HUNGARY

NATIONAL REPORT

Fifth Report

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

2014

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Section A. Introduction

The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (hereinafter Convention) was promulgated by Act LXXVI of 2001 [I.10]. (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/Rev.2).

Section B describes the general policies and practices of radioactive waste management and spent fuel management 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 in Solymár. As the site proved to be inadequate for long-term disposal, it was closed and cleaned up, and a new radioactive waste storage 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 radioactive 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. Since December 2012 the first underground shaft has been accepting the LLW/ILW of the NPP.

In Section C on the scope of application it is declared 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 Hungarian 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 of spent fuel and closure of the fuel cycle, and the decommissioning of nuclear facilities.

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 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 human health and 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 radioactive 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 volume and activity 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 and post-remediation long term monitoring activity. Annex 8 deals with the spent fuel management and releases of nuclear facilities other than spent fuel management facilities.

This *fifth* National Report prepared in the framework of the Convention is a stand-alone document, demonstrating the fulfilment of our obligations undertaken under the Convention. The new developments, in comparison with the previous (i.e. the fourth) National Report, are typeset in Italics. Having taken into account the lessons learned from the fourth review conference, this report discusses in a more detailed way the strategic issues and the regulatory system, as well as financial and human resources.

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The compilation of the report was finalized on 31 March 2014; the inventory data herein, unless otherwise indicated, described the conditions as of 31 December 2013.

Declaration

Hungary declares that:

- priority is given to the safety of spent fuel management as well as the safety of radioactive waste management, and both are achieved by way of legal regulation alongside 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 further to mitigate the consequences of such accidents should they occur during any stage of spent fuel management or radioactive waste management.

Budapest, November 2014

Section B. Policies and Practices

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 HLWs, 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 in the Centre for Energy Research of the Hungarian Academy of Science (Budapest Research Reactor), and the Training Reactor of the Institute of Nuclear Techniques at Budapest University of Technology and Economics (Training Reactor).

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, out of which the high level wastes can be disposed 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 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 was elaborated.

In line with the development of the strategy, the investigations of the Boda Claystone 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 for the final disposal of LLW/ILW of Paks Nuclear Power Plant, hence the schedule of the project aiming at selection of site for an underground research laboratory had to be revised.

At the beginning of 2008 a document entitled “Updated concept of the long term research programme of the Boda Claystone Formation including content, financial and schedule aspects” was prepared. On the level of a draft concept, the study discusses 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 Swiss radioactive waste management organization (that being NAGRA) was asked for the professional evaluation of the study. The evaluation of NAGRA concluded that the step by step approach, applied during the development of the programme, is in compliance with the method followed world-wide by advanced national programmes. At the same time, NAGRA called attention to the importance of the problem oriented approach that is supported by safety assessment, as well as to the establishment of a strong leader and manager group within the Public Limited Company for Radioactive Waste Management (PURAM) in order to assure the harmonization, and successful accomplishment of research activities. This group should be responsible for programme planning and strategic issues, as well as for integration of results coming from various fields of expertise.

Taking also into account the results of the NAGRA evaluation, the Public Limited Company for Radioactive Waste Management is prepared to professionally manage the site selection of a deep geological disposal facility of HLWs (see the organization structure of the Public Limited Company for Radioactive Waste Management in Figure F.2.2.1-1). During 2012-2013 the Public Limited Company for Radioactive Waste Management prepared its geological survey plan for the next stage of the investigation of the Boda Claystone Formation, which was approved by the competent authority (Pécs Mining District Authority). The objective of the present investigation stage, which is planned to be implemented between 2014 and 2018, is the general qualification of the host formation and the provision of geological data and information required for the safety assessment.

The long term 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 did not have 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 wanted Hungary to 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. *Currently the facility contains 16 modules in the Western side (each having a storage capacity of 450 fuel assemblies) and 4 modules in the Eastern side (each having a storage capacity of 527 fuel assemblies).* 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 Spent Fuel Interim 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 Budapest 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 Budapest Research Reactor and the Training Reactor contributes to spent fuel generation.

The spent fuel of the Budapest Research Reactor 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. Currently, after the repatriation of the spent fuel assemblies to the Russian Federation, the storage tank is empty (see B.1.2).

The Training Reactor is operating with the fuel elements that were placed in the core at the start of the operation and after the reconstruction in 1980. The burning rate of the reactor fuel elements is slow as a result of the low maximum power and the carefully planned operation in connection with student training and research activities. Adequate fuel cladding condition was confirmed by analyses. Consequently, the reactor can operate for many years further without refuelling.

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.

In the course of the elaboration of the strategy for the closure of the fuel cycle it is worthwhile 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 by the Government of the Republic of Hungary and the Government of the Russian Federation. That future decision should be based on technical, economic, political, social considerations and also on achievable guarantees at intergovernmental level.

The document supporting the new programme regarding the treatment and management of radioactive waste and spent fuel was finalized by the beginning of 2010, and it provides a comparison between several options regarding the closure of the fuel cycle, based on qualitative and quantitative aspects. Based on analyses a decision was made that Hungary considers the direct disposal of the spent fuel as a reference scenario. This scenario is the basis for the budget plan justifying the financial contribution of the Paks NPP Ltd to the Central Nuclear Financial Fund. *In the future, it might become necessary to revise and amend the long-term policy as well as the reference scenario taking into consideration the tasks arising from the implementation of the two new nuclear power plant units planned at the site of the Paks NPP.*

Spent fuel from the Budapest Research Reactor and from the Training Reactor

Advantageous changes have occurred with regard to the fuel elements of the Budapest Research Reactor since the completion of the previous National Report. The first step of the repatriation process to the Russian Federation initiated and financially supported by the US DOE was completed in 2008 in the frame of the IAEA RER/4/028 programme; all fuel used before 2005 was repatriated. *The second step took place during October and November of 2013, following which Hungary is free from highly enriched fuel. The Budapest Research Reactor is over the phase of conversion, the core operates with low enriched (19.75% ^{235}U) fuel elements.*

According to plans, the operation of the Budapest Research Reactor will finish in 2023. The repatriation of the low enriched fuel assemblies will be possible in line with the effective intergovernmental agreement. The earliest possible date of transport is 2025. Nevertheless, as an alternative solution to repatriation the disposal within Hungary could also be mentioned.

Currently spent fuel is not stored in the Training Reactor. The replacement of the irradiated fuel by fresh fuel as well as its transport is a theoretical option; the related technical aspects are under consideration.

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

Figure B.2.1-1 Sites of importance in Hungary

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.

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 the Public Limited Company for Radioactive Waste Management.

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.

The Radioactive Waste Treatment and Disposal Facility is operated based on the extendable license that is currently valid until 28 February 2015.

The results of the safety assessments, at the same time, unambiguously indicated that certain spent radiation sources may pose a risk in the distant 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 (effecting, in the first place, 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 so, the repository – which reached capacity in 2004 – can continue to accommodate the institutional radioactive waste from all over the country.

Figure B.2.1-2 Bird’s eye view of the Radioactive Waste Treatment and Disposal Facility

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

National Radioactive Waste 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 a national programme was launched in early 1993 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 from safety and economic studies, and 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 the Geological Institute of Hungary made a recommendation to start the detailed site characterisation in the Bátaapáti research area.

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.3]. Thus, from the geological point of view, it is suitable for the disposal of low and intermediate level radioactive waste.

As the first phase of the construction of the repository, the above surface facilities were completed in 2008. It has enabled the temporary storage of solid waste from the nuclear power plant in 2008. The competent Radiation Health Centre of the National Public Health and Medical Officer Service granted license for commissioning the National Radioactive Waste Repository on 25 September 2008; the scope of the license also covered the operation of the above surface facilities.

The first two disposal shafts were completed by the end of 2011 (I-K1, I-K2), in 2012 the licensing authority granted the operating license for the accomplished portion of the National Radioactive Waste Repository: the above surface facilities and the I-K1 shaft. The license became executable on September 10, 2012. The transport and final disposal of the first reinforced concrete containers took place in the frame of a ceremony on December 5, 2012.

Until December 31, 2013, altogether 3960 drums were shipped from the Paks NPP to the National Radioactive Waste Repository. Out of that, 1629 drums were disposed into Shaft I-K1 at their final position.

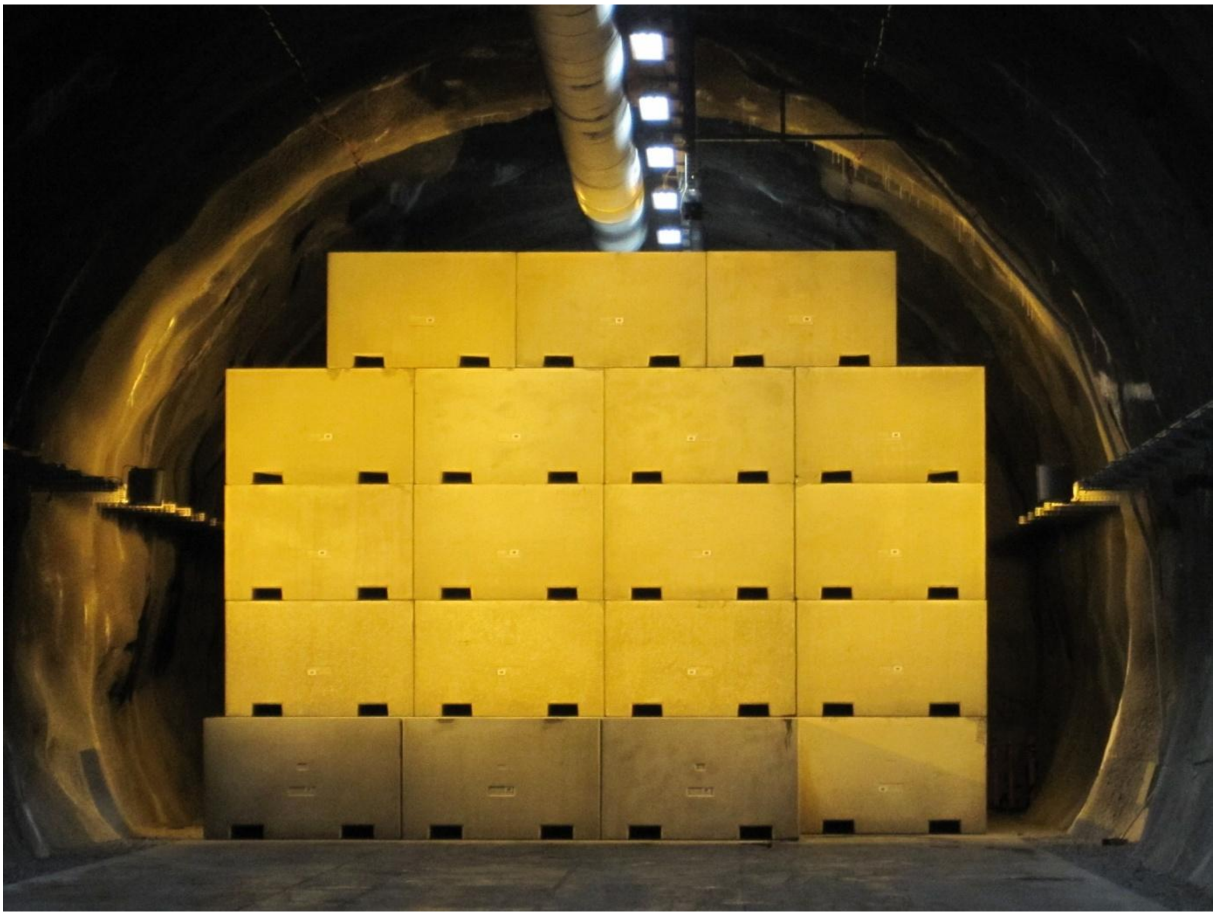


Figure B.2.1 – 3. Containers disposed in the *I-K1 shaft of the National Radioactive Waste Repository*

Further details about the construction 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 dispose 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 the long lived radioactive wastes and wastes containing nuclear material until the repository for the disposal of high level long lived radioactive wastes is completed.

National Radioactive Waste 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. 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 promulgated the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management on 2 June 1998 by an act [I.10] 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, 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 defence programmes of the Hungarian Ministry of Defence produced exclusively low and intermediate level radioactive waste that 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 first of all as a consequence of the operation of Paks Nuclear Power Plant. In addition, the Budapest Research Reactor and the Training Reactor contribute to the generation of spent fuel.

In Hungary there is only one facility on the list of spent fuel management facilities, the Spent Fuel Interim 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 *4.2*%. Based on our present knowledge, along with the consideration of the 20 year service life extension, the number of spent nuclear fuel assemblies that will have been generated by the end of the life-time of the nuclear power plant (2037) and may remain in Hungary will be about 17,728, with approximately 2100 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 2013, 1,751 fuel assemblies were stored in the spent fuel (cooling) ponds of the nuclear power plant and 7,684 fuel assemblies in the Spent Fuel Interim Storage Facility, respectively.

At the end of 2013, the total capacity of the Spent Fuel Interim Storage Facility was 9,308 assemblies in 20 modules. The extension of the storage facility with preparation for construction of four new modules is in progress. In order to provide storage capacity for every spent fuel assembly remaining in the country, the storage facility shall be extended to accommodate 36 modules in total (see G.1).

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. Neutron- and gamma-spectroscopy methods were developed and measurements were performed for quantitative and qualitative determination of the fission content of the residues.

Actions are in progress on extending the planned 30-year life-time of the nuclear power plant by 20 years. *In December 2012, the HAEA granted the operation license for Unit 1 which is valid until the end of 2032*. The service life extension has an effect on both the amount and the management of radioactive waste and spent fuel. In harmony with the 13th Medium and Long

Term Plan of the Public Limited Company for Radioactive Waste Management (see Chapter E.1) the present report takes into consideration the consequences of service life extension.

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

Currently, the Budapest Research Reactor operates with 190 fuel assemblies of VVR-M2 with an enrichment of 19.75%. The fuel with an enrichment of 36% has been replaced in the core and repatriated to the Russian Federation. These assemblies are used either as single fuel elements or as fuel bundles including a group of three.

In total 38 spent fuel assemblies are stored on site having about 8 kg of heavy metal. The reactor is scheduled to operate until 2027; thus, from the end of 2010 to the end of its operational life, a further 760 VVR-M2 “single” spent assemblies (approximately equivalent to 167 kg heavy metal content) should be taken into account.

There are 24 partly modified fuel assemblies of type EK-10 in the core of the Training Reactor. There is no spent fuel stored on site, however the available backup fuel assemblies are registered as irradiated ones, since, although with little burn-up, they have been shipped to the facility as used ones. After the closure of the operation planned for 2023, - no matter whether the reactor will be refuelled or not - all the fuel assemblies in the reactor building (56 assemblies, altogether with 68.91 kg of heavy metal) will be legally qualified as spent fuel.

D.2 Radioactive Wastes

In Hungary there are two facilities on the list of radioactive waste management facilities, these being the Radioactive Waste Treatment and Disposal Facility and the National Radioactive Waste Repository. The main characteristics of these facilities are described in Section B, their safety in Section H, further details are contained in Annex 2.

D.2.1 Classification of radioactive waste

The relevant ministerial decrees [III.10 and III.14] regulate the classification of radioactive wastes. The type of radioactive waste in which the heat production during the disposal (and storage) could be neglected is qualified as low and intermediate level radioactive waste. Further,

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

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

Within the above classification the authority can prescribe more detailed categorization 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 of radioisotopes, 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.6] in accordance with the regulations of the European Union. The procedure of clearance from regulatory control is regulated by another ministerial decree [III.4]. 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 HLWs 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 1,114 storage tubes (pits) designed for this purpose. *At the end of 2013, approximately 98 m^3 of the total 222.8 m^3 storage capacity was 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. The built-in storage capacity is not sufficient to store the total quantity of high level radioactive wastes expected to be generated during the 20 years of service life extension. It can be foreseen that storage capacity shall be provided between 2030 and 2035 by removing the low and intermediate level waste content of those high activity wastes that have such material content. The NPP launched a storage volume optimization programme which covers the retrieval and treatment of the wastes that are currently stored in pits.

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 5 - 15 m^3 low and intermediate level waste, 300 used radioactive sources and typically 1000 radioactive sources from dismantled smoke detectors per year. To date, *3662* shipments were carried out from *643* different consignors to the Radioactive Waste Treatment and Disposal Facility. The low and intermediate level radioactive waste generated by the non-fuel-cycle producers and accepted until the end of 2005 occupied 2540 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, thus the shafts serving for disposal were full at the end of 2005. Between 2005 and *2013* the wastes were primarily stored in the interim storage area constructed in 2004, where *140 m^3 wastes were stored at the end of 2013. Out of this volume 60 m^3 was shipped from producers, while 80 m^3 is the waste that was removed from the disposal shafts in the framework of the safety improvement programme that was accomplished between 2007 and 2009. 25 m^3 wastes have been disposed in the final storage, by which 100 m^3 capacity was retrieved as a result of the aforementioned safety improvement programme* (*by the compression of the waste and its partial placement in the storage area). In addition to that, 20 m^3 waste is waiting for further processing and later disposal. At the end of 2013 the total activity of the radioactive wastes in the repository was 380 TBq based on the available data.*

Most radioactive wastes, including spent sealed sources, are generated in medical, industrial and research applications. The most important isotopes are ^{60}Co, ^{137}Cs, ^{90}Sr and ^{3}H. The quantity and activity of isotopes in 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. The waste streams generated include solid and liquid wastes, spent ion-exchange resins, and contaminated oils too. The small amount of radioactive waste generated in the Spent Fuel Interim Storage Facility is treated together with the waste of the nuclear power plant.

