222: Waste inventory record keeping systems for the management and disposal of radioactive waste). In parallel with the development of the new waste inventory record keeping system, a major revision of inventory data was carried out, which also included a critical review of all existing old information (paper documents as well).

In accordance with the regulations, the Radioactive Waste Treatment and Disposal Facility reports detailed data on the disposal of sealed spent sources to the central registry of radioactive materials, and also submits to the registry annual reports on the volume and radionuclide inventory of bulk waste disposed of.

An2.4 Guarding

The access control system, as part of the refurbishment programme, was installed in 2001. The site is guarded by well-equipped security guards, applying up-to-date security systems. The access control system ensures that only licensed persons and shipments have access to the site and can stay there. The system provides for the identification and computer based registration of accessing persons. The access control system is designed to prevent uncontrolled access of persons and/or vehicles and to warn the security staff of any attempt to trespass. Access to the site is possible only through the access point of the security system, in a controlled manner.

An2.5 Radiation protection and environmental protection

Tight radiation protection control begins already at the waste producers when receiving the waste. Surface dose rate and contamination of the packages are regularly measured. The transport vehicles are subject to radioactive contamination and exposure control. The exposure of personnel is measured by two different types of personal dosimeter.

Prior to start-up of the repository (between 1974 and 1976) the basic radiological levels (so called zero levels) were determined, based on the guidelines of the authority. These levels serve as reference values to interpret the results obtained during the operation of the repository.

The radiological status of the site is continuously monitored; the stringent rules and limits set for discharges are regularly checked by the competent authorities. Installed and portable devices measure the dose rate near the vaults and wells, as well as the surface contamination at the site. All signals of the installed detectors are centrally processed and displayed.

The monitoring system was planned and installed to provide information and data about the radiological conditions of the repository and its environment.

Meteorological data are collected by a special station. The water collection system is designed to collect run-off and is routed to two large basins. The radioactivity of the collected water is sampled and monitored before being discharged via a drainage ditch to a local stream. The water samples are also checked by the authority.

The environmental monitoring system was reconstructed between 2000 and 2001 by replacing obsolete equipment and adding some new checking points.

The character and frequency of sampling and also the methodology of its evaluation are in accordance with the recommendations of international organizations.

PURAM, as the licensee of the repository, monitors all the elements of the repository environment which are relevant to radiological protection according to the annual sampling plan approved by the authority.

Soil-, flora- and fauna samples are taken from the site as well as from the 20 km vicinity of the repository. Analysis of fish samples taken from a nearby pond is also part of the environmental monitoring programme. Radioactivity of flesh, bones and the pluck of sheep and goats grazing in the vicinity of the site is regularly measured. Processing and measurement of the samples take place partly at the local laboratory, partly at external laboratories.

The results of the measurements carried out by the licensee are published in reports which are edited specially for this purpose and also sent to the authority.

The facility is regularly inspected by the competent authority. During inspections, the authority supervises the site itself and does sampling in the vicinity of the site.

Any possible changes in the monitoring measurements can be evaluated by comparing the data with the results of the pre-operational activity concentrations given below:

water	$7x10^{-5}$ - $6x10^{-4}$	Bq/g
mud/soil	0.2 - 0.9	Bq/g
plant	5 - 9	Bq/g ash
fish	~ 3	Bq/g

The results of environmental monitoring, confirmed also by the regulatory authority, prove that there has been no elevated radioactivity level in the environment of the Radioactive Waste Treatment and Disposal Facility.

ANNEX 3: ISOTOPE COMPOSITION OF LLW/ILW

In Hungary, the inventory of radioactive waste - as described in Section D - consists of two major components:

- the waste disposed of in the Radioactive Waste Treatment and Disposal Facility;
- the radioactive waste temporarily stored in Paks Nuclear Power Plant.

The quantity of waste temporarily stored at small-scale waste producers is negligible from the point of view of the overall national inventory. This Annex gives detailed data on the isotope composition of LLW/ILW in the above mentioned two facilities.

An3.1 Radioactive Waste Treatment and Disposal Facility

The following table contains the estimated activity of main isotopes, important for safety, in the inventory of the Radioactive Waste Treatment and Disposal Facility as of 31 December 2007. Isotopes with a half-lifetime of less than 5 years are not included.

Table An3.1-1 Isotope composition of the waste disposed of in the Radioactive Waste Treatment and Disposal Facility (Bq)

Isotope	*Vaults**	*Wells ***	*Sum ****
^{3}H	1.78E+14	1.94E+12	1.80E+14
^{14}C	3.84E+12	7.39E+07	3.85E+12
^{60}Co	8.56E+11	4.24E+14	4.25E+14
^{85}Kr	1.59E+11	1.94E+10	1.78E+11
^{90}Sr	3.13E+13	3.89E+11	3.17E+13
$^{99}Tc^{+}$	1.91E+11	3.37E+06	1.91E+11
^{137}Cs	4.87E+12	9.99E+12	1.49E+13
^{210}Pb	5.03E+08	3.21E+07	5.35E+08
^{226}Ra	9.21E+10	2.19E+11	3.11E+11
^{226}Ra-Be	2.65E+10	1.27E+11	1.53E+11
^{232}Th	4.37E+10	0	4.37E+10
^{234}U	4.84E+09	0	4.84E+09
^{235}U	2.60E+08	0	2.60E+08
^{238}U	4.04E+10	5.00E+04	4.04E+10
^{238}Pu	1.26E+10	8.84E+09	2.15E+10
^{238}Pu-Be	8.28E+11	0	8.28E+11
^{239}Pu	1.40E+12	2.52E+08	1.40E+12
^{239}Pu-Be	4.46E+12	0	4.46E+12
^{241}Am	1.41E+12	3.99E+11	1.81E+12
^{241}Am-Be	3.49E+12	6.29E+12	9.79E+12

Notes:

* *In the column designated as 'vaults' the data of 'A' disposal vaults, 'C' storage vaults and nuclear material stores are listed.*

** *In the column designated as 'wells' the data of radiation sources of 'B' and 'D' storage wells and that of the storage tubes in the operation building are indicated.*

*** *'Total' activity includes both the wastes kept in store and disposed of at the given site.*

$^{99}Tc^{+}$: the majority of it is ^{99m}Tc (^{99}Tc represents up to 1% of the total).

An3.2 Paks Nuclear Power Plant

Table An3*.2-1 summarises the average and the highest activity concentrations of radioisotopes measured so far in the various waste streams of the nuclear power plant.*

The figures were calculated based on the measurements carried out between 1992 and 31 December 2006because at the time of drafting this report new data on the-difficult-to-measure nuclides were not available.

Table An3.2-1 Average and maximum activity concentration of radioisotopes contained in the waste of Paks NPP (Bq/dm^3)