<u>Gaseous wastes:</u>

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 nuclear power plant. 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 2013 was 6,615 m^3, of which 211 m^3 was generated during 2013. The total volume of evaporation waste that includes the 1,817 m^3 evaporator bottom – containing alpha radiants – produced until 31 December 2013 in consequence of the serious incident at Unit 2 is stored in special tanks separately from the other concentrates.* Bearing in mind the present 250 m^3/year generation rate for the evaporation wastes the total volume till the end of the 30 year service life will be *7,800 m^3. Considering the 20 year service life extension, altogether 12,350 m^3 evaporation residue can be expected.*

A special tank was provided for the storage of evaporator acid solution. Evaporator acidation solution was not generated in *2013;* thus as of 31 December 2013 the tank contained the total volume of 211 m^3 evaporator acidation 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 50 year service life will be 526 m^3.*

The total quantity of resins used up to 31 December 2013 was 205 m^3;of which 23.6 m^3 was generated during the year 2013. At present, there is no necessity for immediate processing of the ion exchange resins. Considering the present 5 m^3/year generation rate for ion exchange resin, the total volume till the end of the 50 year service life will be 454 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 till the end of the extended service life of the nuclear 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 560 m^3 decontamination solution was produced up to 31 December 2013.*

The technology developed to reduce the volume of evaporation residues giving the majority of liquid radioactive wastes was commissioned in 2013. The purpose of volume reduction is to be able to release the cleaned liquid wastes after processing and under the conditions specified in the water release rules of the plant and in the license of the technology.
Subsystems of the Liquid Waste Processing (LWP) technology:

1. *complex dissolving, cobalt isotope separator system,*
2. *ultra filtration system,*
3. *selective caesium isotope separator, filtration system,*
4. *boric acid crystallizer and remover system.*

During the processing of evaporation bottom the following secondary wastes are generated:

- *cobalt remover post-filter cartridge (place into 200 l drums),*
- *ultra filter membrane modules,*
- *caesium selective sorbent columns (placed into reinforced concrete containers),*
- *borax (hazardous waste that can be exempted).*

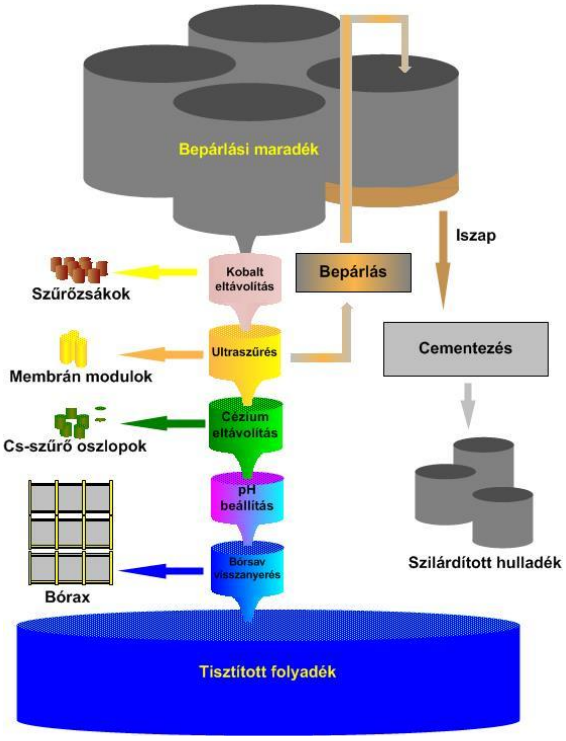


Figure D.2.4 - 1. Steps of the LWP technology

Cementation is used before disposal to solidify liquid wastes that cannot be processed by the LWP technology according to the optimized final disposal concept described in Section H.3.

<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 during the collection, since non-compactable wastes are very rarely loaded into plastic bags.
- 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.
- Earlier, active sludge was solidified with the addition of diatomaceous earth in a ratio of 1:1. (The ratio depends on the liquid content of the sludge.) Since March 2007, the solidification has been performed by settling and then removing the liquid content with an industrial suction cleaner rather than by soaking with diatomaceous earth.

Figure D.2.4 – 2. Waste compressor machine

- Solid waste, including aerosol filters and solidified sludge, is loaded uniformly into special 200 l metal drums (internally coated with plastic).

As of 31 December 2013, 10,004 drums loaded with low and intermediate level solid radioactive waste 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.

Figure D.2.4 – 3. Storage of low and intermediate level waste

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.

Only relatively small amounts of waste are planned to be produced by the early stages of decommissioning, e.g. from the removal of fuel and the flushing out of the reactor coolant circuits. The accepted decommissioning strategy includes a 20 year protected preservation of the primary circuit; thus it entails postponed dismantling. The total estimated volume of low and intermediate wastes generated during the implementation of this decommissioning strategy is summarized in the table below.

Table D.2.5 Total estimated volume of low and intermediate level waste generated during decommissioning

Decommissioning option	number of containers having the dimensions 1.9 m*1.9 m*1.6 m	number of containers having the dimensions 2.3 m*2.3 m*1.4 m
20 year long protected preservation of the primary circuit	302	2,805

The volume of HLW to be disposed of in the deep geological facility is estimated to be approximately 500 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 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 atomic energy oversight organization (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 public administration bodies 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 maximum 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, a safety code or regulatory requirement, or failing to comply with an obligatory standard (prescribed by the authority) 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 disposal of radioactive waste, *the closure of the nuclear fuel cycle*, the interim storage and final disposal of spent fuel, and for the decommissioning of nuclear facilities;
- prescribes the establishment of a Central Nuclear Financial Fund intended solely for financing the disposal of radioactive waste, the interim storage and final disposal of spent fuel elements, *the closure of the fuel cycle*, and for the decommissioning of nuclear facilities;
- prescribes the obligation of physical protection, regulates that the licensees shall prevent the unauthorized access to their nuclear and other radioactive materials, facilities and equipment under the control of the user of atomic energy, the loss of control over them and their diversion toward non-licensed applications, in addition it requires that the nuclear facilities and radioactive waste repositories shall be protected by armed guards.

There are two more or less specific issues in Hungary defined by the Act on Atomic Energy:

- The Act states that radioactive waste management facilities (e.g. repositories) are not considered as nuclear facilities.
- The other specific issue is that the Act, and the implementation decrees thereof, establish a so-named 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 the public administration bodies responsible for health (regionally competent radiation health centres working within the public health professional administration organizations of the capital and county government offices, and the Office of the Chief Medical Officer of the National Public Health and Medical Officer Service). *(This is to change from July 1, 2014 according to an amendment to the Atomic Act and the related implementation decrees and the safety regulatory system of radioactive waste repositories will be adjusted to that of the nuclear facilities and in that frame the main licensing and oversight authority will also be the atomic energy oversight organization – Hungarian Atomic Energy Authority).*

As far as radiation protection is concerned, the Act on Atomic Energy 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 and storage 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 belongs 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 generated amount 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 the 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 committed to the international agreements concerning environmental impact assessment too. As a member of the European Union, Hungary also complies with the relevant Council Directive 2001/42/EC of the European Parliament and of the Council on the assessment of the effects of certain plans and programmes on the environment.

Service life extension of the Paks NPP

The extension of service life of the units of Paks Nuclear Power Plant by 20 years is on the agenda in Hungary. It requires both a new environmental license issued within the framework of an environmental protection procedure and a new operating license to be issued within the framework of a nuclear safety licensing procedure.

The environmental protection license was issued by the competent authority in 2006; it became effective, subsequent to an appeal procedure, on 31 January 2007. In accordance with the regulations of Govt. decree on nuclear safety authority procedures [II.24] Paks NPP Ltd submitted a programme to the HAEA in 2008 in order to establish the operational conditions for service beyond the designed lifetime and to demonstrate the operability of the plant. The HAEA accepted the programme with a resolution and monitors its implementation. One year prior to the end of the design service life the licensee shall submit the license application for the operation beyond the designed lifetime for each unit. *The design service life of Unit 1 expired on December 31, 2012. The licensee requested an extension of the service life by 20 years by submitting the application to the authority in December, 2011. In the licensing process the HAEA assessed the compliance with the effective requirements [I.6, II.25], among others whether the disposal of radioactive wastes and storage of spent fuel is appropriately provided for during the extended service life.*
In December 2012, the HAEA granted the operating license for Unit 1 that is valid until December 31, 2032.

The design service life of Unit 2 expires on December 31, 2014. The licensee applied for the 20 years extension of service lifetime in November, 2013. The documentation supporting the application is now under regulatory assessment in the HAEA (see in Section D.1.1).

E.1.1 Spent fuel management

In 2011 the sixth annex of the governmental decree [II.24] entered into force, and the nuclear safety code titled "Interim Storage of Spent Fuel" was issued. The application of the safety codes is supported by guidelines: eighteen guidelines are related to the spent fuel storage facilities with dry storage; additional guidelines are being elaborated as appropriate.

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.4]. The dose limits in the decree are in accordance with the values laid down in the IAEA's Basic Safety Standards (Safety Series 115) 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.10] 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 of the repository 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.
- Operation licences 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 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.3] 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 for radioactive waste facilities.

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.21]).

The HAEA is a government office dealing with peaceful usage of atomic energy, acting under the control of the government with independent task and regulatory competence; it is independent both organizationally and financially. The HAEA is supervised by a minister designated by the prime minister (in the reporting period the minister for national development) independently of his portfolio. The HAEA cannot be instructed in its scope of authority defined by law.

Licensing (at facility, system and system-component level) and inspection of the nuclear safety of nuclear facilities, *regulatory licensing an inspection of design, operation and modification of physical protection systems of nuclear facilities, radioactive waste storages and repositories, radioactive sources and radioactive wastes,* accountancy for and control of nuclear and other radioactive materials as well as the licensing of related shipments and packaging designs, taking a stand as special authority in the licensing procedure of nuclear export and import, evaluation and coordination of research and development related to the safety of the application of atomic energy, fulfilment of regulatory tasks falling under its jurisdiction in the field of nuclear emergency preparedness, approval of emergency response plans of nuclear facilities, and the related international relations all come under the competence of the HAEA.

The legislation supports the involvement of experts (being an institute, company or private expert) into the work of the HAEA, in the cases when it does not possess the required expertise. In order to provide an appropriate scientific background for its activities, the Authority has concluded agreements with several scientific institutions and professional companies. Such agreements seal its cooperation with the *Hungarian Academy of Science Centre for Energy Research*, the Institute of Nuclear Techniques of the Budapest University of Technology and Economics, the Nuclear Safety Research Institute, and with the *SOM System Ltd.*

In accordance with the Act on Atomic Energy, the work of the Authority is also supported by a Scientific Council that is composed of members having a national reputation. The Council taking into account the latest scientific results takes position in the most important conceptual research and development issues related to nuclear safety, non-proliferation of nuclear weapons, radiation protection and nuclear emergency preparedness.

The organizational structure of the HAEA can be seen in Figure E-2.1-1.

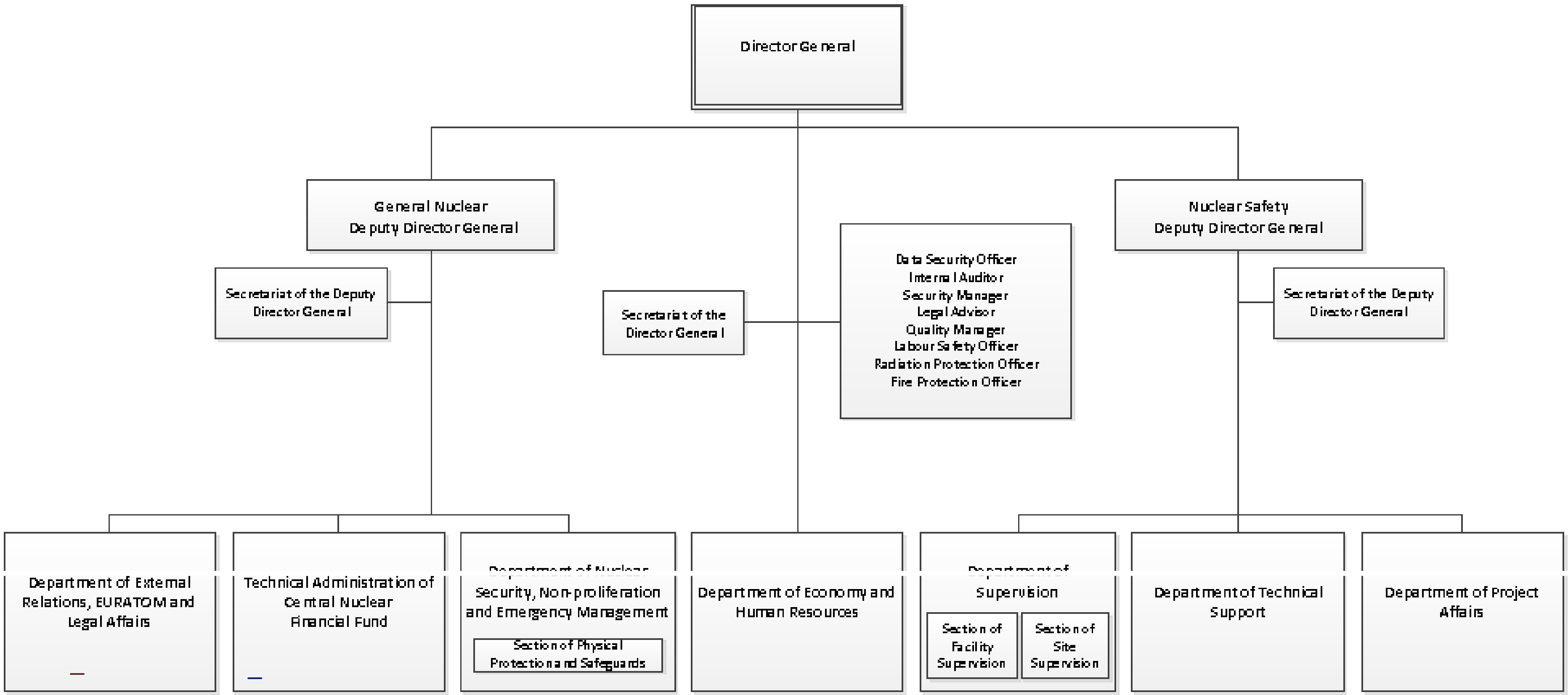


Fig. E.2.1-1 Organisational structure of the Hungarian Atomic Energy Authority

E.2.2 The public health administration bodies

With regard to issues concerning radiation health (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 the radiation health centres working within the public health professional administration organizations of the capital and county government offices, and the Office of the Chief Medical Officer of the Public Health and Medical Officer Service according to the relevant governmental decree [II.30] and ministerial decrees [III.4 and III.10]. This also applies to spent fuel management facilities.

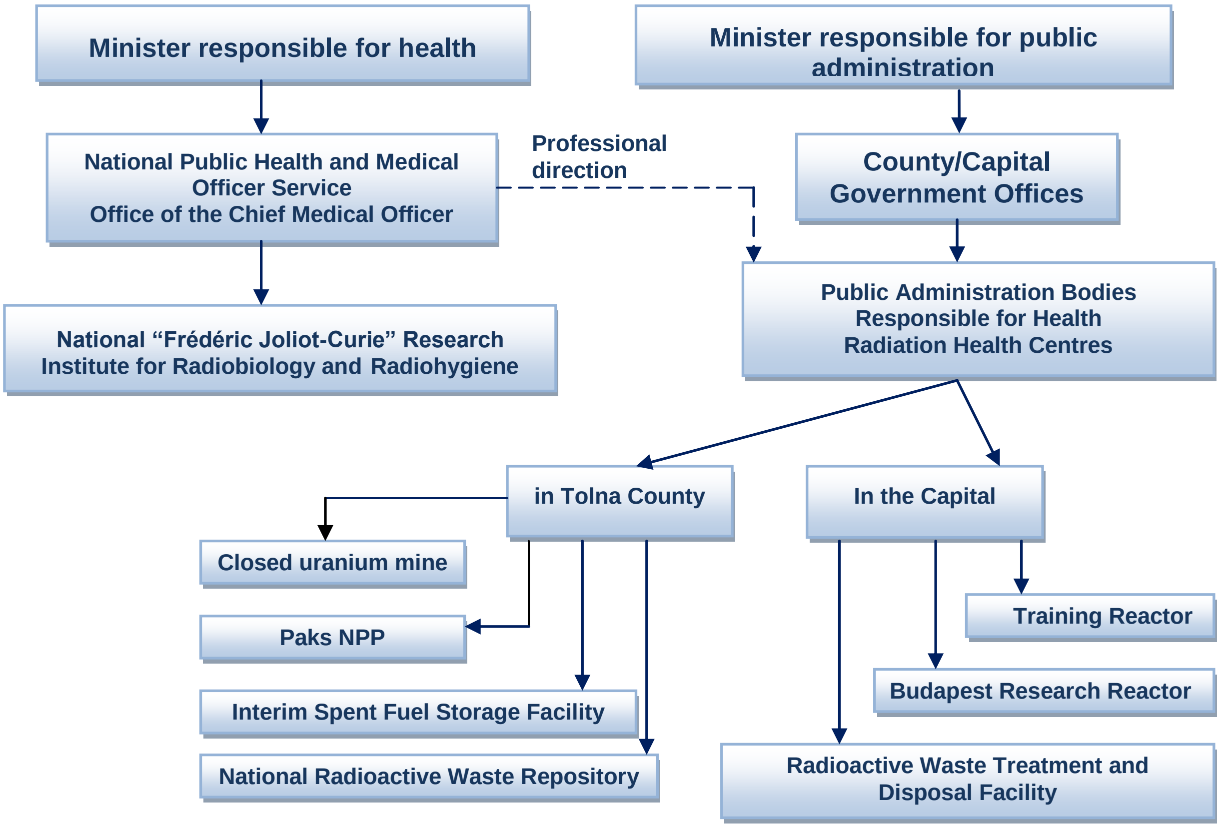


Figure E.2.2-1 Structure of the radiation health authorities and their supervisory system

The national expert body and authority, the Office of the National Chief Medical Officer, is the licensing authority for radiation protection regulation, the health physics service sections of the major facilities, and it also participates in the nuclear safety licensing procedures as a special authority on radiation health questions. 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 Radiation Health Centre working within the Public Health Professional Administration Organization of the Tolna County Government Office is empowered to supervise (including field inspections) the adherence to radiation health 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 at the finalization of this report, a nuclear safety licence should be obtained from the authorities for all periods during the lifecycle of the Spent Fuel Interim Storage Facility. Moreover, separate licences must be obtained for all changes of construction to a given facility or modifications of 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 [II.21] *[II.30]* (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 facility that operates without a licence, or operates contrary to a valid licence falls under the Penal Code [I.2]; among the sanctions for an operator of a facility found guilty in these respects is a severe sentence of imprisonment.

E.3.2 Radioactive Waste Management

The Regionally Competent Radiation Health Centres working within the Public Health Professional Administration Organizations of the Capital and County Government Offices, and the Office of the Chief Medical Officer of the Public Health and Medical Officer Service, with expert advice and technical assistance provided by the National Research Institute for Radiobiology and Radiohygiene perform the licensing procedures.

In the licensing procedure all the other relevant public administration organisations participate as so-named special authorities. These special authorities designated in the government decree [II.30] 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, heritage protection and building;
- the HAEA enforces aspects in relation to the accountancy for and control of nuclear and other radioactive materials, as well as to nuclear emergency preparedness and response;
- the Hungarian Police Headquarters enforces aspects relating to police administration;
- the Authority Office of the Ministry of National Defence enforces the defence aspects;
- the regionally competent Emergency Management Local Offices, the County (Capital) Emergency Management Directorates as well as the National Directorate General for

Emergency Management enforce aspects relating to civil defence, industrial safety and fire protection;
- the regionally competent mine authority enforces aspects relating to mining technology, mining safety and geology.

Licensing and inspection of the physical protection system of radioactive waste storage and disposal facilities have belonged to the competence of the HAEA according to the relevant government decree [II.33] since 2011. In these procedures the National Police Headquarters takes part as a special authority.

Further to those mentioned above, pursuant to Govt. decree [II.27], the authorities listed below shall be involved in the construction and operation licensing procedure of the Bátaapáti National Radioactive Waste Repository:

- the Food Chain Safety and Animal Health Directorate and the Plant and Soil Protection Directorate of the Tolna County Government Office which enforce aspects relating to animal health, food protection, plant and soil protection;
- the Transport Inspectorate of the Baranya County Government Office which enforces aspects relating to public and cargo transport.

E.4 Inspection

The Act on Atomic Energy stipulates that nuclear energy can be deployed only in the way defined by law, and with regular inspection and assessments by the authorities.

The licensing authority is liable to check compliance with all legal stipulations, and the safety of the applications of nuclear energy.

The authority is entitled to perform inspections either with or without advance notice.

In addition to the HAEA's inspection activities, the special authorities taking part in the licensing procedure or giving their separate licenses may also carry out 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 annually evaluates 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 keeping the operation license further in force, 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 (see Section K1).

In 2013, according to the new regulation the HAEA re-designated the earlier fix size exclusion zone of facilities. In the new designation the public dose limits, the minimum distance specified by the regulation, and the potential impact of human activity on the facilities were considered. According to the new regulation the designation of an exclusion zone is required for nuclear facilities with a reactor having higher than 150 kW nominal thermal power, for radioactive waste disposal facilities and for spent fuel interim storage facilities.

In the field of radioactive waste management, the Regionally Competent Radiation Health Centres working within the Public Health Professional Administration Organizations of the Government Offices 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 authorities inspect the Radioactive Waste Treatment and Disposal Facility at Püspökszilágy and the National Radioactive Waste Repository in Bátaapáti 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 also published in the annual reports of the National Environmental Radiation Protection Monitoring System (OKSER) set up by governmental decree [II.20]. (These annual reports are accessible on the internet: http://www.okser.hu.)

The central registration of radioactive wastes falling within the scope of the Act on Atomic Energy is a further means of the regulatory supervision of radioactive wastes; this task belongs to the competence of the HAEA.

According to the relevant directives of Euratom and recommendations of the IAEA, the HAEA maintains a computerized system for registering radioactive materials (including wastes). The Ministerial decree [III.14] that became effective in April 2010, extended the scope of radioactive materials to be registered to include radioactive wastes in addition to radioactive sources. In accordance with the new decree a licensee shall keep a local register, which provides up-to-date information on the actual inventory, type, activity, and storage location of radioactive wastes under its ownership. The local register shall be maintained by software provided to the licensees by the HAEA free of charge. The inspection frequencies of local registers were specified within the framework of a risk-informed inspection regime considering the estimated probability and consequences of losing regulatory control over radioactive sources.

E.5 Enforcement of the regulatory requirements

The conditions for executing legal mandates of the authorities are included in the Act on the general rules of regulatory procedures and services in the public administration, in the Penal Code, and in governmental decrees.

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.

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 licensee of the relevant operational licences of spent fuel management facilities and radioactive waste management facilities, the Public Limited Company for Radioactive Waste Management.

Public Limited Company for Radioactive Waste Management is responsible for the following activities:

- elaboration of *its* medium- and long-term plans (strategies);
- elaborating cost estimates to identify the necessary payments into the Central Nuclear Financial Fund (Fund) each year;
- *development of proposals on the national policy and national programme related to management of radioactive wastes and spent fuel;*
- 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 Spent Fuel Interim Storage Facility;
- *preparation for construction of a disposal facility for HLW and construction of an underground research laboratory for site selection research;*
- completion of work required for decommissioning of nuclear facilities *(*after final shut-down of nuclear facilities – till the demolition – the maintaining, guarding, decommissioning of nuclear facilities and remediation of their sites);
- operation of the existing low- and intermediate level repository of institutional wastes, i.e. the Radioactive Waste Treatment and Disposal Facility;
- operation of the nuclear power plant originated low and intermediate level waste repository, the National Radioactive Waste Repository;
- provision of information and maintaining public relations.

The basic tasks of the Public Limited Company for Radioactive Waste Management 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 quality 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 radiation levels and concentrations of the radionuclides in the environment continuously and provide the local public with relevant information;
- to maintain an appropriate organisation which is capable of accomplishing each and every prescribed periodic and event reporting obligation in due time (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 through continuous improvements, including evaluation of all relevant operation experience available, 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 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.29] 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, intensity 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 Hungarian Atomic Energy Authority has been *83* people in the recent years, of whom more than *90%* hold a higher education degree (university or college), and 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 *75%* of them have state level certificate from one or more foreign languages.

A systematic education plan has been introduced 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 the fulfilment of the basic tasks of the Hungarian Atomic Energy Authority, the Act on Atomic Energy designates two financial sources:

- funding of the technical support activities for supervision of safe use of atomic energy shall be provided from the state budget;
- the licensees of nuclear facilities 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].

It can be concluded however that for the effect of measures aiming at improvement of state budget balance the state budget support for the HAEA dropped to a minimum level, funding is provided by its own incomings (supervision fee) in 99%.

The Hungarian Atomic Energy Authority performs its regulatory activities impartially, independently of the nuclear facilities, and its funding provides to carry out its duties efficiently. At the same time significant problems in human resources appeared when performing certain activities because of the decrease in the number of staff that occurred in the last years and because of the rate of earnings stated in *the act on public officers*.

F.2.1.2 The National Public Health and Medical Officer Service

In Hungary, the licensing of radioactive waste management falls under the competence of the Regionally Competent Radiation Health Centres working within the Public Health Professional Administration Organizations of the Government Offices, and the National Chief Medical Officer Authority of the Public Health and Medical Officer Service (health administration organizations) [II.30].

The public health authorities are independent from the sphere of the licensees. In 7 regional radiological centres some 46 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 regulatory tasks are supported by the National Research Institute for Radiobiology and Radiohygiene (with about 65 highly qualified employees). The National Radiation Hygiene Preparedness Service with its appropriately equipped vehicle provides a 24-hour service every day.

The health administration organizations are public administration offices financed from the state budget *most recently struggling with serious resource problems (shortage of staff, outdated infrastructure, non-competitive incomes of the staff).*

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 organization to be designated by the Government shall prepare a proposal for the national radioactive waste and spent fuel management policy and national programme as well as their revision, furthermore it shall take care of the performance of tasks related to the final disposal of radioactive waste, interim storage of spent fuel, closure of nuclear fuel cycle and to the decommissioning of a nuclear facility. Based on this, the Government commissioned the Director General of the Hungarian Atomic Energy Authority with the task of establishing this organisation (See Section B). *The so established Public Limited Company for Radioactive Waste Management performs the public tasks as listed in the Atomic Act as to be performed by the organization designated by the Government, performs activities of public use according to, among others, the act on public utilities [I.14] and performs the permanent tasks determined by the government decree [II.31] on the designation, activities and financial resources of the organization performing specific tasks related to radioactive wastes and spent fuel.*

The central offices of the Public Limited Company for Radioactive Waste Management are in Budaörs, close to Budapest. The management and administrative activities within each directorate are performed at Paks. *The National Radioactive Waste Repository is located in Bátaapáti, while the Radioactive Waste Treatment and Disposal Facility in Püspökszilágy. 207 employees work at four sites, including 88 security guards.* The operation and maintenance of the Spent Fuel Interim Storage Facility is performed by the staff of the Paks NPP on a contractual basis under the direction of the Public Limited Company for Radioactive Waste Management.

The organisational scheme of the Public Limited Company for Radioactive Waste Management is shown in Figure F.2.2.1-1.

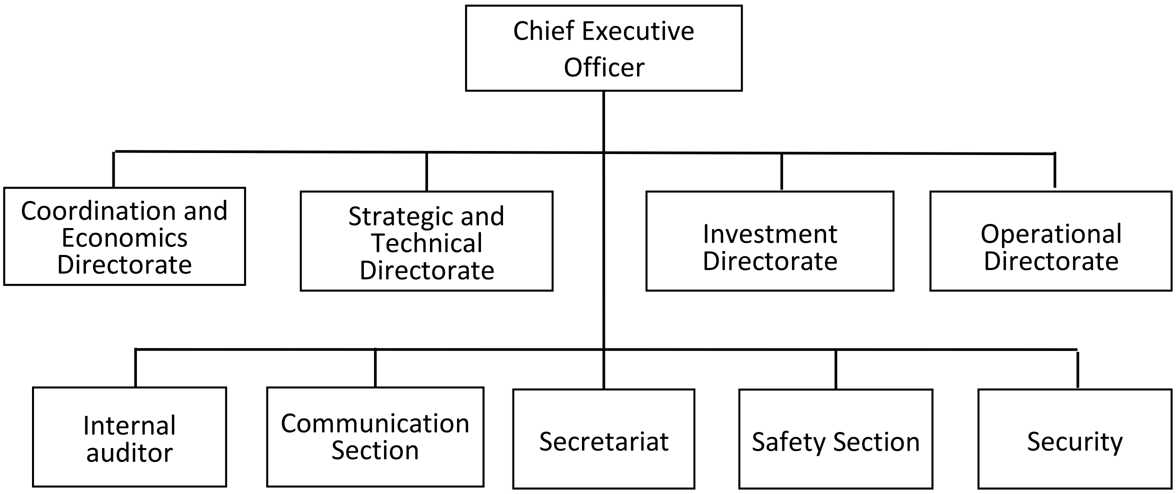


Figure F.2.2.1-1 Organizational scheme of the Public Limited Company for Radioactive Waste Management

The Ministerial Decree [III. 17] on the special professional education and further training of employees of nuclear facilities and on the employees authorized to perform activities related to the use of atomic energy regulates employment issues in the Spent Fuel Interim Storage Facility.

F.2.2.2 Financial resources

As required by the Act on Atomic Energy [I.6], the Minister supervising the Hungarian Atomic Energy Authority disposes over the Central Nuclear Financial Fund operating as of 1 January 1998. *From January 1, 2014 the ministry lead by this Minister is responsible for the management of the Fund* (until December 31, 2013 the Hungarian Atomic Energy Authority was responsible for its management). The Fund is a separate state fund pursuant to the Act on public finance [I.4]. It is primarily earmarked for financing the construction and operation of disposal facilities for the final disposal of radioactive waste, the interim storage of spent fuel, *the closure of nuclear fuel cycle*, and the decommissioning of nuclear facilities.

A medium and a long-term plan (covering up to the decommissioning of the various nuclear facilities) and an annual work schedule on the use of the Fund shall be prepared by the Public Limited Company for Radioactive Waste Management and shall be approved by the minister supervising the Fund. The long- and medium-term plans are to be reviewed annually and revised as required.

The due payments into the Fund are defined in accordance with these plans. The annual financial obligations of the Paks NPP to the Fund are proposed by the minister supervising the Hungarian Atomic Energy Authority. Due payments are based upon submittals prepared by the Public Limited Company for Radioactive Waste Management preliminary assessed by the Hungarian Atomic Energy Authority from professional aspects, to which the Expert Panel of the Fund supporting the work of the Minister shall develop a preliminary opinion.

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 Annex of the Atomic Act [I.6.]. For nuclear facilities financed from the central budget (the Budapest Research

Reactor and the Training Reactor), the sources required to cover payments into the Fund are provided by the central budget, when necessary.

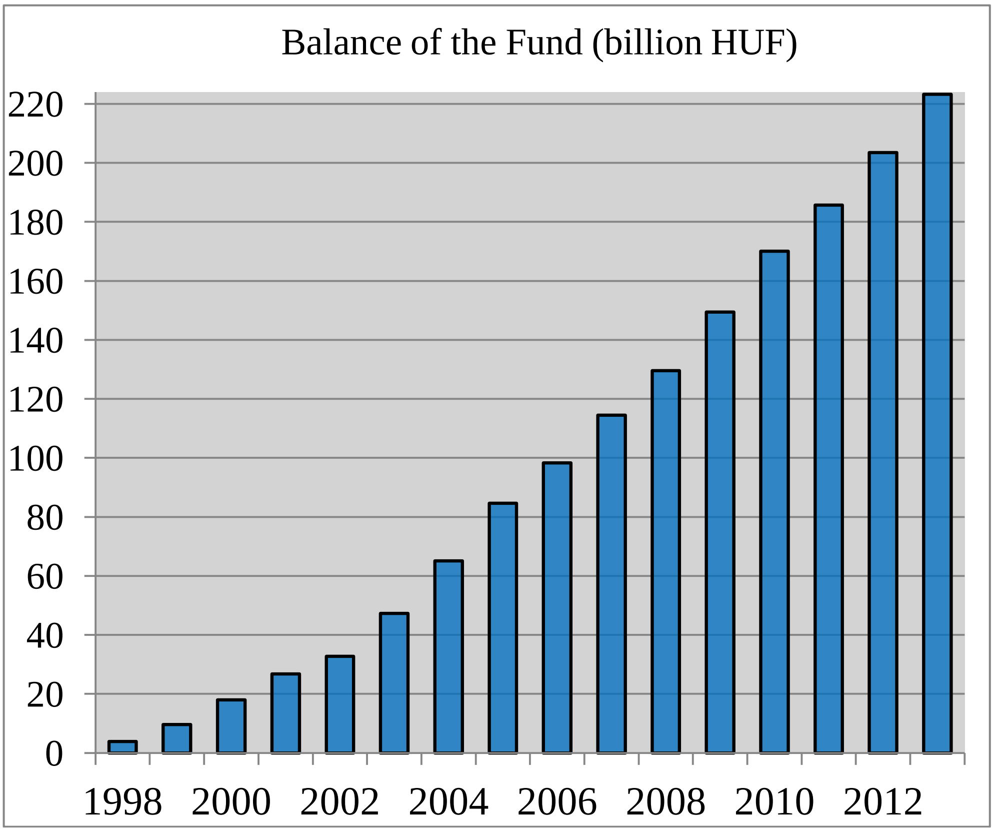
The rate of payments into the Fund shall be specified in such a way as to provide appropriate sources for all costs of management of radioactive wastes and spent fuels and of the decommissioning of nuclear facilities. *These sources also provide coverage for supporting the municipal associations aimed at public control and information activities as well as for the operational expenses of the existing repositories. A government decree [II.32] regulates the support of control and information purpose municipal associations.*

In order to ensure that the Fund maintains its value, the Government annually 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 of the same period.