Isotope	*Waste stream*					
	Solid		*Concentrate*		*Resin*	
	Max.	*Average*	*Max.*	*Average*	*Max.*	*Average*
^{124}Sb	5.67E+06	3.90E+05	5.00E+04	9.60E+03	N.A.	N.A.
^{58}Co	7.98E+07	3.89E+06	2.30E+06	2.18E+05	6.40E+06	2.40E+06
^{110m}Ag	3.15E+07	1.20E+06	9.70E+05	2.28E+05	5.40E+08	9.80E+07
^{54}Mn	7.23E+07	4.33E+06	1.60E+07	7.57E+05	3.90E+08	1.00E+08
^{134}Cs	5.90E+07	3.06E+06	8.50E+06	2.87E+05	1.30E+08	1.90E+07
^{55}Fe	7.80E+07	2.50E+06	2.70E+07	1.89E+06	8.00E+09	3.36E+09
^{60}Co	1.16E+08	8.67E+06	4.90E+07	1.64E+06	6.30E+07	1.70E+07
^{3}H	N.A.	N.A.	6.40E+05	1.66E+05	4.30E+05	9.55E+04
^{244}Cm	1.20E+01	2.00E-02	1.50E+04	6.29E+02	4.20E+04	7.60E+03
^{90}Sr	9.60E+00	1.90E+00	4.20E+05	1.86E+04	6.29E+06	2.59E+06
^{137}Cs	1.08E+08	2.59E+06	5.90E+06	1.02E+06	2.20E+08	4.00E+07
^{238}Pu	2.80E-01	4.20E-02	4.90E+03	2.47E+02	9.60E+04	1.40E+04
^{63}Ni	2.20E+05	1.60E+04	1.90E+06	4.28E+05	1.10E+07	7.00E+06
^{241}Am	8.90E-01	9.60E-02	4.20E+03	2.25E+02	1.80E+04	2.88E+03
^{14}C	2.80E+05	1.50E+04	1.56E+04	6.67E+03	4.30E+05	1.13E+06
^{243}Am	N.A.	N.A.	3.00E-01	4.60E-02	6.60E-01	6.60E-01
^{94}Nb	5.80E+05	1.70E+02	3.90E+01	4.60E-02	1.40E+02	1.40E+02
$^{239+240}$Pu	3.90E-01	5.50E-02	3.30E+03	1.91E+02	9.50E+04	1.38E+04
^{59}Ni	2.20E+03	1.70E+02	4.60E+04	8.60E+03	4.50E+05	1.29E+05
^{41}Ca	1.10E+01	5.50E-02	5.50E+01	1.06E+01	1.70E+04	2.50E+03
^{99}Tc	5.60E+00	1.00E+00	7.67E+01	9.88E+00	5.76E+04	1.92E+04
^{234}U	1.20E-02	3.80E-03	2.67E+00	4.43E-01	1.46E+02	4.20E+01
^{36}Cl	2.90E-01	2.10E-02	6.40E+00	2.50E+00	5.07E+03	2.15E+03
^{135}Cs	1.20E+00	2.40E-02	3.70E+00	3.90E+00	1.10E+03	6.90E+02
^{129}I	3.00E-02	1.10E-03	2.17E+03	2.64E+02	1.79E+04	5.13E+03
^{235}U	2.50E-03	8.40E-04	1.20E-01	3.93E-02	2.60E+01	1.32E+01
^{238}U	9.20E-03	2.70E-03	8.11E-01	2.33E-01	5.50E+01	1.65E+01

Notes:
N.A.: no data available
The "mean values" are the arithmetic mean of the values measured during the period between 1992 and 31 December 2006 (25-110 measurements for each isotope).
The waste streams do not contain the amounts from the incident in 2003 (see table below).
The "Max values" are the highest activity concentrations measured so far.

Table An3.2-2 Calculated quantity and total activity of wastes resulting from the incident in Paks NPP Unit 2 (Bq)

Isotope	***Waste stream***		
	Solid (400 m^3)	***Concentrate (310 m^3)***	***Resin (60 m^3)***
^{124}Sb	2.21E-17	1.61E-15	2.17E-14
^{58}Co	1.27E-11	9.23E-10	1.25E-08
^{242}Cm	3.05E+00	6.45E+02	2.75E+03
^{110m}Ag	1.09E+03	4.40E+04	1.07E+06
^{54}Mn	1.53E+05	1.11E+07	1.50E+08
^{134}Cs	7.72E+08	1.65E+10	7.71E+11
^{55}Fe	1.06E+09	7.73E+10	1.04E+12
^{60}Co	1.16E+09	8.45E+10	1.14E+12
^{3}H	9.61E+07	8.01E+10	1.60E+10
^{244}Cm	1.00E+08	2.12E+10	9.03E+10
^{90}Sr	7.44E+02	3.01E+04	7.29E+05
^{137}Cs	5.81E+10	1.24E+12	5.80E+13
^{238}Pu	5.09E+08	1.07E+11	4.58E+11
^{63}Ni	6.55E+08	4.76E+10	6.42E+11
^{241}Am	2.71E+08	5.72E+10	2.44E+11
^{14}C	2.76E+06	3.04E+08	2.48E+09
^{243}Am	2.50E+06	5.27E+08	2.25E+09
^{94}Nb	6.29E+06	4.57E+08	6.17E+09
$^{239+240}Pu$	5.24E+08	1.11E+11	4.73E+11
^{59}Ni	8.26E+06	6.00E+08	8.09E+09
^{41}Ca	3.45E+03	1.04E+05	3.38E+06
^{99}Tc	2.35E+02	4.71E+03	2.31E+05
^{234}U	1.67E+06	3.52E+08	1.50E+09
^{36}Cl	4.66E+04	4.66E+06	4.20E+07
^{135}Cs	3.02E+05	6.44E+06	3.01E+08
^{129}I	2.17E+04	2.17E+05	2.15E+07
^{235}U	4.75E+04	1.00E+07	4.27E+07
^{238}U	3.36E+05	7.10E+07	3.03E+08

Note:
The activity values are valid for 2017.

Table An3.2-3 contains the activity of certain radioisotopes which are important for safety assessments. These were calculated from the average activity concentrations in the various waste streams and the quantity of wastes expected by the end of the operational life-time of the nuclear power plant (2017).

Table An3.2-3 Estimated activity of certain radioisotopes by the end of the operation of Paks NPP (Bq)

Isotope	***Waste stream***			
	Solid	***Concentrate***	***Resin***	***Sum***
^{124}Sb	*8.45E+08*	*1.56E+09*	*N.A.*	*2.40E+09*
^{58}Co	*1.81E+10*	*1.73E+11*	*1.23E+10*	*2.03E+11*
^{110m}Ag	*2.18E+10*	*9.01E+10*	*7.68E+11*	*8.80E+11*
^{54}Mn	*3.17E+10*	*1.03E+11*	*9.00E+11*	*1.03E+12*
^{134}Cs	*1.70E+09*	*2.02E+11*	*3.32E+11*	*5.35E+11*
^{55}Fe	*1.76E+12*	*3.17E+11*	*5.61E+13*	*5.81E+13*
^{60}Co	*3.38E+11*	*1.03E+12*	*6.15E+11*	*1.98E+12*
^{3}H	*N.A.*	*4.77E+11*	*7.52E+10*	*5.53E+11*
^{244}Cm	*4.07E+04*	*2.99E+08*	*5.52E+07*	*3.54E+08*
^{90}Sr	*2.32E+05*	*1.28E+10*	*2.48E+11*	*2.61E+11*
^{137}Cs	*1.68E+10*	*2.85E+12*	*2.85E+12*	*5.71E+12*
^{238}Pu	*1.08E+05*	*2.05E+08*	*1.55E+08*	*3.60E+08*
^{63}Ni	*4.12E+10*	*5.92E+11*	*2.79E+11*	*9.12E+11*
^{241}Am	*2.58E+05*	*1.92E+08*	*3.77E+07*	*2.30E+08*
^{14}C	*4.07E+10*	*2.46E+10*	*3.01E+11*	*3.66E+11*
^{243}Am	*N.A.*	*1.96E+05*	*5.61E+04*	*2.52E+05*
^{94}Nb	*4.62E+08*	*6.80E+07*	*1.19E+07*	*5.42E+08*
$^{239+240}Pu$	*1.50E+05*	*1.73E+08*	*8.43E+06*	*1.81E+08*
^{59}Ni	*4.62E+08*	*2.39E+10*	*3.25E+10*	*5.68E+10*
^{41}Ca	*1.50E+05*	*4.30E+07*	*1.19E+09*	*1.23E+09*
^{99}Tc	*2.72E+06*	*3.04E+07*	*3.70E+08*	*4.03E+08*
^{234}U	*1.03E+04*	*1.01E+06*	*5.93E+06*	*6.95E+06*
^{36}Cl	*5.71E+04*	*9.97E+06*	*8.43E+07*	*9.43E+07*
^{135}Cs	*6.53E+04*	*1.66E+07*	*1.79E+07*	*3.45E+07*
^{129}I	*2.99E+03*	*2.33E+08*	*9.15E+07*	*3.24E+08*
^{235}U	*2.28E+03*	*2.65E+05*	*2.08E+06*	*2.35E+06*
^{238}U	*7.34E+03*	*7.70E+05*	*3.97E+06*	*4.74E+06*

Note:
N.A.: No data available

The data presented in Table An3.2-3 were based on the quantities as follows.

- *Up to 31 December 2001:*
  - *Solid waste: 120 m^3/year*
  - *Concentrate: 250 m^3/ year*
  - *Resin: 2.5 m^3/ year*

- *From 2002 to 2017:*
  - *Solid waste: 160 m^3/ year*
  - *Concentrate: 250 m^3/ year*
  - *Resin: 5 m^3/ year*

The total life-time of the nuclear power plant is taken to be 30 years. The solid low level waste that was transported to the Radioactive Waste Treatment and Disposal Facility is not included in the quantities. The effects of the planned liquid waste treatment technology are not taken into account. Wastes arising from decommissioning are not taken into account.