The Central Nuclear Financial Fund is managed within an individual account of the Hungarian State Treasury. The State Audit Office of Hungary annually audits the budget planning of the Fund, the execution of the budget plan and the fulfilment of tasks.

Table F.2.2.2-1 Financial data of the Fund *between 1998 and 2013*

	Income	*Expenditure*	*Increase of assets (MHUF)*
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
2008	31 362.6	16 288.8	15 073.8
2009	33 751.4	13 913.6	19 837.8
2010	35 646.0	15 003.6	20 642.4
2011	*32 212.6*	*16 528.7*	*15 683.9*
2012	*30 595.7*	*12 843.6*	*17 752.1*
2013	*33 271.0*	*13 462.2*	*19 808.8*



Change of the balance of the CNNF

The assets of the Fund amounted to 223.3 billion HUF as of 31 December 2013 (please note that 1 Euro was 297 HUF on 31 December 2013).

F.3 Quality assurance

All organizations dealing with spent fuel management are obliged by the Act on Atomic Energy [I.6] and the relevant governmental decree [II.24] to operate under an appropriate quality management system. The requirements for the operation of the integrated quality management are included in Volume 2 of the Nuclear Safety Code. As part of the Final Safety Assessment Report required by the Nuclear Safety Code the licensee shall explain the basics of the integrated quality management system to the HAEA. The Hungarian Atomic Energy Authority is empowered by law to inspect the effectiveness of the integrated quality management system of the licensee.

All organisations contracted by the licensee and working on *nuclear* 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 (including the operability of the integrated quality management system).

The Public Limited Company for Radioactive Waste Management developed a Quality Management System based on *ISO 9001:2008* and an Environmental Management System based on *ISO 14001:2004* standards, into which *it integrated the requirements of Volume 2 of the Nuclear Safety Code.* Their introduction and *continuous operation* is *regularly audited* by an accredited *auditor* organization.

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 first certified in December 2002 and the Authority has had a valid certificate since then.

The regulatory tasks, including measurements, of the public health authorities are also carried out under their quality management system. Most of the laboratories operate a management system accredited by the National Accreditation Body according to the requirements of the relevant legal regulations and the ISO/IEC 17025:2005 standard.

F.4 Operational radiation protection

As demonstrated in Section E, the Hungarian legal regulations require that the radiation exposure of workers and of the public shall be kept as low as reasonably achievable, and in normal situations no individual shall be exposed 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.7] 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. In accordance with the characteristics of the facilities, the dose constraint for Paks Nuclear Power Plant is 90 μSv/year, for the Spent Fuel Interim Storage Facility 10 μSv/year, for the Radioactive Waste Treatment and Disposal Facility and the National Radioactive Waste Repository 100 μSv/year, for the Budapest Research Reactor 50 μSv/year, for the Training Reactor 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 environmental authority. The licensees have to monitor the environment and determine the releases in compliance with the requirements of the decree, and to report regularly 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 and Response

F.5.1 Emergency response organization

The National Nuclear Emergency Response System (NERS) was renewed by a government decree promulgated in 2010 [II.29]. The legislation, which was accepted with consensus among experts, takes the developments of international recommendations and the recent experience into consideration, and defines the national preparation in a basically new structure. It reflects the concept of continuous operation, and the criterion based concept of operating states of the National Nuclear Emergency Response System. It can be concluded that an up-to-date decree was created, and it provides a basis for the more effective operation of the National Nuclear Emergency Response System.

The National Nuclear Emergency Response System regulated by the above mentioned decree is an essential part of the general disaster management system established as the implementation of the Act on protection against catastrophes [I.9]. The central body of the command structure is the Inter-ministry Disaster Management Coordination Committee (IDMCC), the chairperson of which is the minister responsible for the defence against emergencies, and its members are the state level leaders designated by the competent ministers. The managers of the central state administration bodies participate as advisors in the meetings of the Committee.

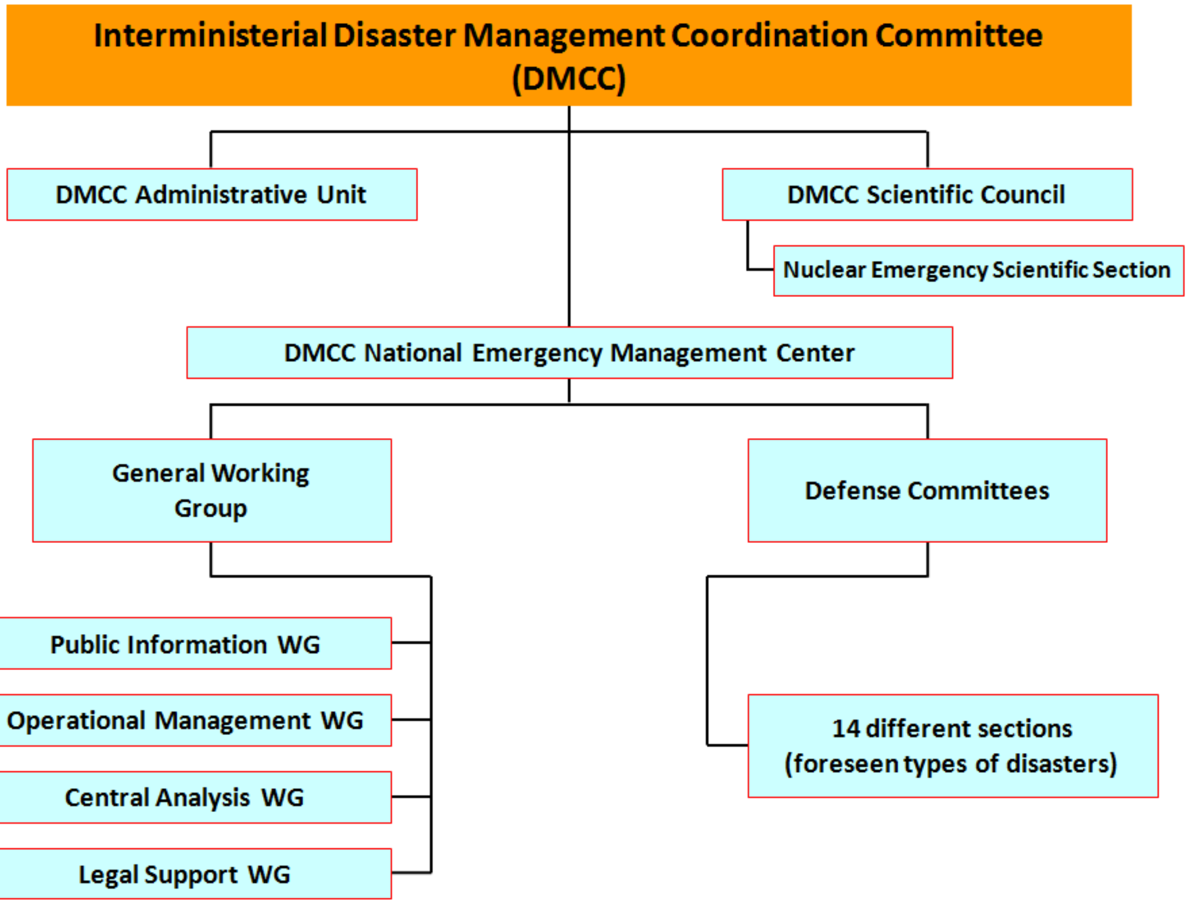


Figure F.5.1 – 1. Organizations participating in emergency management

The scientific task force of the IDMCC is the IDMCC Scientific Council; the operative task force is the IDMCC National Emergency Management Centre (IDMCC NEM). The IDMCC NEM consists of its chair, a general working group and emergency-specific defence working groups tasked with professional issues. The IDMCC NEM operates a Public Information Group. Among others, the Nuclear Defence Working Group is operated by the central public administration organization responsible for disaster management, called the National Directorate General for Disaster Management of the Ministry of Interior.

Should a threat of a disaster or a declared emergency occur the IDMCC NEM commences its activity after an alerting process. Its members are experts of various professional areas, and their role is the coordination of the sectoral tasks of emergency response. The IDMCC NEM shall make -in line with the emergency decisions of the Government and the IDMCC - appropriate, fast decisions to be implemented immediately.

The main task of the Nuclear Emergency Response Scientific Section is to provide a technical-scientific foundation for nuclear emergency preparedness decisions, emergency decision support, support in emergency decision making, as well as for the mitigation of consequences. The President of the Hungarian Academy of Science makes proposals to the chair for the members of the IDMCC Scientific Council. The Council consists of the leading professionals of the most important Hungarian research institutes.

Under normal operation conditions the coordination of execution of nuclear emergency response tasks falls under the responsibility of national, regional and local branches of the official disaster management organizations, in case of an emergency the presidents of the regionally competent County (Capital) Defence Committees in the counties and the capital, and the chairperson of the IDMCC at national level are in charge of nuclear emergency response tasks. Within the nuclear facility the manager is responsible for the coordination and implementation of emergency response tasks.

Under non-emergency conditions the organizations of the National Nuclear Emergency Response System in order to improve the operability and effectiveness conduct preparatory work and exercises in order to improve the operability and effectiveness. Certain organizations perform, apart from preparation, continuous data gathering, planning, and information or cooperation tasks.

F.5.2 Sectoral and local nuclear emergency response organisations

The order of direction and of operation of the sectoral system are determined by the ministers and the heads of central administration organizations concerned. Formation of special organisations for responding to a nuclear emergency, designation of staff and resources to be applied in the response, as well as local emergency response planning and maintenance of those plans are the tasks of the County (Capital) Defence Committees.

Sectoral coordination and management of emergencies affecting more than one county and causing unplanned radiation exposure of the population is the responsibility of sectoral organizations taking part in the operation of the National Nuclear Emergency Response System.
Disaster management organizations are in charge of regional nuclear emergency prevention and preparation tasks, while regional defense committees coordinate the implementation of consequence mitigation.

F.5.3 National Nuclear Emergency Response Plan

A High Level Working Group was established for the revision and maintenance of the National Nuclear Emergency Response Plan (NERP). The revision was based on the experience gained during national nuclear emergency response exercises, the recommendations identified in the report on the severe incident that occurred at the Paks NPP in 2003, the relevant new legislations and the new international recommendations. The new version of the Plan was issued in 2008 as a result of the two-year-long efforts of the High Level Working Group. In comparison with the former version, the most significant changes are: the extension of the planning and intervention objectives, the definition of operating states and their criteria, the extension of emergency classification to radiological emergencies, the re-definition of the action and intervention levels, the development of national level procedures to be implemented in the case of events that do not exceed the action and intervention levels, and the definition of public information tasks.

The IDMCC approved the new version of the National Nuclear Emergency Response Plan and ordered that the organizations of the national system shall review or, if needed, develop their own plans based on the new National Plan. The IDMCC authorized the High Level Working Group to harmonize the nation-wide planning and to develop technical-scientific documents (guidelines) in expert questions that are not regulated in sufficient detail by the National Plan.

The High-level Working Group performed the revision of the National Emergency Response Plan in 2010. The review aimed at adopting the new ministerial responsibilities derived from the reorganization of the government structure, and its further development by reasonably reducing the size of the document based on the experience gained from application of the Plan.
The issuance of methodical guidance in connection with the Plan was continued; two guidelines were published in 2010: the "Organized assistance in response" and the "Local management of a radiological emergency". The legal background of the High-level Working Group was strengthened in 2010 by the promulgation of a new government decree [II.29].

In 2013 the revision of the already issued guidelines and preparation of new ones were continued. Until March of 2014 the director general of the HAEA issued the second version of eight guidelines and one new guideline entitled "Communication between the organizations of the NERS".

Guidelines and technical aids issued till now:

- Legal basis of the NERP,
- Critical tasks of the NERS,
- Evaluation of the critical tasks of the NERS,
- Organized assistance in response,
- Structure and operation of the National Radiation Monitoring, Alert and Control System,
- Emergency monitoring strategy,
- Planning work of the NERS organizations related to preparedness,
- Communication between NERS organizations,
- Development and continuous maintenance of organizational nuclear emergency plans,
- Preparation, conduct and evaluation of nuclear emergency response exercises,
- Decision on, introduction and implementation of urgent protective actions,
- Local management of a radiological emergency,
- Organization of treatment of radiation injuries.

F.5.4 Emergency preparedness in the facilities

F.5.4.1 Spent Fuel Interim Storage Facility

The Paks Nuclear Power Plant and the Spent Fuel Interim 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. 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 nuclear emergency preparedness activities are specified by the Nuclear Emergency Response Plan valid for the given facility.

The Nuclear Emergency Response Plan of the Spent Fuel Interim Storage Facility shall be regularly reviewed by the operator and approved by the atomic energy oversight organization.

F.5.4.2 Radioactive Waste Treatment and Disposal Facility

In 2007 the Radioactive Waste Treatment and Disposal Facility introduced a new Nuclear Emergency Response Plan which is harmonized with the Hungarian legal background and with international expectations. The new plan was approved by the National Public Health and Medical Officer Service. The nuclear emergency response plan of the Public Limited Company for Radioactive Waste Management was revised and updated based upon the new National Emergency Response Plan in 2011 and 2013; it was approved by the National Chief Medical Officer Authority.

F.5.4.3 National Radioactive Waste Repository

The operating license for the surface facilities was granted to the National Radioactive Waste Repository in 2008. A condition for the license was the preparation of an emergency response plan. The emergency response plan was approved by the Office of the Chief Medical Officer based on the expert opinion of the National "Frédéric Joliot-Curie" Research Institute for Radiobiology and Radiohygiene. The National Radioactive Waste Repository was commissioned on December 5, 2012, and it has continuously been accepting the low and medium level waste of the NPP since then.

F.5.5 Preparation and exercises

The emergency preparedness and exercise activities at the spent fuel storage and radioactive waste repository facilities are realized pursuant to the facility emergency response plans. According to law, the plans shall define the qualification requirements for the personnel of the emergency response organization and their preparation, regular training and exercises. The legislation requires the organization of comprehensive emergency exercises at regular intervals. In such exercises the potential participation and contribution of off-site emergency organizations shall be assured and their conduction is regularly observed by the Hungarian authorities within the framework of field inspections.

The preparation and exercising of the off-site emergency response organizations is performed according to annual plans that are developed on the basis of the National Nuclear Emergency Response Plan. Taking into account the national training and exercise plan, each organization shall prepare its own plan and is responsible for the preparation of its own emergency response organization based on that.

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 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 countries 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.

From May 2012, the National Directorate General for Disaster Management, Ministry of the Interior took over the responsibilities of the National Warning Point (NWP) from the Ministry of Foreign Affairs, so beside the Hungarian Atomic Energy Authority this organization performs the notification and informational tasks toward the International Atomic Energy Agency.

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.

In 1991 the Republic of Hungary agreed 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 renewal of the National Nuclear Emergency Response Plan.

Hungary joined the European Community Urgent Radiological Information Exchange (ECURIE) system before joining the European Union.

In compliance with article 36 of the EURATOM treaty and the EURDEP agreement the Nuclear Accident Information and Evaluation Centre operated by the National Directorate General for Disaster Management serves as national centre for international radiological monitoring data exchange. It can also follow the changes in background radiation in Europe through the international radiological monitoring data exchange centre of the EU. At the moment Hungary exchanges radiological monitoring data continuously through the Nuclear Accident Information and Evaluation Centre with Austria, Croatia, Slovenia and Slovakia among the neighbouring countries.

Apart from that Hungary 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 first 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. Based on the contract the Nuclear Emergency Response Organisation of the Hungarian Atomic Energy Authority provides professional support in nuclear and radiological evaluation of an emergency and in public communication at the request of the European Commission. *After the second period of the contract between 2010 and 2013, as recognition of the successful work and as a result of the successful bid for the tender called for the next three years, the HAEA won the assignment for the third time until the end of 2016.*

F.6 Decommissioning

Decommissioning is covered in the Hungarian regulations as the final phase of the life-cycle of the facilities.

In the frame of the obligatory periodic revision of the nuclear safety codes, within the last revision affecting the entire Nuclear Safety Code, the Hungarian Atomic Energy Authority published the requirements for decommissioning of nuclear facilities as a separate volume. The new requirements are based upon the reference levels of the Western European Nuclear Regulators' Association (WENRA) regarding decommissioning. *The regulation was promulgated by the government decree [II.24]as its Annex 8, and it entered into force in August, 2011.*

For licensing of decommissioning, a multi-step licensing procedure is established, where the first step is to obtain the HAEA's consent to terminate operation. A further requirement is a valid environmental protection licence based on environmental impact assessment and public hearing. Radiation health authorities have a role in these licensing processes, and they license the appropriate radiation health programme and radiation protection organisation separately. 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 as well as discharges and the radiation in the environment. Emergency plans have to be updated regularly according to the current life cycle phase, and shall be supplemented as necessary with new or likely scenarios. Any necessary organisational changes required must be adjusted accordingly.