ANNEX 4: LIST OF LAWS RELEVANT TO THE CONVENTION

Acts, Law-decrees

I.1	Law-decree 12 of 1970	on the promulgation of the treaty on non-proliferation of nuclear weapons resolved by Session No. XXII. of the General Assembly of the United Nations Organisation on the 12th of June in 1968
I.2	Act IV of 1978	concerning the Penal Code
I.3	Law-decree 8 of 1987	on the promulgation of the convention on physical protection of nuclear materials
I.4	Act XXXVIII of 1992	concerning the state budget
I.5	Act LIII of 1995	on the general rules for the protection of the environment
I.6	Act CXVI of 1996	on atomic energy
I.7	Act I of 1997	on the promulgation of the Convention on Nuclear Safety concluded in Vienna on the 20th of September in 1994 under the umbrella of the International Atomic Energy Authority
I.8	Act CLVI of 1997	on non-profit organizations
I.9	Act L of 1999	on the confirmation by the Republic of Hungary and on the promulgation of the Comprehensive Test-ban Treaty resolved by the General Assembly of the United Nations Organisation on the 10th of September in 1996
I.10	*Act LXXIV of 1999*	*on the management and organization for the protection against disasters, and on the protection against severe accidents involving dangerous materials*
I.11	Act LXXVI of 2001	on the promulgation of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management concluded under the International Atomic Energy Agency
I.12	*Act CXL of 2004*	*on the general rules of regulatory procedures and services in the public administration*
I.13	*Act IV. of 2006*	*on business associations*
I.14	*Act LXXXII of 2006*	*on the promulgation of the safeguards agreement and protocol in the implementation of Article III(1) and (4) of the Treaty on the Non-Proliferation of Nuclear weapons, and on the promulgation of the Additional Protocol, enclosed with the agreement*

Governmental decrees, decrees of the Council of Ministers

II.1	Decree of the Council of Ministers 28/1987. (VIII. 9.)	on the promulgation of the convention on early notification of a nuclear accident signed in Vienna on the 26th of September in 1986
II.2	Decree of the Council of Ministers 29/1987. (VIII. 9.)	on the promulgation of the convention on assistance in the case of a nuclear accident or radiological emergency, signed in Vienna on the 26th of September in 1986
II.3	Decree of the Council of Ministers 70/1987. (XII. 10.)	on the promulgation of the agreement on regulation of mutually interesting questions relating to nuclear facilities concluded between the Government of the Hungarian People's Republic and the Government of the Austrian Republic, signed in Vienna on the 29th of April in 1987
II.4	Decree of the Council of Ministers 93/1989. (VIII. 22.)	on the promulgation of the Reviewed Complementary Agreement on the technical assistance of the International Atomic Energy Agency to Hungary concluded between the Government of the Hungarian People's Republic and the International Atomic Energy Agency, signed on the 12th of June in 1989
II.5	Decree of the Council of Ministers 24/1990. (II. 7.)	on the promulgation of the international convention on civil liability for nuclear damage concluded in Vienna on the 21st of May in 1963
II.6	Governmental Decree 73/1991. (VI. 10.)	on the promulgation of the agreement on regulation of mutually interesting questions relating to nuclear safety and radiation protection between the Government of the Republic of Hungary and the Government of the German Federal Republic, signed in Budapest on the 26th of September in 1990
II.7	Governmental Decree 108/1991. (VIII. 28.)	on the promulgation of the agreement on mutual information and co-operation in the field of nuclear safety and radiation protection between the Government of the Republic of Hungary and the Government of the Czech and Slovak Federal Republic, signed in Vienna on the 20th of September in 1990
II.8	Governmental Decree 130/1992. (IX. 3.)	on the promulgation of the joint record of the application of the Vienna Convention on civil liability for nuclear damage, and the application of the Paris Convention on the civil liability in the field of nuclear energy, signed on the 20th of September in 1989
II.9	Governmental Decree 17/1996. (I. 31.)	on the actions in connection with the found or confiscated radioactive or nuclear materials
II.10	Governmental Decree 124/1997. (VII. 18.)	on radioactive materials as well as equipment generating ionising radiation, exempted from the scope of the Atomic Energy Act CXVI of 1996.
II.11	Governmental Decree 185/1997. (X. 31.)	on the promulgation of the agreement on the early notification in the case of radiological emergency concluded between the Government of the Republic of Hungary and the Government of the Republic of Slovenia, signed in Budapest on the 11th of July in 1995
II.12	Governmental Decree 213/1997. (XII. 1.)	on the exclusion zone of the nuclear installation and the spent fuel storage facility

II.13	Governmental Decree 227/1997. (XII. 10.)	on the type, conditions and sum of the liability insurance or other liability financial coverage concerning nuclear damage
II.14	Governmental Decree 240/1997. (XII. 18.)	on the establishment of the organisation designated for implementing the disposal of radioactive waste and spent fuel, as well as decommissioning of nuclear installations, and on the financial source for performing such tasks
II.15	Governmental Decree 248/1997. (XII. 20.)	on the National Nuclear Emergency Response System
II.16	Governmental Decree 61/1998. (III. 31.)	on the promulgation of the agreement on the early notification in the case of nuclear accidents concluded between the Government of the Republic of Hungary and the Government of Romania, signed in Bucharest on the 26th of May in 1997
II.17	Governmental Decree 108/1999. (VII. 7.)	on the promulgation of the agreement on the early notification in the case of nuclear accidents, and on the mutual information and co-operation in the field of nuclear safety and radiation protection, concluded between the Government of the Republic of Hungary and the Government of Ukraine, signed in Budapest on the 12th of November in 1997
II.18	Governmental Decree 13/2000. (II. 11.)	on the promulgation of the agreement on the early notification in the case of radiological accidents concluded between the Government of the Republic of Hungary and the Government of the Republic of Croatia, signed in Zagreb on the 11th of June in 1999
II.19	Governmental Decree 72/2000. (V. 19.)	on the special conditions of acquiring the possession rights of certain materials, equipment and facilities belonging in the scope of application of atomic energy, as well as on the procedure for reporting their possession and operation
II.20	Governmental Decree 136/2002. (VI. 24.)	on the promulgation of the agreement on cooperation in the field of the peaceful use of atomic energy between the Government of the Republic of Hungary and the Government of Australia
II.21	Governmental Decree 275/2002. (XII. 21.)	on the monitoring of radiation levels and radioactivity concentrations in Hungary
II.22	Governmental Decree 114/2003. (VII. 29.)	on the duties, scope of authority and the jurisdiction of imposing penalties of the Hungarian Atomic Energy Authority, and on the activity of the Atomic Energy Co-ordination Council
II.23	Governmental Decree 165/2003. (X. 18.)	on the information to be provided to the public in nuclear and radiological emergencies
II.24	Governmental Decree 155/2004. (V. 14.)	on the licensing of shipment of radioactive waste across the national border
II.25	Governmental Decree 244/2004.(VIII. 25.)	on the promulgation of the protocol on conditions concerning the reshipment to the Russian Federation of Russian-made (irradiated) spent fuel assemblies
II.26	Governmental Decree 263/2004. (IX. 23.)	on the regulation of international trade of nuclear and nuclear dual-use items

II.27	Governmental Decree 89/2005. (V. 5.)	on the nuclear safety requirements of nuclear facilities and the related regulatory activities
	Annex No. 1 Nuclear Safety Code Volume 1	Regulatory procedures for nuclear power plants
	Annex No. 2 Nuclear Safety Code Volume 2	Quality management of nuclear power plants
	Annex No. 3 Nuclear Safety Code Volume 3	Design requirements for nuclear power plants
	Annex No. 4 Nuclear Safety Code Volume 4	Safety requirements for the operation of nuclear power plants
	Annex No. 5 Nuclear Safety Code Volume 5	Nuclear safety code for research reactors
	Annex No. 6 Nuclear Safety Code Volume 6	Nuclear safety code for spent fuel interim storage facilities
II.28	*Governmental Decree 314/2005. (XII. 25.)*	*on environmental impact assessment and on the integrated environmental usage permitting process*
II.29	*Governmental Decree 257/2006. (XII. 15.)*	*on declaring the outstanding importance of certain administrative regulatory matters in connection with the project of a repository of low and intermediate activity, to be established in Bátaapáti*
II.30	*Governmental Decree 362/2006. (XII. 28.)*	*on the National Public Health and Medical Officer Service and on the designation of the administrative body of pharmaceutics*
II.31	*Governmental Decree 267/2006. (XII. 20.)*	*on the Hungarian Office for Mining and Geology*