With regard to the Paks Nuclear Power Plant, the Budapest Research Reactor, the Training Reactor and the Spent Fuel Interim Storage Facility, the safety codes contain provisions that decommissioning shall be taken into account at the design stage. The summary of the preliminary decommissioning plan constitutes an obligatory part of the documentation prior to commissioning as well as of the final Safety Assessment Report. 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 of the licensing procedure aimed at decommissioning. All decommissioning plans have to cover organisational and qualification issues together with technical ones. *It is a change that the new regulation determines the main steps of withdrawal of the facility from nuclear safety authority oversight following the termination of the decommissioning process.*

In the case of Paks Nuclear Power Plant no preliminary decommissioning plan was originally made. This situation was corrected in the early 1990s and since then it has been updated regularly. The third revision of the plan was carried out in 2008. The Preliminary Decommissioning Plans shall be updated every five years. However, together with the service life extension documentation, the final decommissioning plan had to be submitted to the authority (HAEA) in relation to Unit 1. Thus the next revision period counts from 2011, and the next submission is expected in 2016. In parallel to the service life extension activities, but independently of them, the NPP launched the public procurement process for the revision of the 2008 plan, and the revision has been carried out.

In the case of the Budapest Research Reactor and the Training Reactor, the IAEA provided professional support to prepare the preliminary decommissioning plans in the form of expert missions. In 2010 a mission took place in the Budapest Research Reactor. Now both facilities, the Budapest Research Reactor and the Training Reactor have Preliminary Decommissioning Plans approved by the Hungarian Atomic Energy Authority.

The Spent Fuel Interim Storage Facility was designed by taking into account all relevant requirements of decommissioning, so this facility had already possessed a simplified preliminary decommissioning plan from the beginning. *Based on the requirements of the periodic safety review conducted in 2008, the document was updated and submitted to the authority in 2011.*

Section G. Safety of Spent Fuel Management

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

G.1 Spent Fuel Interim Storage Facility

Siting
The facilities of the Spent Fuel Interim Storage Facility are located 500 m south of the geometric centre of the power plant units. By design the foundation of the Spent Fuel Interim Storage Facility was set at an elevation so 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 Spent Fuel Interim 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 were determined following a conservative approach:
- 0.08 g horizontal acceleration for a design earthquake;
- 0.35 g horizontal acceleration for a maximum design earthquake.

Seismic design of the Spent Fuel Interim Storage Facility took place by taking into account 0.35 g peak ground acceleration determined for the maximum design earthquake. This input was applied to the building structures and systems fulfilling safety functions, using the response spectra of the US Nuclear Regulatory Commission guideline (Regulatory Guide 1.60) and the attenuation values specified in the requirement 4/86 of the American Society of Civil Engineers.

Re-evaluation of the seismic hazard of the site defined a horizontal peak ground acceleration value of 0.25 g at an earthquake frequency of one in 10,000 years.

Design and construction

The reception building of the modular interim storage system and the first three storage modules was completed in 1996. The facility was commissioned in 1997. In 2012 the facility already contained 20 modules suitable for storing 9,308 spent fuel assemblies. The facility is operated in parallel with its expansion, the increase of storage capacity is in harmony with the demands of Paks NPP. The planned 36 modules are assumed to be capable of storing all spent fuel generated until the end of the extended service life of the plant. Beginning with module 17 of the Spent Fuel Interim Storage Facility, instead of triangular arrangement that is used in modules 1-16, square arrangement will be applied for the storage tubes; consequently 527 storage tubes can be stored instead of the original 450. When the storage facility reaches its maximum planned capacity, it will be capable to store a total of 17,740 fuel assemblies within the 36 modules.

Figure G.1-1 Spent Fuel Interim Storage Facility

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

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

- min. 3.5 year cooling before placing in the store,
- maximum of initial enrichment: 4.2%,
- average burn-up level: 47.25 GWday/tU,
- maximum burn-up level: 54 GWday/tU,
- 482 W/assembly residual heat production for average burn-up level,
- 720 W/assembly residual heat production for the maximum burn-up level
- 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 Spent Fuel Interim 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.

The Spent Fuel Interim Storage Facility was specifically designed to store spent nuclear fuel, but the criticality calculations omitted conservatively the reactivity reduction from burn-up of the fuel. 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 following criteria have been used by criticality calculations of the established Spent Fuel Interim Storage Facility:*

- *if flooding by a potential moderator medium, such as unborated water of various density would occur, the k_{eff} neutron-multiplication factor defined by ANSI/ANS-817-1984 shall not exceed 0.95.*
- *the Spent Fuel Interim Storage Facility shall have due safety margin against a criticality accident, even if two improbable and independent condition changes occur at the same time.*

The nuclear safety assessment of the Spent Fuel Interim 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. The programme has been operating since, and includes the regular inspection and testing of all safety-related systems and system components, beyond the normal maintenance work. A computer database was established for recording the operational safety parameters of the systems of the facility.

No problems were discovered by the analyses carried out till now that would affect the safety indicators of the Spent Fuel Interim Storage Facility.

Figure G.1-2 Re-fuelling machine in the Spent Fuel Interim Storage Facility

Operation of the facility

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

The operation and maintenance of the Spent Fuel Interim Storage Facility are performed on a contractual basis by the personnel of Paks Nuclear Power Plant. The Public Limited Company for Radioactive Waste Management supervises the operation and maintenance works.

The operation licence issued by the Hungarian Atomic Energy Authority in relation to Modules 1-20 of the Spent Fuel Interim Storage Facility is valid until *30 November 2018*. 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, Volume 6 of the Nuclear Safety Code "Interim Storage of Spent Nuclear Fuel" issued as an annex to the relevant governmental decree [II.24] shall be applied.

The operational limits and conditions are included in the Operational Limits and Conditions document of the Spent Fuel Interim Storage Facility. This document was approved by the Hungarian Atomic Energy Authority in accordance with the legal rules.

The Final Safety Assessment Report contains the information required to grant the operating licence and those that substantiate the safe operation of the Spent Fuel Interim Storage Facility. The licensee has the obligation to review/update the Final Safety Assessment Report annually.

The safety criteria applied to the Spent Fuel Interim 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.

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 Spent Fuel Interim 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 aim to establish 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 deep, geological 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 Spent Fuel Interim Storage Facility, there is sufficient time to elaborate the national policy and strategy.

The Boda Claystone Formation in the Western-Mecsek Mountain is applicable to host a deep geological repository. Several research phases have already been completed to survey this area. Based on the results obtained during the survey of the Formation and on the survey launched in 2000 for the whole country to designate the formations potentially able to accept the disposal facility, it was confirmed that the Boda Claystone Formation is the first potential formation to host a deep geological repository.

For the selection of the site of the disposal facility and to designate the location of an underground research laboratory, a Research Programme divided into surface and underground phases started in 2003.

The Public Limited Company for Radioactive Waste Management prepared the Boda Claystone Formation Phase I Section 2 geological research plan in 2012-2013. The objective of the research is the general qualification of the formation and to produce data and information for the safety assessment in order to implement the ranking of the further research areas and to complete Phase I of the surface research.

The competent authority (Pécs Mining District Authority) has approved the plan. In parallel to that, the Public Limited Company for Radioactive Waste Management has initiated the licensing process of the research facilities and has contracted for the research activities.

Section H. Safety of Radioactive Waste Management

The general safety requirements of radioactive waste management are described in Section E.

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 (first of all due to the unfavourable impermeable properties of the soil and the disadvantageous hydrogeology of the site), 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 cleared the territory for limited utilisation.

In Hungary uranium mining started 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 as described in 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 facility, no comprehensive safety evaluation was carried out. Therefore, in the licensing process for extending the capacity of the repository in 1990, on the initiation of the Hungarian Geological Survey taking part in the process, only temporary operation licences were issued and safety assessments were to be carried out as required by the authority, which were completed in 2000.

Although the Radioactive Waste Treatment and Disposal Facility has been reliably operating for over 30 years, some waste types that were emplaced in it earlier unfavourably influence the long term safety. The results of safety evaluations show that by disturbing the waste layer, the raising of certain sealed radioactive sources and long lived wastes may cause radiation exposures significantly exceeding the respective dose limits to both the intruders and some inhabitants in the vicinity of the repository.

Therefore, in 2002, a multi-stage programme 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-named preparatory stage – was launched in 2006, the objectives of which 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 improvement programme started with a demonstration programme, the results of which, and the relevant further plans, are described in Chapter K.2.

Refurbishment

From the beginning of the 2000s' refurbishments and modernizations have been carried out in several phases and areas. The most important ones:
- *modernization of the physical protection system;*
- *modification of the operational building, installation of radioactive waste management technologies (hot chamber, compressor, cementing equipment etc.)*
- *soil stabilization works of number III and IV pool rows.*

Further modernization of the physical protection system of the Radioactive Waste Treatment and Disposal Facility has been decided, in the frame of which a new fence is being built according to the newest requirements, a modernized sensing-alarm system will be installed and the office-laboratory building will be extended. Installation of certain elements of the visual control system (cameras and detectors) will take place under the agreement between the HAEA and DoE (US Department of Energy) about joint counter-terrorism efforts: the DoE will finance some parts of the equipment to be installed. Based on the contracts concluded the modernization of the system has started.

Incident

On December 2, 2013 three employees were processing 4 pieces of 200 l drums of radioactive waste containing ^{241}Am. Their intention was to open the drums for separating and compacting the waste. The post-work radiation control detected radioactive contamination on the hands and clothes of the employees, in the compacting room and other rooms, and in the passage routes of the hall. Based on the internal exposure measurements the radiation dose of two employees subjected to higher contamination is currently estimated for five years to be 286 and 101 mSv, respectively, while in the case of the third person the dose estimation for the first year is 54 mSv. The event was provisionally classified as INES-2. The release monitoring instruments have not measured a release exceeding the examination limit criteria neither from the process building, nor from the site. No action was necessary for the protection of the public. (At the time of compilation of the Report the investigation of the event has not been completed yet.)

H.3 National Radioactive Waste Repository

After the development of an increased new disposal capacity, the Radioactive Waste Treatment and Disposal Facility is 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 needed to be built.

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.

Based on series of investigations in 1996, a granite formation in the village of Bátaapáti in south-west Hungary was selected as the site for the underground repository.

Milestones in the construction of the repository

In 2003 the geological investigations from the surface were completed. The geological authority stated that the Bátaapáti 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 or three orders of magnitude less than the dose constraint (100μSv/year) for the public.

Preparing for the Environmental Impact Study, the environmental monitoring of the site was 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 goals of these research activities (within the granite formation declared as suitable) were aimed at defining the precise location of the repository. This research work commenced in February 2005 by way of two declined shafts.

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 and based upon them, the environmental licence was issued by the competent authority in 2007.

On the basis of the pre-commissioning safety assessment – prepared based upon the design documents and the environmental impact assessment – the competent authority issued the construction licence in 2008.

On 25 September 2008, the competent organization of the National Public Health and Medical Officer Service granted an operation license for the surface facility of the National Radioactive Waste Repository, which was renewed on 5 October 2010. Holding the licenses, the first 16 drums containing low and medium level radioactive waste were transported on 2 December 2008.

Figure H.3-1 Technology hall of the National Radioactive Waste Repository

In parallel with the operation of the surface facility and in accordance with the construction license, the construction works of the sub-surface repository were carried out.

In the second phase of the construction, the first two shafts were completed by 2012 (I–K1 and I–K2) and the auxiliary process systems were constructed. The operation license authorizing for transporting down and final disposal of radioactive waste in Shaft I-K1 of the National Radioactive Waste Repository came into force on September 10, 2012. The inauguration ceremony and the final disposal of the first reinforced concrete container took place on December 5, 2012.

Figure H.3 – 2. Disposal of the first reinforced concrete container in the National Radioactive Waste Repository

The construction of further shafts will take place in parallel with the disposal of waste into the existing ones. One shaft will always remain empty between the used ones and the ones under construction in order to meet the seismic safety requirements.

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 220-270m long section (by so called cross drifts), thereby ensuring the run through ventilation and the necessary escape routes.

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

National regulations require the retrievability of the waste packages during the operational period of the facility.

Optimization of the arrangement concept

In parallel with putting the first shaft of the facility into operation, the preparation for the expansion of the National Radioactive Waste Repository has started based on a new arrangement concept. This concept provides for the construction of the largest disposal area and the most effective use of the space available and at the same time maintaining the required safety level. The basis of the new concept is that instead of the currently used reinforced containers a new waste package will be introduced. This is a metal container that is applicable to accommodate four drums, in which the empty space is filled with active cement pulp produced from the liquid waste on the site of the NPP. The placement of the compact waste package is planned in the reinforced concrete pool constructed within the disposal shaft. The I-K2 shaft will be constructed in compliance with these plans. In order to use the available space most effectively the arrangement of shafts I-K3 and I-K4 will be planned with a section dimension according to the new arrangement concept. Shaft I-K2 will protect the operating Shaft I-K1 against the unfavourable seismic effect occurring while drifting the shafts.

A preliminary safety assessment has been prepared to support the new arrangement concept, which demonstrated its feasibility. In order to introduce the planned changes, the modification of the necessary licences started in 2013.

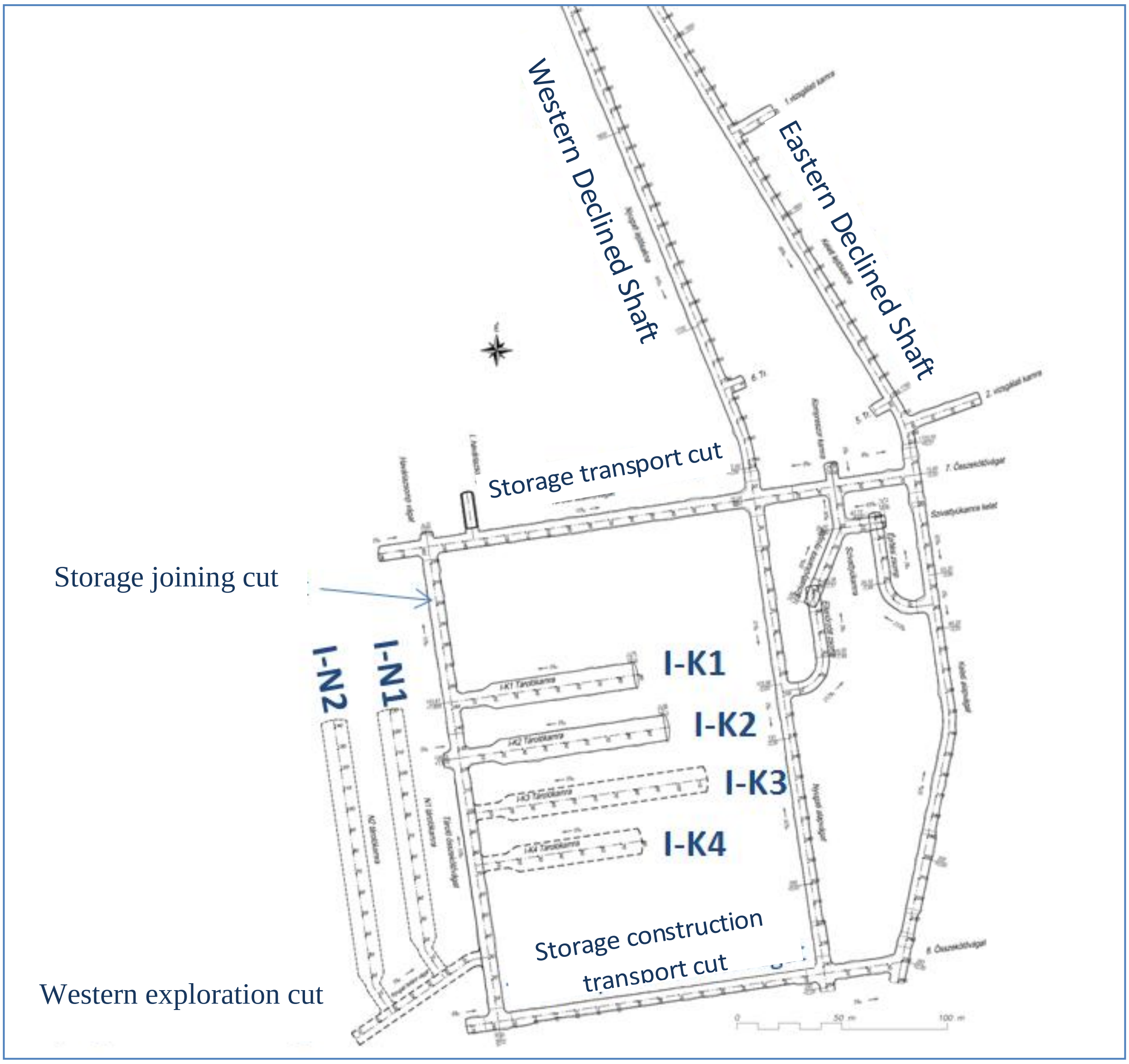


Figure H.3 – 3. Arrangement of the shafts of the National Radioactive Waste Repository

Section I. Transboundary Movement

With regard to the transboundary movement of radioactive waste and spent fuel, Hungary promulgated a governmental decree on the licensing of shipments of radioactive wastes and spent fuel across the national border in 2009. This decree [II.28] implements regulation based on Council Directive 2006/117/Euratom of 20 November 2006 on the supervision and control of shipments of radioactive waste and spent fuel.