Ministerial Decrees

III.1	Decree of the Minister of Transportation and Post 20/1979. (IX. 18.)	on the promulgation and inland application of Appendixes “A” and “B” of the European Agreement about the International Public Road Transportation of Dangerous Goods
III.2	Decree of the Minister of Construction and City-planning 11/1984. (VIII. 1)	on the rules for constructing nuclear facilities
III.3	Decree of the Minister of the Interior 47/1997. (VIII. 26.)	on the tasks of the police in connection with the application of atomic energy
III.4	Decree of the Minister of Industry, Trade and Tourism 62/1997. (IX. 26.)	on the geological and mining requirements for the siting and planning of nuclear facilities and radioactive waste disposal facilities
III.5	Decree of the Minister of Transportation, Telecommunication and Water 13/1997. (IX. 3.)	on the promulgation of the regulation on the safe railway transportation of spent nuclear fuel
III.6	Decree of the Minister of Transportation, Telecommunication and Water 14/1997. (IX. 3.)	on the transportation, shipment and packaging of radioactive materials
III.7	Decree of the Minister of Public Welfare 23/1997. (VII. 18.)	on the exemption levels (activity-concentrations and activities) of radionuclides
III.8	Joint Decree of the Minister of Industry, Trade and Tourism and the Minister of Education 49/1998. (VI. 25.)	on the professional training and further education of those employed at the nuclear power plant, or at the research reactor, or at the training reactor, and on those who are entitled to pursue activities connected with the application of nuclear energy
III.9	Decree of the Minister of Economy 27/1999. (IV. 4.)	on the fees for final disposal of radioactive wastes
III.10	Decree of the Minister of Health 16/2000. (VI. 8.)	on the execution of certain provisions of Act CXVI of 1996 on Atomic Energy associated with radiation protection
III.11	Decree of the Minister of Health 30/2001. (X. 3.)	on the operational radiation protection of the outside workers
III.12	Decree of the Minister of Health 31/2001. (X. 3.)	on the protection of the health of individuals exposed to ionising radiation during medical services
III.13	Decree of the Minister of Environment 15/2001. (VI. 6.)	on the radioactive releases into the air and into the water in connection with the application of atomic energy, and on their control
III.14	Decree of the Minister of Health 8/2002. (III. 12.)	on the establishment and operation of radiological monitoring and data collecting network in the health-care sector
III.15	Decree of the Minister of Defence 33/2002. (V. 3.)	on the application of Act CXVI of 1996 on Atomic Energy regarding national defence issues
III.16	Decree of the Minister of Health, Social and Family Affairs 47/2003. (VIII. 8.)	on certain issues of interim storage and final disposal of radioactive wastes, and on certain radiohygiene issues of naturally occurring radioactive materials concentrating during industrial activity
III.17	Decree of the Minister of Interior 33/2004. (VI. 28.)	on the central and local accountancy system for radioactive materials
III.18	*Decree of the Minister of Justice 14/2005. (VII.25)*	*on the operation and administration of the Central Nuclear Financial Fund*
III.19	*Decree of the Minister of Justice and Law Enforcement 7/2007. (III. 6.)*	*on the rules of accountancy for and control of nuclear materials*

IV. Government Resolutions

IV.1	*2161/1994. (XII. 30.) Korm. határozat*	*on uranium mining*
IV.2	*2085/1997. (IV. 3.) Korm. határozat*	*on discontinuing uranium mining in the Mecsek Hills*
IV.3	*2385/1997. (XI. 26.) Korm. határozat*	*on the investment programme of the remediation tasks for the abandonment of the uranium industry in Hungary*
IV.4	2006/2001. (I. 17.) Korm. határozat	on the modification of governmental resolution 2085/1997. (IV. 3.) on discontinuing uranium mining in the Mecsek Hills, and of governmental resolution 2385/1997. (XI. 26.) on the investment programme of the remediation tasks for the abandonment of uranium mining in Hungary
IV.5	*2122/2006. (VII. 11.) Korm. határozat*	*on further tasks related to the abandonment of uranium mining in Hungary*

ANNEX 5: REFERENCES TO OFFICIAL NATIONAL AND INTERNATIONAL REPORTS RELATED TO SAFETY

An5.1 Report to Parliament on the safety of nuclear applications in Hungary

The Act on Atomic Energy [I.6] obliges the Director General of the Hungarian Atomic Energy Authority to submit an annual report to the Government and Parliament on the safety of nuclear applications in Hungary. According to the executive order of the Act [II.22] it is the task of the Hungarian Atomic Energy Authority to prepare this report.

In preparing the report, the Hungarian Atomic Energy Authority is supported by the other regulatory authorities competent in nuclear applications. The report is subject to intergovernmental discussion and the Government decides on its presentation to Parliament.

The annual report describes the manifold activities related to the safety of the nuclear facilities as well as to the safety of applications of radioactive and nuclear materials and devices emitting ionising radiation. The report consists of the following main chapters:

- Utilisation of atomic energy;
- State-level framework of safety;
- *Supervision of nuclear facilities;*
- *Supervision of nuclear and radioactive materials;*
- *Supervision of radiation safety and radiation protection;*
- Nuclear emergency preparedness;
- *Scientific-technical background;*
- International relations;
- *Hungary`s role in the European Union;*
- Public relations.

The report for the years 2005 and 2006, similarly to the previous reports, concluded that the nuclear applications in Hungary fulfil the relevant safety requirements. The Government presented the reports simultaneously to Parliament: the competent committees of Parliament agreed with them, and the plenary session accepted them without objecting or abstaining votes on 14 April, 2008.

An5.2 National Report prepared in the framework of the Convention on Nuclear Safety

Hungary is a Party to the Convention on Nuclear Safety and prepared a National Report on the fulfilment of the obligations contained in this Convention in 1998, in 2001, in 2004 and in *2007*. The Reports were favourably taken up in the review meetings. The reports are available on the homepage of the Hungarian Atomic Energy Authority (www.haea.gov.hu).

An5.3 Participation in the reporting schemes of the IAEA

Hungary, as a Member State of the International Atomic Energy Agency, takes part in the international systems (Incident Reporting System-IRS, and International Nuclear Event Scale-INES) for exchanging information on safety related events. In applying INES, the national INES co-ordinator reports all safety-related events above the level INES 0 to the International Atomic Energy Agency.

Since 2000 this obligation is extended to the Interim Spent Fuel Storage Facility, but in this facility, corresponding to the favourable operational experience, no events took place that were to be reported in the framework of IRS or INES.

ANNEX 6: REFERENCES TO REPORTS ON INTERNATIONAL REVIEW MISSIONS PERFORMED AT THE REQUEST OF HUNGARY

An6.1 IRRT mission at the Hungarian Atomic Energy Authority

Teams of the International Atomic Energy Agency visited the Hungarian Atomic Energy Authority twice, at the request of the Hungarian Government authorities, to conduct a mission. In each case, the purpose of the International Regulatory Review Team (IRRT) mission was to review the effectiveness of the activity of Hungarian nuclear safety regulatory body and to exchange information and experience in the regulation of nuclear, radioactive waste and radiation safety. The first review was conducted from 22 May to 2 June 2000. The second mission took place on 9-18 February 2003. In the final report of the review, the situation and the accomplished work were evaluated, and the expert team concluded that the Hungarian Atomic Energy Authority had made efforts with regard to each recommendation and suggestion to improve its performance and had made significant steps forward in most areas.

An6.2 After incident expert mission of the International Atomic Energy Agency

In April 2003, a serious incident occurred in a cleaning system of nuclear fuel installed in the service pool during the refuelling period of Unit 2 of Paks NPP. Such processes occurred that the fuel assemblies handled in the system suffered severe damage. Upon the suggestion of the Director General of the Hungarian Atomic Energy Authority, and at the request of the Minister of economy and transport (supervising at that time the Hungarian Atomic Energy Authority) on behalf of the Government, the International Atomic Energy Agency conducted a review and assessment on the activity of the regulatory body and the utility in connection with the incident. The result of the expert mission conducted between 16 and 25 June 2003 is available on the homepage of the Hungarian Atomic Energy Authority (www.haea.gov.hu).

The International Atomic Energy Agency expert group had a follow-up mission in Hungary from 20 February – 1 March 2005. According to the report prepared at the end of the investigations, 34 of the 48 recommendations on the practice of authority had been completed while good progress had been made regarding the other 14. The final report prepared by the International Atomic Energy Agency is also available on the web site of the Hungarian Atomic Energy Authority.

The recommended measures for the improvement of regulatory practices were fully undertaken by Hungarian Atomic Energy Authority until the end of 2005. The recommendations were primarily focused on the amendment of the legal basis (e.g. regulations planned for 2003 were issued only in 2005, thus recommendations of the mission could be taken into account) and on the improvement of the efficiency of the organisation (which was carried out in autumn 2004).

In addition, the Hungarian Atomic Energy Authority had been permanently inspecting the fulfilment of the improving measures of Paks Nuclear Power Plant as well. Some of these tasks were able to be finished in recent years, an example of which was the Operational and Organisational Improving Project of NPP Paks.

The removal of the consequences of the incident is dealt with in Annex 8.

ANNEX 7: THE REMEDIATION OF THE CLOSED URANIUM MINE

An7.1 Antecedents

Six mining plots were established during the operation of the underground and surface facilities of Hungarian uranium ore mining and milling. These plots are located to the west of the city of Pécs, on the western and southern sides of the Mecsek Hills.

Because uranium mining became uneconomical in the 1980s, the Government decided that it should be discontinued. Production was terminated in 1997. In accordance with the decision, an investment plan was developed for the remediation of the environmental damage caused by Hungarian uranium ore mining and milling. *The implementation of the plan commenced on 1 January 1998 in compliance with government resolutions [IV.1] and [IV.2].*

Remediation tasks were carried out according to plan until the end of 2002. However, since 2003 the funds allocated by the government in its annual budget acts have been insufficient to allow the completion of work by the planned deadline. *At present*, the financial arrangements related to the state-controlled investment project are made in *accordance with government resolution [IV.5]* on subsequent tasks related to the abandonment of uranium ore mining in Hungary. The resolution set a *new deadline for the completion of the remediation activities, this being 31 December 2008. Also, the budget of the remediation project has been increased from HUF 19.1 to HUF 20.7 milliard.*

An7.2 Environmental remediation programme

An7.2.1 Primary remediation objectives

The remediation objectives to be achieved were specified in the concept plan developed in 1996:

- eliminating or minimising the environmental damage caused by uranium mining:
  - protecting the drinking water reserve of Pécs,
  - reducing the harmful effects of the formerly carried out mining and milling activities to the extent that the additional dose received by workers will remain below approved limits,
  - monitoring the effects of contamination sources, ensuring the possibility of intervention if needed,
  - decreasing future harmful effects of mining to the lowest possible level;
- re-utilising the areas and facilities of the uranium industry to the optimum extent:
  - decontaminating objects,
  - making the infrastructure originally created for mining suitable for other purposes,
  - creating new jobs in the context of the above mentioned issues;
- defining the costs of both the cessation of uranium ore production and environmental remediation;
- implementing the concept plan in a cost-effective and appropriately scheduled way.

An7.2.2 Radiation protection requirements

Relevant Hungarian as well as international laws and standards, the recommendations of the International Atomic Energy Agency, and the practices of other countries play an important role in setting out requirements. The authorities laid down the environmental protection conditions of the planning and licensing process of decommissioning and remediation activities in the environmental protection licence issued by the South Transdanubian Environmental Protection Inspectorate. The system was based on the document entitled “Environmental impact assessment of uranium ore mining in the Mecsek Hills” and on the specifications drawn up by the Baranya County Institute of National Public Health and Medical Officer Service in connection with the radiation protection requirements of remediation.

The following limit values for the release and environmental load have to be complied with in the course of mine closure and remediation projects according to the environmental protection licence and the specifications of the Baranya County Institute of National Public Health Medical Officer Service.

Table An7.2.2-1 . Radiation protection requirements for the remediation of waste rock piles, heap leaching piles and tailings ponds

Rn exhalation	0.74 $Bq/m^2/s$
Rn concentration	*background + 30* Bq/m^3
Gamma-dose rate	background + 200 nGy/h
Activity concentration of soil in the uppermost 0-15 cm layer in the next 15 cm layer	 background + 180 Bq/kg background + 550 Bq/kg

Table An7.2.2-2 . Radiation protection requirements for the remediation of surface facilities, buildings and their immediate surroundings

Surface facilities	Rn exhalation	0.74 $Bq/m^2/s$
	Activity concentration of soil in the uppermost 15 cm layer	background + 180 Bq/kg
	Activity concentration of soil below 15 cm depth	background + 550 Bq/kg
Inside buildings	Rn concentration	*1000* Bq/m^3
	Gamma-dose rate workplace average 1 m from floor or walls	 background + 200 nGy/h background + 200 nGy/h
	Fixed alpha contamination (on floor and walls)	0.5 Bq/cm^2

Note on Tables An7.2.2-1 and An7.2.2-2: the limit for radon concentration was changed by the relevant authority in 2007. The environmental protection licence permits only limited use of the buildings: utilisation as living space, as a facility for children, or for foodstuff production is not permitted.

An7.2.3 Dimensions of the remediation programme

The determination of the size of mining objects was a basic requirement for the execution of remediation tasks in the planned manner. The characteristic features of the main objects and facilities on the mining plots and other sites are the following:

- volume of underground openings $17.9 \ast 10^{6}$ m^{3}
- volume of the nine waste rock piles $10 \ast 10^{6}$ m^{3}
- volume of the two heap leaching piles $3.4 \ast 10^{6}$ m^{3}
- contaminated industrial area *62 ha*
- volume of the two tailings ponds $16.2 \ast 10^{6}$ m^{3}

An7.2.4 An overview of the remediation tasks of the Investment Programme

The Investment Programme consisted of ten projects. The schedule of the programme is shown in Table An7.2.4-1.

Table An7.2.4-1 Schedule of the remediation programme

Project title	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	***2007***	***2008***
Underground mines											
Surface facilities											
Waste rock piles											
Heap leaching piles											
Tailings ponds											
Mine water treatment											
Restructuring of electricity supply											
Water supply and sewage											
Infrastructure works											
Monitoring, misc. activities											

Parallel with the Investment Programme, another programme called "The Follow-up Survey of Uranium Miners' Health Status" has been going on for several years on the initiative of the Scientific Committee on Mining of the Hungarian Academy of Sciences. *The website of MECSEK-ÖKO Zrt, the company in charge of the remediation project, provides the public with information on the solutions and achievements in the fields of remediation, landscaping, water treatment, and monitoring.*

An7.3 Post-remediation tasks

The "Investment Programme of the remediation tasks of the abandonment of the uranium mining in Hungary" approved by a *government resolution [IV.3]* included the costs of the so-called long-term tasks (water purification, maintenance, monitoring activities) until 31 December 2002. Since these tasks will continue to be ongoing responsibilities in the future for environmental, health and water reserve protection reasons, *a new government resolution [IV.4]* was made to provide for the financing of these tasks as of 1 January 2003. Under the resolution the funds must be earmarked in the budget of *the Ministry of Transport, Telecommunication and Energy in a format agreed to by the Ministry of Environment Protection and Water Management.*

For the long-term success of technical interventions made for the purposes of environmental protection and reclamation according to the plans of the Investment Programme and meeting official requirements, controlling, monitoring and maintenance tasks are to be performed. These tasks vary in terms of their scale, character and length of time in the case of each object.

In accordance with the methodology accepted internationally in the field of remediation, the execution of these tasks are divided into two phases with regard to the amount and character of the required activities:

- the first five-year phase generally involves a broad and diverse range of control activities as well as more intensive after-care procedures;
- the second, long-term phase involves only limited control and after-care procedures as and when needed.

Environmental monitoring and environmental protecting activities constitute the two main fields of after-care work. Environmental monitoring includes on-site measurements, sampling, data recording, laboratory analyses, data processing, interpretation and modelling. Providing information for authorities and the public is another important task. The following long-term tasks have to be performed in the interest of environmental protection:

- removal of uranium from surface and groundwaters (the capacity of the water treatment station is 1.5 million m^3 annually);
- groundwater treatment (treatment of a water volume of 1000-1200 m^3/day);
- maintenance of water treatment stations, decontamination and water discharging systems;
- operation of the unified water discharge system;
- maintenance and after-care of areas of limited utilisation.