The Hungarian Atomic Energy Authority is the competent body for licensing shipments of radioactive waste and spent fuel across Hungary and in case the licensing authority in the procedure is not the authority of Hungary, the consent of HAEA is needed to the licensing of the shipment. The decisions of the Hungarian Atomic Energy Authority in these acts are supported by the Headquarters of the Police and by the The Office of the Chief Medical Officer of the National Public Health and Medical Officer Service, as special authorities.

The decree [II.28] 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 and spent fuel.

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.4] of the minister responsible for health in order to ensure safety. All sealed radioactive sources are recorded in a central registry, operated by the Hungarian Atomic Energy Authority. The Centre for Energy Research of the Hungarian Academy of Science assists the Hungarian Atomic Energy Authority in the establishment of conditions for authority control over radioactive materials (receipt, evaluation and computer processing of data supply). 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 upgraded on the basis of the new decree [III.14] of the minister supervising the HAEA in 2010. 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 owner of the source. The new system has strengthened the regulatory control, and greatly improved its efficiency.

One essential change introduced by the [III. 14] decree is a special regulation on radioactive wastes. It provides accountancy requirements for ensuring traceability equally strict for sealed sources qualified as waste, and for sealed radioactive sources in use.

Legislation requires that unused radioactive sources be disposed of safely. 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. Disused sources are disposed of at the Radioactive Waste Treatment and Disposal Facility at Püspökszilágy. The facility has sufficient space and infrastructure to handle the disused 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 based on non-destructive measurements and by carrying out the measurements of about 100 such sources.

Hungarian manufacturers of radioactive sources have the obligation to take back radioactive sources produced by them should users within the country or abroad request it. These sources are either re-furbished 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 similar obligations have been undertaken, and returns of sources take place regularly.

Section K. Planned Activities to Improve Safety

K.1 Spent Fuel Interim Storage Facility

The design work of the Spent Fuel Interim 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 have not been required until now. 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 also been improved. The modifications facilitated the operation of the facility, so they improved operational safety.

Safety reassessment of nuclear facilities shall take place every 10 years. The Periodic Safety Review is required by the Act on Atomic Energy. At the beginning of 2008, in order to support the further operation of the Spent Fuel Interim Storage Facility, the Public Limited Company for Radioactive Waste Management submitted the respective Periodic Safety Review Report to the Hungarian Atomic Energy Authority.

Since the Hungarian Atomic Energy Authority decided to issue unified operation license for the modules 1-11 originally built and for the modules 12-16 constructed during the expansion, the Public Limited Company for Radioactive Waste Management supplemented the unified Final Safety Assessment Report, so it became applicable to support the operation license of phase 2 and of every module.

In August 2008, based on the evaluation of the respective documentation, the Hungarian Atomic Energy Authority extended the validity of the operation license of the waste receiving building and modules 1-16 of the Spent Fuel Interim Storage Facility.

During the extension of the Spent Fuel Interim Storage Facility, in Phase 1 of Stage III Modules 17-20 were constructed. Subsequent to the successful completion of the licensing procedure, the first spent fuel assembly was placed into the newly constructed storage module in June 2012, and the active test operation started by that step. The Hungarian Atomic Energy Authority granted the operation license for Modules 1-20 on June 7, 2013.

K.2 Radioactive Waste Treatment and Disposal Facility

Based on 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, but even the dose limit to be exceeded.

Safety improvement programme was launched to address the problem, in the frame of which the demonstration programme referred to in Section H.2, planned the opening of four vaults. 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. The latter were treated separately from other wastes and they were encapsulated to prepare them for disposal.

The demonstration programme launched in 2006 was accomplished in 2009 by conditioning the most critical waste packages and re-disposal of complete waste packages. A summary evaluation completed the programme.

220 m^3 of waste was removed from the storage facility and then sorted. After conditioning and re-packaging the volume of the waste was 200 m^2. The volume of 20 m^3 gained is equal to the waste volume received during 2 years. About one-third of the waste is long lived and will be stored in the interim storage facility. Approximately 650 radioactive sources were removed from the waste. The activity of the isotope inventory set up originally and after re-qualification, differs only by one magnitude, which can be considered favourable if the uncertainty of the original inventory is taken into account.

Successful implementation of the demonstration programme has proven that it is feasible to remove and re-condition the waste with low employee doses, acceptable costs for a reasonable duration and by reaching appropriate qualification of the waste.

Based on the results of, and experience gained during the demonstration programme the scope of the next period of safety improvement was determined by a safety analysis in 2010, and the respective licensing and implementation plans were developed accordingly. The safety improvement covers the vaults in which a potential future inadvertent intruder would receive a dose ten times exceeding the dose limit and the dose avertable by a current intervention is higher than expected radiation exposure of employees performing the planned intervention. In addition, in order to gain storage volume by compacting, easily removable wastes will be removed from those vaults that do not have space filling.

The continuation of the safety improvement programme was permitted by the competent radiation health authority based on the plans submitted. The investment will continue with contractor selection and with the licensing of auxiliary installations. In line with the plans, re-conditioning of an additional 1000 m^3 of radioactive waste is expected in the mid-term.

Figure K.2-1 Removal of special packages

Figure K.2-3 Storage of re-packed wastes

In order to provide the possibility of waste retrieval, it is necessary for the long term to build a large, light-structure hall which can ensure appropriate working conditions and satisfies the radiation safety and environment protection functions necessary for the work. The documentation supporting the building license of the light-structure building has been prepared, and the Construction Authority Section of the Municipality of Town Vac has granted the building license based on it.

ANNEXES

ANNEX 1: THE SPENT FUEL INTERIM STORAGE FACILITY

An1.1 Description of the facility

The Spent Fuel Interim Storage Facility is a modular dry storage facility 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 *located between* the first and *the seventeenth module.* It houses the equipment necessary to handle and position the transfer cask prior to fuel assembly removal and drying operations*, as well as the fuel assembly drying system, which dries out the fuel assembly removed from the cask that is filled with water*. 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 and the fuel charging board 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. The cooling air inlet channel being a labyrinth shape structure is located on the side of the modules. The air-inlets are protected from outside by a stainless steel mesh. Each of the modules 1-16 is suitable for receiving 450 spent fuel assemblies. After the technological modifications each of the future modules will be suitable for storing 527 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 based 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. A small amount of He gas is mixed in the nitrogen gas of the storage tubes. Measurements utilising He-leak tests are carried out to identify postulated leakages. Appropriate technology solutions are available to eliminate identified leakages.

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 12-20 are concerned, periodic inspection of the plugs is not needed as the rubber sealing has been replaced by a metal one.

During the construction of the modules metal ‘corrosion’ samples were inserted into the modules in order to allow in service investigation of the appropriateness of the applied surface protection (i.e. metal vaporization against corrosion).

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 assemblies stored in the metal tubes are cooled by the passage of air between the tubes, using the heat emitted from the stored fuel as the driving force and the difference between the level of the inlet and outlet of the cooling air.

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 Physical protection

The site of the Spent Fuel Interim Storage Facility is situated in the immediate vicinity of Paks Nuclear Power Plant. From 2004 on, the physical protection of the Spent Fuel Interim Storage Facility 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 site can be accessed by persons and transports only with due authorization, under strict control of the security staff. The system assures the identification and registration of those accessing the facility. Transport of the spent fuel assemblies of Paks NPP is carried out under strict control from one facility to the other via the transport gate.

An1.5 Radiation protection and environmental protection

Operational monitoring, sampling and the subsequent laboratory assessment of samples, as well as personal dose monitoring are included in the radiation protection system of the Spent Fuel Interim 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 had been performed with the use of film dosimeters, as required by the authorities until March 2013, which was then replaced by a system using thermo-luminescent technology. The regulatory personal dose measurements are supplemented with thermo-luminescent detectors and electronic dosimeters.*

The airborne discharge of the Spent Fuel Interim 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. The liquid discharges of the facility are drained into the waste water system of the nuclear power plant, after assessing the samples taken from the tanks located in the basement of the facility. *The discharges from the storage facility are very small: in 2013 the amount of actual value of airborne releases was only 0.017%, while the actual value of liquid discharges was only 0.009% of the derived limits. Accordingly, only 0.026% of the derived airborne and liquid discharge limit values were utilized in 2013.*

Since the site of the Spent Fuel Interim 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. The entire network, together with the meteorological data obtained by the meteorological monitoring system of the power plant, enables dispersion model calculations to be completed. The samples taken by the sampling station of the Spent Fuel Interim Storage Facility are processed and assessed in the environmental monitoring laboratory of the nuclear power plant.

Until 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 based on calculations using discharge data. Up to now, the excess dose calculated for the critical group of the population from emission data has been less than 3 nSv/year every year; in other words, orders of magnitude less than the dose constraint (10 μSv/year).

ANNEX 2: THE RADIOACTIVE WASTE MANAGEMENT FACILITIES

An2.1 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.

An2.1.1 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 *several* 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. Also the "AT" interim storage halls, "ATCS" storage tube wells and the nuclear material store located in the acceptance building including waste management technologies 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. Most of the vaults are only partially backfilled. After reaching their capacity, two vault rows were temporarily covered with soil. The final cap is to be produced only after the safety enhancement measures are 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 as well as the reconstruction of the vaults.

The 'C-type' vaults were used to store contaminated organic solvents the activities of which were higher than the limit acceptable for incineration. Prior to emplacement the liquid wastes were solidified or soaked up by diatomaceous earth 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.

The 'B' type well group consists of 16 wells 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. Out of the six meter depth of the well, 5 m is the effective depth to provide effective radiation protection at ground level. During service the wells are protected by lead plugs.

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 longer than 5 years. One of the wells was used for interim storage of very long lived sealed radioactive sources. These wells have also been filled up by now.

The total underground portion of the so-named service building hosting waste management technologies is an interim storage place, which ensures the long term interim storage of low and intermediate level, long lived radioactive wastes. It is also a puffer storage of short lived wastes, while freeing of storage capacity is going on in the type "A" vault. The interim storage contains two halls, which are capable of storing more than 900 waste drums. The drums are arranged in fours in a support frame. Additional cubic plate containers of 1.2 m^3 volume are used to store wastes, which occupy the area of just a support frame. In the interim storage facility storage area was established to retrievably store sealed radioactive sources. The storage area further consists of 50 tubes of 4 m depth and of 40-100-200 mm diameter. Storage of nuclear materials takes place in separate compartments.

An2.1.2 Handling and Storage

Review of waste acceptance requirements and their adjustment to the new waste management technologies took place in 2010, *the licensing of the new requirements was concluded in 2011.*

In the past, the used sealed radioactive sources were not conditioned before placement to type "B" and "D" stainless steel vaults. Currently the sealed radioactive sources are placed in a metal capsule in the hot chamber and sealed by welding, and then they are put into type "B" vaults or tubes for interim storage. The metal capsule can be grasped at its head and lowered into or raised from the tube well.

The unsealed radioactive sources are either handled like the sealed ones, or disposed of along with the other low and intermediate level radioactive wastes after cementing. The compressible wastes are compressed by a 500 kN force press. Wastes requiring conditioning (e.g. solidified waste waters, organic liquids, bodies of experimental animals, salts, wastes of powder content, ion exchanger resins etc.) are primarily embedded into cement by using accessory materials with a specified mixing ratio. The uncompressible and conditioned wastes are disposed of in drums of 200 l or plate containers of 1.2 m^3, the internal spaces in the packages are filled with cement grout.

Collection, selection, treatment and packaging of wastes takes place at the ground level of the so-named service building by way of an assorting chamber, hot chamber, press, waste water treatment and cementing device. Subsequent to its packaging the waste is qualified administratively or by measurement, and then compared to activity limits of disposal requirements. Based on the qualification it is decided whether the particular waste package can finally be disposed of in type "A" vaults or is stored in one of the interim storage places.

Since 1998, radioactive wastes containing thorium, uranium and plutonium isotopes as well as disused plutonium sources collected from the country's institutions have been stored in the nuclear material store. The source containers made of depleted uranium are accepted in this repository since 2005.

An2.1.3 Transport, disposal and record keeping

The transport of radioactive waste to be disposed of or stored in the facility from waste generator to site and on-site is organised by the Public Limited Company for Radioactive Waste Management under its own responsibility, using its own work force and equipment (transport vehicles, containers). Radioactive sources and radioactive waste are transported in accordance with ADR regulations.

Before transportation the used radioactive sources are packed in aluminium or polythene casing and then disposed of in a lead container. Paraffin/danamid protection is applied for neutron sources as necessary. Other wastes are transported *in industrial packages (i.e. in metal drums) to the facility.*

Large gamma sources are prepared for transport usually by taking and sealing into a special disposal container by the Institute of Isotopes Ltd.

If treatment is required prior to disposal or interim storage to meet the respective requirements, the waste is conditioned. 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.

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 operates a radioactive sources and waste registry system.

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, and also submits annual reports on the volume and radionuclide inventory of bulk waste disposed of.

An2.1.4 Physical protection

A new access control and defence system was installed in 2001 as part of the refurbishment programme. The site is guarded by armed security guards applying up-to-date security systems. The access control system ensures that only authorized 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. Access to the site is possible only through the access point of the security system, in a controlled manner. *Renewal and technical extension of certain components of the physical protection system started in 2013.*

An2.1.5 Radiation protection and environmental protection

Personal dosimetry control is the task of the Radiation Protection Service of the Radioactive Waste Treatment and Disposal Facility and takes place according to the respective regulation [III.4]. Normal operation of the facility and the waste transports typically cause 0-2 mSv/year radiation dose for the employees.

Surface contamination of transport vehicles, employees and instruments are inspected in every case by manual devices during treatment, transportation and maintenance or repairs. Surface contamination has never been detected on the external surface of vehicles. Accidents or radioactive release have never taken place during transportation of radioactive wastes.

A remote controlled radiation protection monitoring system is operated within the radiation controlled area of the site. The typical average value of background gamma dose-rate on the site of the facility is around the natural background value: 70 – 130 nSv/h.

Environmental monitoring is an integral part of the radiation protection monitoring system of the Radioactive Waste Treatment and Disposal Facility. Measurement samples are taken from the whole area of the site and its 20 km vicinity with regard to the surface water flows.

The so-named pre-commissioning base level was determined at the most important locations in the vicinity of the facility, and it is referred to as the pre-commissioning background level. The measurement results produced in line with the annual programme approved by the radiation health authority are compared to those values determined in 1976-77.

The monitoring system was extended in 1992 by a hydrology monitoring system (ground water level, stream flow rate) and by a system regularly measuring the downhill movement. The meteorology station and soil erosion examinations also support data collection required for safety analysis.

Ecology survey having been performed since 2003 involves soil sampling, plant sampling and animal origin sampling, as well as local measurements on the site of the facility. *Based on the experience gained during the last decade, the monitoring programme was reviewed in 2012; and in 2013 the measurements were conducted according to a revised and approved procedure.*

An annual report is prepared for the authority describing the radiation protection and environmental monitoring activity. *The radiation protection authority inspects the operation of the plant twice a year while the inspection of the environmental authority takes place once a year* by administrative instruments and measurement of environmental samples.

The annual amount of tritium released from the facility to the soil humidity via diffusion and from there to the atmosphere or to the ground water under the disposal facility is taken into account by theoretical calculation in support of release analysis. Since the geological formation hosting the facility has very favourable hydrological characteristics from the aspect of radioactive waste disposal and the movement of ground water is very slow, the tritium accumulated in the body of ground water under the facility during the years of operation (within the controlled zone) is measurable. According to measurements even the direct consumption of the ground water under the facility would not cause radiation exposure above the dose restrictions, and so it complies with the limit defined by the World Health Organization for drinking water. *In case of using ground water as drinking water the water* *should also be in compliance with the quality and procedural requirements in Government Decree 201/2001. (X. 25.).*

Based on the measurement results of the monitoring system the emissions from the facility are negligible, the activity of direct releases to atmospheric and water environment is *below the annual investigation limit.*

The environmental monitoring system detected a release of a small amount of ^{241}Am as a consequence of the incident occurred on December 2, 2013. The measured discharge was 3 millionth of the discharge limit value.

Radioactivity of the environment of the facility shows fluctuation as compared to the base level values measured in 1976-77, but it has not increased. The radiation exposure to the public from the operation of the disposal facility, which is immeasurable, can be at most 0.5 μSv/year based on release data.

An2.2. National Radioactive Waste Repository

The final disposal facility of the nuclear power plant generated low and intermediate level wastes is located in the south part of the Trans-Danubian region, in the Nagymórágy valley, in Tolna county, on the outskirts of the village Bátaapáti. The site is located about 20 km west from the Danube, and about 60 km south from Paks Nuclear Power Plant. The site lies on the bottom of the valley, surrounded with security fence. It occupies an area of 2.5 hectares.