Considerable after-care activities are expected on the tailings ponds, which are the largest and most sensitive objects due to the complexity of the cover layer. To protect the drinking water reserve, the sulphate-containing water that seeped into the soil from the tailings ponds is removed and treated chemically. Biological reclamation will not be fully completed by the end of the Investment Programme as the planting and after-care of *woody plants* are likely to take longer due to the circumstances.

The environmental audit of mining remediation took place in 2006. The audit established that remediation works had been carried out according to the originally approved program, and the area of a number of former facilities may now be utilised without any restriction. It also found that the radiological exposure of the public had decreased as the area of contaminated surfaces in direct contact with air had significantly decreased. A further task is to assess the effectiveness and expected length of time of restoring groundwater quality in the surroundings of the tailings ponds by modelling the contaminant transport.

ANNEX 8: NUCLEAR FACILITIES, SPENT FUEL ASSEMBLIES, DISCHARGES

An8.1 Paks Nuclear Power Plant

An8.1.1 Management of the spent fuel assemblies

An8.1.1.a Regulatory framework

The design and implementation of systems and management for spent fuel assemblies as well as the development of handling processes were accomplished according to the Soviet norms that were in effect at the time of constructing the Paks Nuclear Power Plant as were the requirements of Safety Regulations for Nuclear Power Plants promulgated by a decree in force at that time. Legal and technological changes taking place in the meantime made it necessary to renew this regulation. The Government of the Republic of Hungary, based on the authorization given in the Act on Atomic Energy [I.6], issued the governmental decree on the proceedings of the Hungarian Atomic Energy Authority [II.27]. As appendices of this decree, the Nuclear Safety Codes were issued replacing the above mentioned Safety Regulations for Nuclear Power Plants.

Management of the spent fuel assemblies shall meet the requirements of Nuclear Safety Codes. The functional requirements for tools and equipment of spent fuel management are the following:

a) Criticality shall be prevented by sufficient safety redundancy during the expected operational events and supposed operational failures, even among optimal moderating circumstances, by applying physical tools or principles.
b) Removal of remanent heat shall be ensured in all operational states.
c) Possibility of the drop (or other damage) of a fuel assembly shall be kept to a minimum.
d) Unacceptable mechanical stress shall be prevented in the fuel assemblies.
e) The possibility of any heavy objects falling onto the fuel assemblies shall be prevented.
f) Storage of fuel assemblies with potential or detectable damage shall be solved.
g) During spent fuel management, radiation protection shall be ensured.

An8.1.1.b Systems managing spent fuel elements

<u>Storage of spent fuel assemblies</u>

Spent fuel generated during operation of the nuclear power plant need to be stored prior to any potential further processing or direct disposal. The basic function of the storage in the vicinity of the reactor – with limited capacity – is to ensure the storage during the period until the specific activity and heat generation of the spent fuel assemblies diminish to a level that enables its transport from the plant.

In the case of Paks Nuclear Power Plant, the storage at the reactor is ensured under water, in the spent fuel (cooling) pond located in the near vicinity of the reactor. An independent spent fuel pond belongs to each of the four reactors.

According to the Construction Designs of the Plant, the spent fuel assemblies, after three years of decay would have been shipped back to the Soviet Union. Later the duration of decay period preceding the reshipment was *approximately* doubled by changing the lattice pitch of the original storage racks to a high density one. The first spent fuel reshipment took place in 1989. In order to overcome the problems that arose at the beginning of the 1990's with the reshipment a decision was made in 1993 on implementing interim storage in the vicinity of the plant: the Interim Spent Fuel Storage Facility. At present, following the storage in spent fuel ponds the spent fuel assemblies are delivered to the Interim Spent Fuel Storage Facility thereby freeing the necessary storage capacity in the ponds for the continuous operation of the reactors.

In the spent fuel ponds belonging to the individual blocks the spent fuels can be stored at two levels. The storage "rack" of high density grid structure ensuring the operational storage is located at the bottom of the spent fuel pond, it can be used for storing the spent operational fuel elements, control rods, followers and hermetic claddings. The storage of high density grid distribution is built from tubes of neutron–absorbing materials with a pitch of 160 mm. The material of the absorbing tubes is stainless steel with 1.05 – 1.25% boron content ensuring sub-criticality. The airtight sealed claddings are for storing fuel assemblies that became inhermetic during operation. Spare "racks" are available for each spent fuel pond, in case the whole reactor core need to be emptied.

Handling and transport equipment of spent fuel assemblies

Handling equipment is used to move the fuel assemblies, burnt out in the reactors, during refuelling and - if necessary – to check them as well as to prepare for their transport out of the plant after the decay period.

The design basis of tools and equipment for handling of fuel assemblies ensures the removal of remanent heat, the maintaining of sub-criticality, the biological protection of the personnel and the minimization of possible injures during operation.

Judging from experience, there is enough storage space in the spent fuel ponds for storing leaking fuel elements in hermetic claddings.

Removal of the remanent heat

In order to ensure the proper cooling of fuel assemblies the temperature of the water in the spent fuel pond must not exceed 60 °C, therefore two parallel cooling circuits serve the cooling of the spent fuel ponds.

Proper cooling for fuel assemblies placed in transport containers is guaranteed by the design of the container as well as the limitation of the minimum cooling time and the highest burn-up for assemblies to be transported. During preparations for transporting the spent fuel with C–30 containers, based on the safety assessment performed for the container, the following limiting conditions shall be kept (one part of them explicitly serves the safe removal of the remanent heat):

a) highest initial enrichment: 3.82%;
b) maximum 46 GWday/tU average fuel burn-up;
c) 50 GWday/tU highest fuel burn-up;
d) maximum four-year fuel cycle;
e) maximum 15 kW total output;
f) minimum 0.5 year decay time.

Criticality safety

Verification of sub-criticality for fuel storage systems is based on model calculations. The assessments were accomplished for storage filled with radially profiled fresh fuel elements of 3.82% average enrichment, containing 120.2 kg uranium. Thus, sub-criticality of fuel elements stored in the spent fuel pond is ensured by the design/construction of the storage racks. Both storage racks keep the sub-critical state even if they are flooded with clean, i.e. boron-free, water.

Other risks taken into account

- The dropping or any other kind of damage to the fuel assemblies, or the development of unacceptable mechanical stresses are minimized by the transport and lifting technology equipment (with bayonet joint grip, retainers and cranes of prescribed safety factor) and storage technologies.
- The seismic safety revision and the necessary strengthening of Paks Nuclear Power Plant have been accomplished. Ensuing from the frequency of fuel handling manipulations, no seismic event greater than that with a ground surface acceleration of 0.25g and a site-specific response spectrum was assumed simultaneously with re-fuelling and transport activities.
- Evaluations of immunity against external dangers were accomplished for facility level; thus, the extent of risk could not be determined specifically for tools and equipment for handling nuclear fuel. As a whole, however, the facility – and the handling of nuclear fuel included – could be seen as protected against external danger.
- Fire risk assessments accomplished for Paks NPP did not indicate any significant risk in connection with the fuel element handling processes.

An8.1.1.c Compliance with the fuel cycle strategy

From the tasks related to managing the spent fuel, Paks NPP performs independently, in its own competence, only the interim storage in the spent fuel ponds. Maximum storage capacity of the spent fuel ponds amounts to 1052 assemblies for each unit. Spent fuel elements – after a decay period of at least 3 years – are handed over to PURAM, for a further intermediate storage of about 50 years in the Interim Spent Fuel Storage Facility. As for the final disposal, the strategy “wait and see” has been followed. The compliance with this strategy is ensured because the expansion of the Interim Spent Fuel Storage Facility goes by the capacity of the spent fuel ponds, taking into account the quantity of spent fuel assemblies arising yearly.

An8.1.1.d Consequences of the incident of April 2003

The incident on 11 April 2003 at Unit 2 of Paks NPP and the recovery work performed to remove the consequences of the incident are described in detail in the fourth National Report of Hungary prepared in the framework of the Convention on Nuclear Safety in 2007. This National Report is available on the web site of the Hungarian Atomic Energy Agency (www.haea.gov.hu).

The fuel assemblies damaged during the incident in the so-called Pit No. 1 were loaded into canisters designed for storing fragments of fissile materials. The canisters were designed for a minimum of five years storage in the spent fuel pond. The encapsulation work was finished in early 2007. The loaded 68 canisters have been stored in the spent fuel pond.

The radiation conditions were quite favourable during the removal of the damaged fuel elements. This resulted in low operator exposure. Radioactive discharges were also very low and, consequently, the additional radiation exposure of the public from this source can be considered insignificant.

An8.1.2 Discharges

An8.1.2.a Regulatory framework

The constraint for the additional dose resulting from the operation of the nuclear power plant to the critical group of the population is 90 μSv/year, according to the regulation in force since 1998. The relevant decree [III.13] provided for isotope selective limits derived from dose constraints. The new discharge limits for the various discharge modes and isotopes were approved by the authorities in 2004. Based on it, Paks NPP has calculated - for all relevant discharge pathways and all important isotopes - the annual discharge limit values that are derived from the dose constraint according to the following formula:

$$EL_{ij} = \frac{DL}{DE_{ij}},$$

where

EL_{ij}: is the discharge limit for radionuclide "i" with respect to discharge pathway "j" (Bq/year);

DL: is the dose constraint (Sv/year);

DE_{ij}: is the contribution of a unit discharge of radionuclide "i" in discharge pathway "j" to the annual dose (Sv/Bq).

In order to comply with the regulatory restriction, decree [III.13] states that the order, methods and means of the discharge monitoring, as well as features of their capability and effectiveness shall be specified in a Discharge Monitoring Code in order to determine the quantity of radioactive materials discharged into the environment. Furthermore, this document specifies that the discharge monitoring of radioactive materials shall be supplemented with measurements performed in the environment, and the order, methods and means of these monitoring activities, as well as features of their capability and effectiveness shall be also specified in the Discharge Monitoring Code.

An8.1.2.b Systems for discharge monitoring

The system of operational and regulatory monitoring, as well as the measuring methods were planned and established in Paks Nuclear Power Plant so that (a) full monitoring of all planned discharge routes, as well as the revealing of possible non-planned discharge of the radioactive materials into the environment are ensured; furthermore, (b) so that it is possible to track the spreading of radioactive materials discharged, and - if it is possible - to forecast it and finally to estimate and evaluate the radiation exposure of the population. The discharge- and environment monitoring system designed in the 1970s has become obsolete from both technical and ethical aspects; moreover, the execution of this reconstruction was also required by a regulatory decision. *The reconstruction was completed in 2005.*

One of the tasks of the operational discharge- and environment monitoring system in the nuclear power plant is to confirm, by means of continuous monitoring of the discharges, the fulfilment of the discharge limit values. The quick mapping of the radiation condition of the environment is indispensable also for judging the environmental consequences of an eventual incident, as well as for decision making on possible interventions affecting the population.

The discharge monitoring of radioactive materials, as well as the radiological monitoring of the plant's environment is based partly on remote measuring (telemetric) systems and on sampling laboratory tests. The data gained from the discharge- and environment monitoring remote measuring systems, as well as from the data of the meteorological tower are collected and archived in a central computer.

Airborne discharges

The monitoring of the airborne discharges is based on the continuous operation isokinetic sampler installed in the chimney before the discharge point. In addition to laboratory sampling, the changes are checked by two parallel, independent monitoring systems. The monitoring system consists of three sub-units which are continuously sampling and measuring the discharge of aerosol, iodine (I-131) and noble gas. The measuring range of the measuring units is the following:

Aerosol	gross β:	$1 - 10^6$	Bq/m^3
	gross α:	$10^{-2} - 10^4$	Bq/m^3
Noble gas	gross β:	$10^2 - 4x10^9$	Bq/m^3
Radioiodine (I-131)	γ:	$1 - 10^6$	Bq/m^3

Parallel to the monitoring units, a continuous gamma-spectrometric system is available which performs isotope-selective measurement of the noble gas discharge. Laboratory sampler units serve for isotope-selective measurement of the atmospheric discharge in accordance with the chemical forms.

Liquid discharges

Sampling of radioactive liquid discharges is performed from monitoring tanks. The qualitative and quantitative determination of the radio-isotopes existing in the waste waters and generated during operation of the nuclear power plant is executed by means of laboratory analysis of the samples taken from the tanks. Only the waste water in the tank that has been already analysed and has a valid discharge licence is allowed to be discharged into the environment through the specified discharge route.

Detectors equipped with a protective pipe are placed into the meter pits with an overflow sill along the discharge pipeline. By measuring the gross gamma activity concentration of the flowing liquid medium (water), it is possible to monitor continuously the extent of its radioactive contamination. *The measuring range is* $1 - 10^9$ Bq/m^3.

The remote detectors installed along the discharge routes are used for preventing discharge of liquids in an unauthorized way, without laboratory sample analysis.

Environment monitoring

A fixed environmental radiological monitoring system has been installed in the surroundings of the nuclear power plant.

Measuring and sampling capabilities of the various stations:

1. A-type station (9 stations within a range of 1.5km), *and B-type (reference) station (1 station, 28 km north of the nuclear power plant):*
   - gamma-radiation dosage rate (on-line) and dosage measurements executed by TLD;
   - aerosol and iodine *activity-concentration remote metering (on-line);*
   - aerosol and iodine sampling;
   - air sampling for determining tritium and radio-carbon;
   - fall-out;
   - soil and grass sampling.
2. C-type station (14 stations within a range of 30 km):
   - dose measurements executed by TLD;
   - if needed, collection of soil, grass, and fall-out samples.
3. G-type station (11 stations within a range of 30 km):
   - gamma-radiation dose rate (on-line).

Intervention levels

The radiological leader of the Emergency Preparedness Organization, on the basis of values specified below, makes proposals to the leader of the Emergency Preparedness Organization for the introduction of measures to protect the workers, the rescue workers and, in case of quickly escalating events, the population. On the basis of a decision made by the leader of the Emergency Preparedness Organization, it is possible to order the application of a given protective measure also at values lower than those specified in the following:

- Isolation: 10 mSv avertable effective dose, integrated up to two days;
- Evacuation: 50 mSv avertable effective dose, integrated up to one week for temporary relocation;
- Iodine prophylaxis: 100 mGy avertable dose absorbed in thyroid from iodine isotopes.

Action levels to be applied in a nuclear accident:

- Isolation: 0.2 mSv/h dose rate due to the plume and fall-out;
- Evacuation: 1 mSv/h dose rate due to the plume and fall-out;
- Iodine prophylaxis: 0.1 mSv/h dose rate due to the plume.

An8.1.2.c Discharge data for the years between 2005 and 2007

The regulatory limits for the discharges were changed in 2004. For the simultaneous discharge of several isotopes along various pathways, the calculation of the discharge limit value criterion is carried out as follows:

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

where: El_{ij}: the discharge limit (Bq/year) of radionuclide "i" in discharge pathway "j";

R_{ij}: annual discharge (Bq/year) of radionuclide"i" in discharge pathway "j".

Table An8.1.2.c-1 Discharge data for Paks Nuclear Power Plant for the period between 2005 and 2007

Isotope groups	*Total discharge for 2005 [Bq]*	*Discharge limit criterion* *	*Total discharge in 2006 [Bq]*	*Discharge limit criterion* *	*Total discharge in 2007 [Bq]*	*Discharge limit criterion* *
			Airborne discharges			
Corrosion and fission products	*1.09×10^{9}*	*4.21×10^{-5}*	*7.86×10^{8}*	*6.69×10^{-5}*	*7.44×10^{8}*	*4.22×10^{-4}*
Radioactive noble gases	*1.40×10^{13}*	*1.50×10^{-4}*	*1.89×10^{13}*	*1.80×10^{-4}*	*1.65×10^{13}*	*2.57×10^{-4}*
Radio-iodines	*2.61×10^{8}*	*4.05×10^{-5}*	*3.24×10^{7}*	*3.50×10^{-6}*	*3.60×10^{7}*	*3.54×10^{-6}*
Tritium	*1.94×10^{12}*	*1.12×10^{-5}*	*2.98×10^{12}*	*1.72×10^{-5}*	*2.78×10^{12}*	*1.60×10^{-5}*
Radiocarbon	*6.10×10^{11}*	*2.67×10^{-4}*	*6.12×10^{11}*	*3.59×10^{-4}*	*5.65×10^{11}*	*2.61×10^{-4}*
Total	**-**	***5.11×10^{-4}***	**-**	***6.26×10^{-4}***	**-**	***9.60×10^{-4}***
			Liquid discharges			
Corrosion and fission products	*1.56×10^{9}*	*1.11×10^{-4}*	*1.16×10^{9}*	*7.80×10^{-4}*	*1.56×10^{9}*	*1.13×10^{-3}*
Tritium	*1.72×10^{13}*	*5.94×10^{-4}*	*2.38×10^{13}*	*8.20×10^{-4}*	*2.08×10^{13}*	*7.16×10^{-4}*
Alpha radiants	*1.39×10^{5}*	*2.05×10^{-7}*	*2.40×10^{5}*	*3.41×10^{-7}*	*3.07×10^{5}*	*4.36×10^{-7}*
Total	**-**	***1.70×10^{-3}***	**-**	***1.60×10^{-3}***	**-**	***1.85×10^{-3}***

* The sum of the discharge limit criteria for the isotopes of the group.