An2.2.1 Description of the repository

The fence surrounded area can be divided to three parts: a monitored, a controlled and a construction zone. The monitored zone hosts the service-direction unit. The waste is transported to the controlled zone, which hosts the puffer storage, treatment, transport to the disposal location and the disposal of the radioactive waste. The construction and extension works are conducted in the construction zone.

The subsurface system consists of controlled and construction zones. The operation (and the future closure) of the repository is conducted in the controlled zone, while the expansion of the repository is conducted in the construction zone.

The central building is located at the north end of the N-S oriented site; the facility can only be accessed through armed security guard service.

The technology building is located in the south part of the site; it is the closest building to the entrance of the subsurface repository. Here is the place of access to the controlled zone, the control rooms of the dosimetry service and the facility technology. The technology building hosts the reception of waste packages, as well as the storage, check and treatment of wastes.

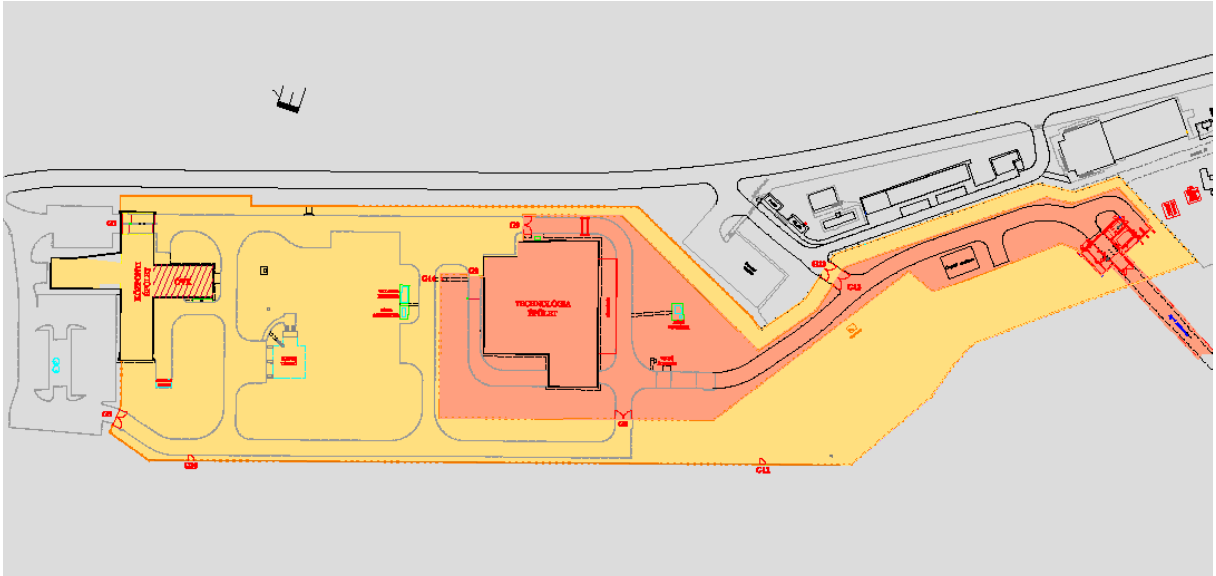


Figure An.2.2.1 – 1: Division of the site of the National Radioactive Waste Repository into zones (the controlled zone of the site is indicated with orange colour)

The subsurface shaft system is divided to a construction zone based on technology and functional needs (i.e. the eastern decline shaft and its connected parts) and a controlled zone (i.e. the western decline shaft and its connected parts). The eastern part serves for construction works performed parallel to waste disposal; it has a role in the proper ventilation of subsurface areas and in the removal of subsurface waters to the surface. The main function of the western decline shaft and its connected parts is the safe and final disposal of properly prepared waste packages, the provision of the technical conditions needed for the disposal tasks, the provision of appropriate work conditions and required inspections.

The current operating license of the facility allows the operation of the receiving and processing site of the surface, as well as of the subsurface I-K1 disposal shaft and the cuts leading thereto. The second, I-K2 shaft has already been established; however, it is not ready for operation. Additional disposal shafts will be established in subsequent steps (see Chapter H.3).

An2.2.2 Treatment and storage

The acceptance of the waste and its loading to the transport vehicle take place on the site of the nuclear power plant in the presence of the representatives of the Public Limited Company for Radioactive Waste Management. Four identical transport frames are transported together on the vehicle. One frame can host four standardized metal drums of 200 litres.

The operating license of the National Radioactive Waste Repository allows the puffer storage of maximum 3,000 drums in the technology building. The following technology actions are conducted in the facility:

- *receipt of waste packages, unloading of transport frames from the transport vehicle,*
- *loading of drums into reinforced concrete containers (one container hosts 9 drums), then filling of the containers with inactive concrete,*
- *temporary storage of the filled concrete containers,*
- *cementation of liquid waste, if appropriate,*

- *verification of compliance with acceptance criteria (gamma-scanning, screening).*

An2.2.3 Transport, disposal and registration

The radioactive wastes are shipped on public road from the nuclear power plant to the National Radioactive Waste Repository with a vehicle constructed in compliance with the requirements for the transport of radioactive materials. Extraordinary event has not occurred during the transports completed so far.

Subsequent to the completion of the registration tasks, the wastes packages reaching their final form in the technology building are disposed in the subsurface disposal shaft, in predetermined and registered positions. The containers, due to their low surface dose rate, do not require special management (i.e. any additional radiation protection measure).

The licensing authority, in its construction license issued in May 2008, in harmony with the relevant ministerial decree [III.10], prescribed that the wastes shall be retrievable, if the retrieval is justified by future operating experience or a regulatory procedure. The first operating disposal shaft is planned to be open for 50 years; close packing will not be performed during this period, thus the ability to retrieve the waste is ensured.

An2.2.4 Physical protection

The entire area of the site is surrounded by a double security fence with security gates; road for patrolling is between the two fences.

The most important aspect considered during the establishment of the physical protection system was that the expansion of the site and the physical protection system shall be fully compatible with the previously installed components. Accordingly, a uniform system was developed, which can be divided, due to the characteristics of the site and the object to be protected, into two well distinguished parts: surface components and subsurface components.

These components significantly differ from each other in their functions, environmental conditions and energy supply. The integrated physical protection system includes the following sub-systems: fence protection system, intrusion detection system, access control system and video surveillance system.

The installation methods of these components provide sufficient environmental resistance and protection against sabotage, as well as the effective cooperation of the physical protection functions (i.e. deterrence, detection, delay and response) and comply with the requirements of the relevant government decree [II.33]. Attack against the facility or any offense on its site have not occurred.

An2.2.5 Radiation protection and environment protection

The operator of the waste repository conducts regular, wide scope radiation protection monitoring, which aims at obtaining information on the radiation conditions of the site, the radiation exposure to the employees, the man-made radioactive material content of environmental media, in order to safely operate the facility through measures decided on the basis of such information. The measurements and the measures introduced based thereon *guarantee that the radiation exposure to the operating personnel is below the regulatory limits, as low as reasonably achievable and the environmental effects are also minimized.*

The radiation protection and environmental monitoring system consists of the environmental monitoring system, discharge monitoring system, the work-place radiation protection and operative measurements at radiation protection critical locations.

The environmental monitoring system complies with the requirements of the relevant ministerial decree [III.7] for radioactive discharges to air and water, the conditions of the operating license and the implementation of the stipulations by the relevant ministerial decree [III.14].

During the commissioning procedure, the planned values of discharges were determined. The radiation protection monitoring of the discharges is performed at specified sampling locations. The weekly average values derived from ten-minute dose rate average values measured by installed dose rate measurement instruments show 90-180 nSv/h evenly.

Based on measurement results from the environment of the facility in 2013, it can be concluded that the radioactivity of the environment of the site has not changed compared to the base-line level. Presence of radioactive materials originated from the facility was not revealed in the environment of the site. The measurement results justified that the activity of discharged radionuclides is lower than hundred-thousandth of the regulatory limit. Consequently, the operation of the facility has not caused any exposure above the natural background.

The monitoring of subsurface areas and the status of the geological barriers is performed by the geotechnical monitoring system and the subsurface hydro-geological monitoring system.

According to regulatory dose meter and the dosimetry records no employee has received exposure above the recorded level; the annual exposure does not reach the 1 mSv value for any employee. Based on the internal radiation exposure monitoring data of employees, it can be concluded that the internal exposure has remained below the measurable limit value.

ANNEX 3: VOLUME AND ACTIVITY OF LLW/ILW

Hungary solves the disposal of low and intermediate level radioactive wastes in two operating facilities. The wastes originated from the nuclear power plant are disposed in the National Radioactive Waste Repository, where the preparation for the disposal of the wastes is made in the technology building, and the sub-surface disposal shaft serves for the final disposal of the waste packages.

The Radioactive Waste Treatment and Disposal Facility receives, processes, stores and disposes the institutional (i.e. not nuclear power plant originated) radioactive wastes. Wastes which are not in compliance with the waste disposal criteria are temporarily stored here, until their final disposal is solved in a Hungarian deep geology repository.

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 volume and total activity of LLW/ILW in the above mentioned three facilities.

An3.1 Radioactive Waste Treatment and Disposal Facility

The following table contains the volume and estimated total activity of the wastes in the inventory of the Radioactive Waste Treatment and Disposal Facility as of 31 December 2013.

Table An3.1-1: Amount of radioactive waste disposed in the Radioactive Waste Treatment and Disposal Facility

	Waste volume (m^3)	*Waste total activity (Bq)*
Storage	*~175**	*2.4E+14*
Disposal	*4900***	*1.4E+14*

* Including the amount of sealed radioactive sources

**Nominal volume of the filled disposal pools

An3.2 National Radioactive Waste Repository

Table An3.2-1 contains the quantity and estimated total activity of the wastes in the inventory of the National Radioactive Waste Repository as of 31 December 2013. The data of the wastes being stored in the surface technology building and those disposed in the I-K1 disposal shaft are presented separately.

Table An3.2-1: Amount of radioactive wastes in the National Radioactive Waste Repository

	Waste volume (m^3)	*Waste total activity (Bq)*
Technology building	*490*	*7.51E+10*
Disposal shaft (I-K1)	*305*	*6.88E+10*

Table An3.2-2 presents the volume and total activity of radioactive wastes originated from the operation of the Paks Nuclear Power Plant (considering the lifetime extended with 20 years) *and its future dismantling as of December 31, 2037, planned to be disposed in the National Radioactive Waste Repository (only the data of relevant wastes are presented).*

An3.2-2: Inventory of the wastes planned to be disposed in the National Radioactive Waste Repository

Type of disposal	*Waste volume (m^3)*	*Waste total activity (Bq)*
Reinforced concrete container	875	7.00E+10
200 l drum	970	3.00E+11
Compact waste package	11100	1.30E+13
Large size waste	800	n.d.
Cemented ion exchanger resin	1390	5.60E+14
Dismantling waste	6635	n.d.
Total:	**21770**	

ANNEX 4: LIST OF LAWS RELEVANT TO THE CONVENTION

I. 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 C of 2012	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 CXCV of 2011*	*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 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.9	*Act CXXVIII of 2011*	*on disaster management, and the amendment to certain acts associated therewith*
I.10	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.11	Act CXL of 2004	on the general rules of regulatory procedures and services in the public administration
I.12	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
I.13	*Act CI of 2013*	*on the amendment to the act on atomic energy, to certain acts associated with energetics, and to the Act CLIX of 1997 on armed security guards, nature protection and field guard service*
I.14	*Act CLXXV of 2011*	*on right of association, non-profit status and the operation and funding of civil society organisations*

II. 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 26^{th} 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 26^{th} 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 29^{th} 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 12^{th} 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 21^{st} of May in 1963
II.6	Govt. Decree 73/1991. (VI. 10.) Korm.	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 26^{th} of September in 1990
II.7	Govt. Decree 108/1991. (VIII. 28.) Korm.	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 20^{th} of September in 1990
II.8	Govt. Decree 130/1992. (IX. 3.) Korm	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 20^{th} of September in 1989
II.9	Govt. Decree 17/1996. (I. 31.) Korm.	on the actions in connection with the found or confiscated radioactive or nuclear materials
II.10	Govt. Decree 124/1997. (VII. 18.) Korm.	on radioactive materials as well as equipment generating ionising radiation, exempted from the scope of the Atomic Energy Act CXVI of 1996.
II.11	Govt. Decree 185/1997. (X. 31.) Korm.	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 11^{th} of July in 1995
II.12	*Govt. Decree 246/2011. (XI. 24.)*	*on the exclusion zone of the nuclear facility and the radioactive waste repository*

II.13	Govt. Decree 227/1997. (XII. 10.) Korm.	on the type, conditions and sum of the liability insurance or other liability financial coverage concerning nuclear damage
II.14	Govt. Decree 240/1997. (XII. 18.) Korm.	on the establishment of the organisation designated for implementing the disposal of radioactive waste and spent fuel, as well as decommissioning of nuclear facilities, and on the financial source for performing such tasks
II.15	Govt. Decree 61/1998. (III. 31.) Korm.	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.16	Govt. Decree 108/1999. (VII. 7.) Korm.	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.17	Govt. Decree 13/2000. (II. 11.) Korm.	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.18	Govt. Decree 72/2000. (V. 19.) Korm.	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.19	Govt. Decree 136/2002. (VI. 24.) Korm.	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.20	Govt. Decree 275/2002. (XII. 21.) Korm.	on the monitoring of radiation levels and radioactivity concentrations in Hungary
II.21	*Govt. Decree 112/2011. (VII. 29.) Korm.*	*on the scope of tasks of the Hungarian Atomic Energy Authority in association with nuclear energy related European Union and international obligations, the designation of co-authorities contributing to the regulatory procedures of the Hungarian Atomic Energy Authority, the amount of imposed penalties, and on the scientific council assisting the work of the Hungarian Atomic Energy Authority*
II.22	Govt. Decree 165/2003. (X. 18.) Korm.	on the information to be provided to the public in nuclear and radiological emergencies
II.23	Govt. Decree 244/2004. (VIII. 25.) Korm.	on the promulgation of the protocol signed by the Government of the Republic of Hungary and the Government of the Russian Federation on conditions concerning the reshipment to the Russian Federation of Russian-made (irradiated) spent fuel assemblies

II.24	*Govt. Decree 118/2011. (V. 5.) Korm.*	*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 facilities
	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	Operation of nuclear power plants
	Annex No. 5 Nuclear Safety Code Volume 5	Design and operation of research reactors
	Annex No. 6 Nuclear Safety Code Volume 6	Interim storage of spent nuclear fuel
	Annex No. 8 Nuclear Safety Code Volume 8	Termination of nuclear facilities
II.25	Govt. Decree 314/2005. (XII. 25.) Korm.	on environmental impact assessment and on the integrated environmental usage permitting process
II.26	Govt. Decree 257/2006. (XII. 15.) Korm.	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.27	Govt. Decree 267/2006. (XII. 20.) Korm.	on the Hungarian Office for Mining and Geology
II.28	Govt. Decree 34/2009. (II. 20.) Korm.	on licensing of transboundary movement of radioactive waste and spent fuel
II.29	Govt. Decree 167/2010. (V. 11.) Korm.	on the National Nuclear Emergency Response System
II.30	Govt. Decree 323/2010. (XII. 27.) Korm.	on the National Public Health and Medical Officer Service, fulfilment of public health administration tasks and on the designation of the administrative body of pharmaceutics
II.31	*Govt. decree 215/2013. (VI. 21.) Korm.*	*on the designation, activity and funding of the organization performing certain tasks in relation with radioactive wastes and spent fuel*

II.32	*Govt. decree 214/2013. (VI. 21.) Korm.*	*on the rules of financial supports provided to monitoring and information aimed local government associations from the Central Nuclear Financial Fund*
II.33	*Govt. decree 190/2011. (IX. 19.) Korm.*	*on the physical protection requirements for various applications of atomic energy and the corresponding system of licensing, reporting and inspection*
II.34	*Govt. decree 234/2011. (XI. 10.) Korm.*	*on the implementation of the Act CXXVIII of 2011 on disaster management and amendment to certain acts associated therewith*

III. 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 Public Welfare 23/1997. (VII. 18.)	on the exemption levels (activity-concentrations and activities) of radionuclides
III.3	Decree of the Minister of Economy 27/1999. (VI. 4.)	on the fees for final disposal of radioactive wastes
III.4	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.5	Decree of the Minister of Health 30/2001. (X. 3.)	on the operational radiation protection of the outside workers
III.6	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.7	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.8	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.9	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.10	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.11	Decree of the Minister of Justice 14/2005. (VII.25)	on the operation and administration of the Central Nuclear Financial Fund
III.12	Decree of the Minister of Justice and Law Enforcement 7/2007. (III. 6.)	on the rules of accountancy for and control of nuclear materials
III.13	Decree of the Minister of National Development 61/2013. (X. 17.) KHEM	on the inland application of the annexes of European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR)
III.14	Decree of the Minister of Transportation, Communication and Energy 11/2010. (III.4.) KHEM	on the order of registration and inspection of radioactive materials and related data supply
III.15	*Decree of the Minister of National Development 33/2013. (VI. 21.)*	*on the geological and mining requirements for the construction and design of a radioactive waste repository and a radioactive waste interim storage facility*
III.16	*Decree of the Minister of National Development 51/2013. (IX. 6.)*	*on the transport, carriage and packaging of radioactive materials*
III.17	*Decree of the Minister of National Development 55/2013. (IX. 17.)*	*on the special professional training and advanced training of workers employed in a nuclear facility, and on the scope of persons authorized to conduct activities in relation with the application of atomic energy*

IV. Government Resolutions

IV.1	Government Resolution 2085/1997. (IV. 3.) Korm.	on discontinuing uranium mining in the Mecsek hills
IV.2	Government Resolution 2385/1997. (XI. 26.) Korm.	on the investment programme of the remediation tasks for the abandonment of the uranium industry in Hungary
IV.3	Government Resolution 2006/2001. (I. 17.) Korm.	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.4	Government Resolution 2122/2006. (VII. 11.) Korm.	on further tasks related to the abandonment of uranium mining in Hungary
IV.5	*Government Resolution 1150/2012. (V. 15.) Korm.*	*on the establishment of the Disaster Management Coordination Inter-ministerial Committee, and on the rules of its organization and operation*

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

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

The Act on Atomic Energy [I.6] obliges the Hungarian Atomic Energy Authority to submit an annual report to the Government and Parliament on the safety of nuclear applications in Hungary.