An8.2 Budapest Research Reactor

An8.2.1 Management of the spent fuel assemblies

a) Regulatory framework

The handling of spent fuel is a part of the operation of the reactor and thus it is regulated by the national Nuclear Safety Codes.

b) Systems managing spent fuel elements (removal of remanent heat, criticality safety, consideration of other dangers)

The criticality of spent fuel of Budapest Research Reactor similarly to that of nuclear power plants cannot cause any problem because, in line with regulatory requirements, the design of spent fuel storage facilities ensures that the infinite multiplication factor of these facilities is less than 0.95. During internal fuel transport, criticality safety is provided by the limited number of fuel elements to be transported together (the device is designed for a limited number of fuel elements only).

Heat production of the research reactor fuel elements is so low that the remanent heat is removed by wet storage. After three years of cooling the spent fuel can even be stored in dry storage, from this time on there is no technical objection against fuel transport. During the internal transport of spent fuel the remanent heat does not cause a problem for the same reason, and because of the short time.

An8.2.2 Discharges

a) Regulatory framework

For radioactive discharges to air and water during the use of atomic energy, decree [III.13] on radioactive discharges and their control is authoritative and, taking into account the dose constraint, the following regulatory limits can be derived from it:

Discharge limits to the atmosphere
Applying a 50 μSv/year dose constraint (with Γ=5 safety factor) the derived discharge limits are the following:

Radionuclide	Discharge limit [Bq/year]
^{41}Ar	7.1E+15
^{85m}Kr	5.5E+16
^{87}Kr	1.1E+16
^{88}Kr	5.0E+15
^{133}Xe	2.7E+17
^{135}Xe	3.5E+16

Discharge limits to water
Applying a 50 μSv/year dose constraint (with Γ=5 safety factor) the corresponding derived discharge limits by nuclides are the following:

Radionuclide	Discharge limit [Bq/year]
^{51}Cr	5.0E+12
^{125}Sb	3.0E+12
^{137}Cs	2.0E+10
^{54}Mn	1.7E+11
^{60}Co	6.3E+10
^{65}Zn	2.1E+11
^{110m}Ag	5.8E+10

b) Control of discharge and measuring equipment

Control

Atmospheric discharge path

During the operation of the reactor ^{41}Ar is produced in the ventilating air circulating around the reactor vessel; this ^{41}Ar is continuously discharged to the atmosphere. Iodine isotopes are occasionally discharged during isotope production (in case of damage of the can); if a fuel element becomes in-hermetic krypton and xenon isotopes are discharged to the ventilation air as well. They are discharged to the environment passing through aerosol and iodine filters. The discharge is continuously checked by the detectors of the Radioprotection Measuring and Control System.

If normal operational values are measured, the samples from the reactor stack are examined in the Material Laboratory of the KFKI Atomic Energy Research Institute, every three months. During this examination the radionuclide content and activity of the samples are measured by gamma spectrometry.

If above-normal operational values are measured, samples are immediately taken and the nuclide specific discharge has to be determined.

Water discharge path

Checking of the water discharge paths is periodic, as the discharge itself is periodic. Discharge may originate from two locations:

- from the so called acid neutralizing shaft;
- from the liquid waste vessels.

The acid neutralizing shaft collects the water from the chemical laboratory of the reactor building and from the water preparation unit. No radioactive discharge can come from here, as neither washing of radioactive or contaminated objects, nor emptying of radioactive liquid is allowed. The detector located in the acid neutralizing shaft measures the activity of the water. The detector is part of the Radioprotection Measuring and Control System, the measurement is displayed in the control room, on the radioprotection board. If radioactive material gets into the acid neutralizing shaft the radioprotection operator in charge observes the increase in level. After taking a sample, the radionuclide concentration must be determined. When the shaft is filled with water, taking a sample is compulsory before the water can be discharged. The sample is measured in the laboratory of the Radioprotection

Group, and knowing the measured result, discharge can be permitted only if the activity is below the limit.

The Budapest Research Reactor has two vessels, each of 150 m^3, to collect the liquid radioactive waste. According to the regulations 150 m^3 of free capacity must be maintained in the vessels. Before discharge the nuclide content and concentration are measured by means of gamma spectrometry; then, after cleaning by ion exchangers, the discharge into the sewage system takes place. During discharge the Environmental Control Group has to check daily the water from the ion exchangers and it is then in a position to give permission for the discharge. The water measuring station of the Environmental Control Group is located in the normal sewage system and it continuously measures the gross β and γ activity, as well as the water circulation. Should there be an increase in level, automatic sampling is performed.

Measuring equipment

Atmospheric discharge

The checking of atmospheric discharge is partly performed by the installed detectors of the Radioprotection Measuring and Control System that operate continuously, and partly by periodic sampling.

The ventilation system of the Budapest Research Reactor is connected via aerosol and iodine filters to the 80 m stack; discharge to the environment is accomplished only here. The stack is also used by the Isotope Institute Ltd. , therefore "reactor", "isotope" and "common" sections are distinguished. The installed detectors measure the gas activity in various parts of the ventilation system.

There is no radioactive iodine discharge from the reactor during normal operation. Iodine filters are installed in the ventilation system and there are three iodine detectors located in all three sections of the stack to monitor iodine discharge. The signals of the iodine detectors are connected to the data collecting system of the Environmental Control Group. If the iodine level increases the system gives an alarm and the members of the group examine what environmental effects might be caused by the discharge.

The Material Laboratory measures the samples taken from the ventilation system by means of gamma spectrometry.

Water discharge

Checking of the discharged water is carried out in the laboratory of the Budapest Research Reactor. The gamma spectrum of the water samples is measured to determine the isotope composition and the activity concentration. After evaporation of a 5 ml sample the gross beta activity is determined. The detectors located in the acid neutralizing shaft measure the beta activity of the water.

c) Results of the measurements

The measured values of the discharges of the Budapest Research Reactor were very low also between 2005 and 2007. For example, the following results were obtained in 2007:

Atmospheric discharge:

noble gas (Ar-41 only):	*52.62 TBq*
iodine:	*below the detection limit (<5 Bq/m^3)*
aerosol:	*below the detection limit (3.7 Bq/m^3)*

Discharge of liquid waste: none

An8.3 Training reactor of the Budapest University of Technology and Economics

An8.3.1 Management of the spent fuel assemblies

Until now no spent fuel originated in the training reactor operating at the Budapest University of Technology and Economics. When removing the fuel at present in the reactor, the management of the spent fuel will take place in line with the Volume 5 of the Nuclear Safety Codes, relating to research reactors.

An8.3.2 Discharges

As a result of the decision of the Office of the National Chief Medical Officer, issued on 4 January 2005, 50 µSv/year dose constraint was prescribed for the training reactor. Taking this into account, and considering the relevant decree [III.13], the regulations for the discharge control and environment monitoring of the training reactor were prepared. The derived discharge limits and the planned maximum yearly discharges are the following:

Type of discharge	*Radionuclide*	*Discharge limit [Bq/year]*	*Planned yearly discharge [Bq/year]*
Airborne	^{41}Ar	7.5×10^{11}	$< 6 \times 10^{10}$
Liquid	^{137}Cs	2.0×10^{10}	$< 2 \times 10^{6}$
	^{60}Co	6.3×10^{10}	$< 1 \times 10^{6}$

The actual airborne discharges are less than 10% of the discharge limit, the actual liquid discharges are less than 1% of the discharge limit.