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 nuclear and other radioactive materials and devices emitting ionising radiation. The report consists of the following main chapters:

- Use of atomic energy;
- State-level regime of safety;
- Safety of nuclear facilities;
- Radiation protection and radiation health
- Safety and security of nuclear and radioactive materials;
- Non-proliferation of nuclear and radiological weapons
- Safety of disposal of radioactive wastes;
- Nuclear emergency management;
- Scientific-technical background;
- International relations;
- Hungary`s role in the European Union;
- Public relations.

The reports for 2009, 2010 and 2011 were discussed and accepted by the Parliament together. The reports concluded that the nuclear applications in Hungary fulfil the relevant safety requirements.
The report for 2012 was submitted to the Parliament by the Minister of National Development on 20 September 2013 and it is currently on the agenda.

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, in 2007, in 2010, *in* 2012 (Extraordinary Conference after the Fukushima accident) and in 2013. The Reports, which are available on the website of the Hungarian Atomic Energy Authority (www.haea.gov.hu), were received favourably in the review meetings.

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 Spent Fuel Interim Storage Facility, but in this facility, corresponding to the favourable operational experience, no events took place which 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 IRRS mission at the Hungarian Atomic Energy Authority

Expert teams of the International Atomic Energy Agency visited the Hungarian Atomic Energy Authority twice (in 2000 and 2003), at the request of the Hungarian Government authorities, to conduct a mission.

In 2010 preparatory actions were commenced for the next review. The international review organized by the International Atomic Energy Agency takes place now in the framework of the International Regulatory Review Service (IRRS). The experts of the International Atomic Energy Agency held a three-day training about the use of software supporting self-assessment (Self-Assessment Tool; SAT). In accordance with the schedule of the self-assessment project commenced in 2011, the action plan was planned to be established in the second half of 2012. *Nevertheless, due to other important obligations of the HAEA and based on the decision of the management, the project was paused in 2012. It restarted in 2013 with the involvement of more staff from HAEA, as well as of the health and environmental protection authorities. Three experts from the IAEA delivered lectures on the advanced self-assessment approach and the use of the SARIS (Self-Assessment of Regulatory Infrastructure for Safety) software in December 2013. The self-assessment of the HAEA according to SARIS is due in the first half of 2014.*

M6.2 WANO mission to the Paks Nuclear Power Plant

The Moscow Centre of the World Association of Nuclear Operators (WANO-MC) conducted a peer review at the Paks Nuclear Power Plant between February 20 and March 2, 2012. The peer review was performed at the request of the Paks Nuclear Power Plant by a group of 21 experts from 8 countries (i.e. Armenia, Bulgaria, Finland, Czech Republic, Russia, Slovakia, Ukraine and the USA).

The review identified 8 good practices and 18 areas for potential improvement. (Such result is normal during peer-reviews.) Subsequent to the mission in 2012, the MVM Paks Nuclear Power Plant Ltd established an action plan to further improve the identified areas and submitted it to the Moscow Centre of WANO. The progress in the implementation of the action plan should be periodically presented in status reports. The practice of WANO peer reviews includes a follow-up review after 2 years of the original mission, during which the effectiveness of the established actions and their results are verified.

The follow-up review of seven experts revealed that progress was made in each of the 18 areas for potential improvement; hazards were not identified. Based on the review 'A' qualification was provided in 6 areas, and 'B' qualification in the other 12 areas. The experts confirmed the appropriateness of the actions made in several areas, where 'B' qualification was given, but the relatively short time from the introduction of such actions did not allow measuring their effectiveness. Such action is for example the new system introduced to report and manage low significant deviations, which was recognized by the experts due to its comprehensiveness and user-friendliness. The international experts encouraged the NPP to continue and in certain cases to expand the commenced developments.

ANNEX 7: THE REMEDIATION OF THE CLOSED URANIUM MINE AND LONG TERM ACTIVITY AFTER TERMINATION OF THE URANIUM ORE MINING

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.1-5].

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. The investment was completed in accordance with government resolution [IV.4] 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 billion.

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 ore mining;
- re-utilising the areas and facilities of the uranium industry to the optimum extent;
- 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 played 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 and in its amendment in 2007 and 2011 issued by the South Trans-Danubian Environmental Protection Inspectorate.

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 limits for the remediation of waste rock piles, heap leaching piles and tailings ponds

Rn exhalation	0.74 Bq/m^2/s
Gamma-dose rate – workplace average – at a specific point	 250 nGy/h 450 nGy/h

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

Surface facilities	Gamma-dose rate as workplace average	250 nGy//h
	Gamma-dose rate at a specific point	450 nGy/h
Inside buildings	Radon concentration, annual average	1000 Bq/m^3
	Gamma-dose rate	250 nGy/h

Note on Tables An7.2.2-1 and An7.2.2-2: at the workplaces qualified as not radiation hazard workplace and at the off-site areas the 1 mSv/year effective dose limit for the members of the population shall be met. The limit for Radon concentration is the same as included in the national regulation [III.4]. 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. If the surface is affected (by construction, modification) the radiological review is mandatory.

Table An7.2.2-3 Background radiation of natural origin in the areas affected by uranium ore mining in Mecsek Hills

Parameter	**Background value**
Rn concentration in open space	12 Bq/m^3
Gamma dose rate	250 nGy/h
Activity concentration of soil	180 Bq/kg

An7.2.3 Characters 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 $17.9 * 10^6 m^3$
- volume of the nine waste rock piles $10 * 10^6 m^3$
- volume of the two heap leaching piles $3.4 * 10^6 m^3$
- contaminated industrial area 62 ha
- volume of the two tailings ponds $16.2 * 10^6 m^3$

Figure An7.2.3-1: Air shaft IV of the uranium ore mine during operation and after remediation

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											

The remediation programme, aimed at the elimination of environmental impacts of uranium ore mining and processing conducted in the Mecsek Hills, was successfully accomplished in 2008. During the activity, in addition to the abandonment of the underground mine areas, the remediation of surface facilities (tailings ponds, dumps, percolation spaces, service areas) took place. As a result, the direct danger of contamination of surface and underground waters and the environment was eliminated.

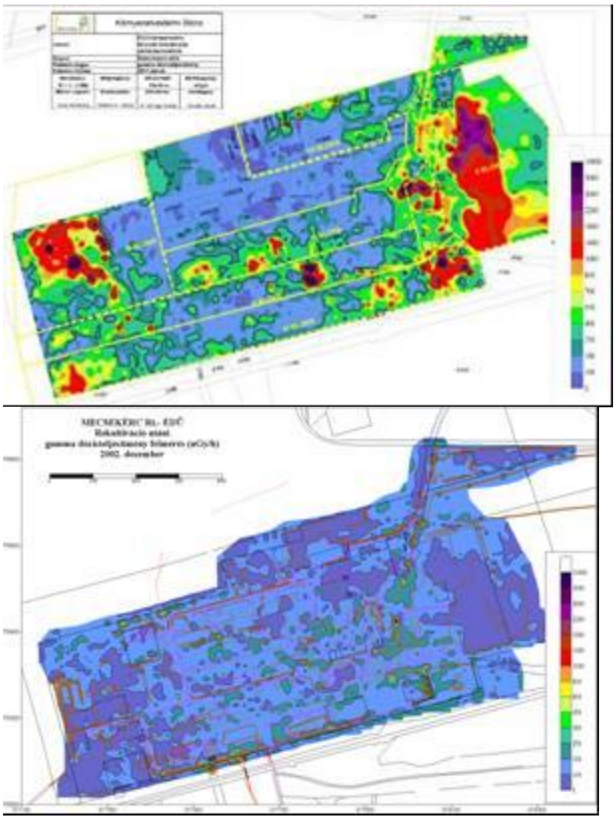


Figure An7.2.4-1: ***Gamma dose measurement rates results in the Ore Enrichment Plant site before and after the remediation***

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-named long-term tasks (water purification, maintenance, monitoring activities) until 31 December 2002. Since these tasks are still existing 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. After the reorganization of the ministries, this task appeared in the budget of the Ministry of National Development.

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.

The following long-term tasks have to be performed in the interest of environmental protection:

- removal of uranium from surface and groundwater (the capacity of the water treatment station is 1.5 million m^3 annually);
- groundwater desalination (treatment of an average water volume of 2000 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-treatment activities have to be performed 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.

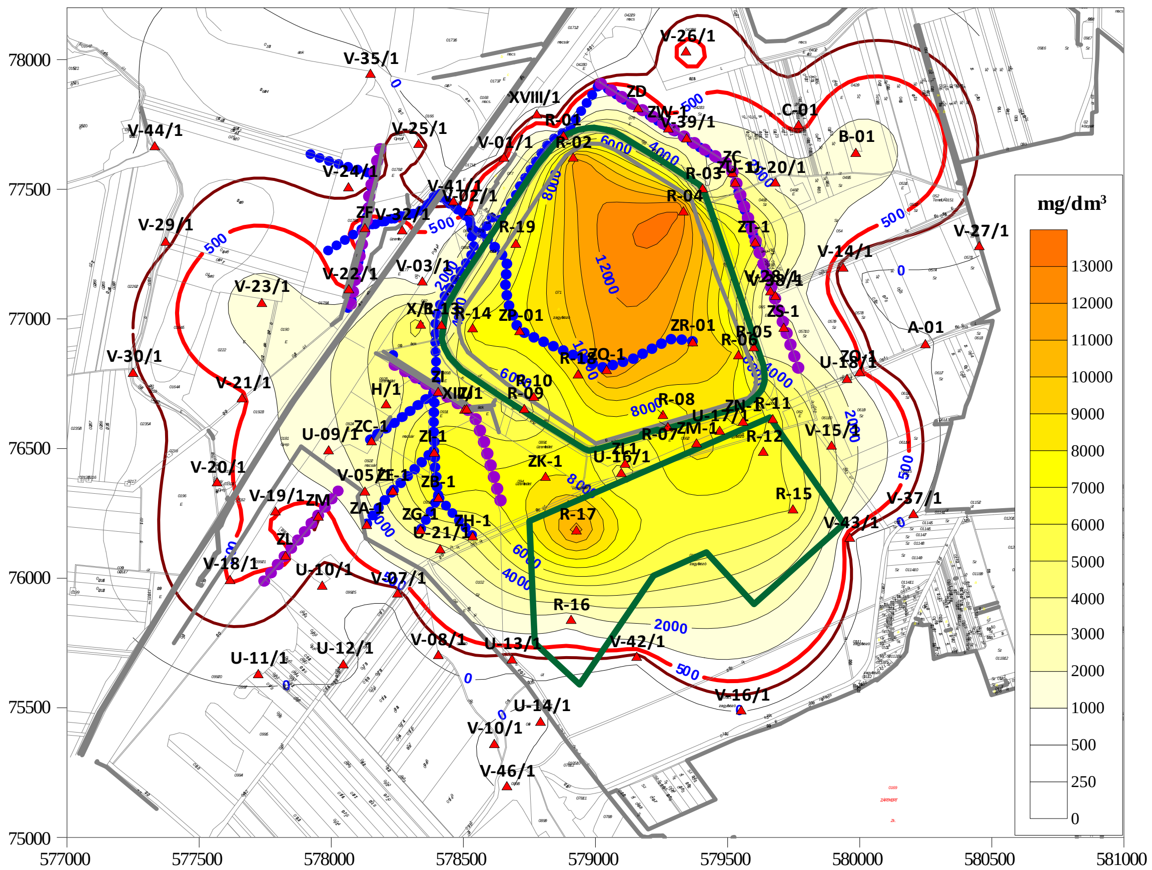


Figure An7.3-1: Sulphate content of ground water in the vicinity of tailings ponds in 2013 (mg/dm³) (green colour is used to delimit the area of the two tailings ponds)


Figure An7. 3-2: Remedied uranium industry tailings pond

The environmental audit of mining remediation was repeated in 2012. The audit, in harmony with the previous one, established that remediation works had been carried out according to the originally approved program, and the radioactive residues of mining and ore-processing discharged to the environment as a consequence of the former uranium industry activity are isolated. It also found that the radiological exposure of the public significantly decreased. In accordance with the recommendations given in the amendment to the environmental license, the optimization of the operation of the damage elimination system took place taking into account the results of transport modelling of contaminants in order to being able to assess the effectiveness and to forecast the expected duration of intervention in the surroundings of the tailings ponds.

ANNEX 8: NUCLEAR FACILITIES, SPENT FUEL ASSEMBLIES, DISCHARGES

An8.1 Paks Nuclear Power Plant

An8.1.1 Management of the spent fuel assemblies

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, since they were the requirements 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.21]. As appendices of this decree, new Nuclear Safety Codes were issued.

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.

In the spent fuel ponds belonging to the individual units 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 (absorbers) 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. *Mobile, reserve racks can be installed on the second level of spent fuel ponds in case of the need to expand storage capacity.*

<u>Handling and transport equipment of spent fuel assemblies</u>

The handling equipment of spent fuel assemblies 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 in the spent fuel ponds.

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

<u>Removal of the decay heat</u>

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:

a) highest initial enrichment: 4.2%;
b) 54 GWday/tU highest fuel burn-up;
c) maximum *five*-year *fuel cycle*;
d) maximum 15 kW total output;
e) minimum 0.5 year decay time *for transport between spent fuel pools, minimum 3.5 year decay time for transport to the SFISF*.

<u>Criticality safety</u>

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. Before the introduction of the new fuel assemblies containing 126.3 kg uranium of 4.2% average enrichment and gadolinium as burning poison the calculations were repeated. Thus, sub-criticality of fuel elements stored in the spent fuel pond is ensured by the design/construction of the storage racks. The storage racks filled up in compliance with the requirement keep the sub-critical state even if they are flooded with clean, i.e. boron-free, water.

<u>Other risks taken into account</u>

- 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 low frequency of fuel handling manipulations, no seismic event of SL-2 level was assumed simultaneously with re-fuelling and transport manipulations (in case of Paks NPP this is defined by 0.25g ground surface acceleration and a site-specific response spectrum).
- 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. *The natural external hazards were independently evaluated for the spent fuel pool. The storage of spent fuel assemblies in the spent fuel pool is protected against external threats within the design basis, and appropriate margin is available for*

such threats beyond the design basis. As a whole, 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.

Compliance with the fuel cycle strategy

From the tasks related to managing the spent fuel, Paks NPP performs only the interim storage independently, in its own competence, in the spent fuel ponds. Maximum storage capacity of the spent fuel ponds amounts to 1025 assemblies *(679 on the operating racks and 346 on the reserve racks)* for each unit. Spent fuel elements – after a decay period of at least 3.5 years – are handed over for a further intermediate storage of about 50 years in the Spent Fuel Interim Storage Facility. (*See chapter B.1.2*)

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 fragments damaged in Pit No. 1 were loaded into canisters designed for storing fuel assemblies. The encapsulation work was finished in early 2007. The loaded 68 canisters are stored in the spent fuel pool.

An8.1.2 Discharges

Regulatory framework

According to the regulation in force since 1998, 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. The relevant decree [III.7] provided for isotope selective limits derived from dose constraints. Based on it, Paks NPP has calculated the annual discharge limit values that are derived from the dose constraint for all relevant discharge pathways and all important isotopes 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.7] 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.

Systems for discharge monitoring

In the Paks Nuclear Power Plant the system of operational and regulatory monitoring, as well as the measuring methods were planned and established, so that (a) full monitoring of all planned discharge routes and 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 refurbishment of the system, designed in the 1970s, was completed in 2005.

The discharge monitoring of radioactive materials and 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 the data of the meteorological tower are collected and archived in a central computer.

<u>Airborne discharges</u>

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 (^{131}I) and noble gas. The measuring range of the measuring units is the following:

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

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

<u>Liquid discharges</u>

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 already been 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 the extent of its radioactive contamination continuously. The measuring range is $1 – 10^9$ Bq/m^3.

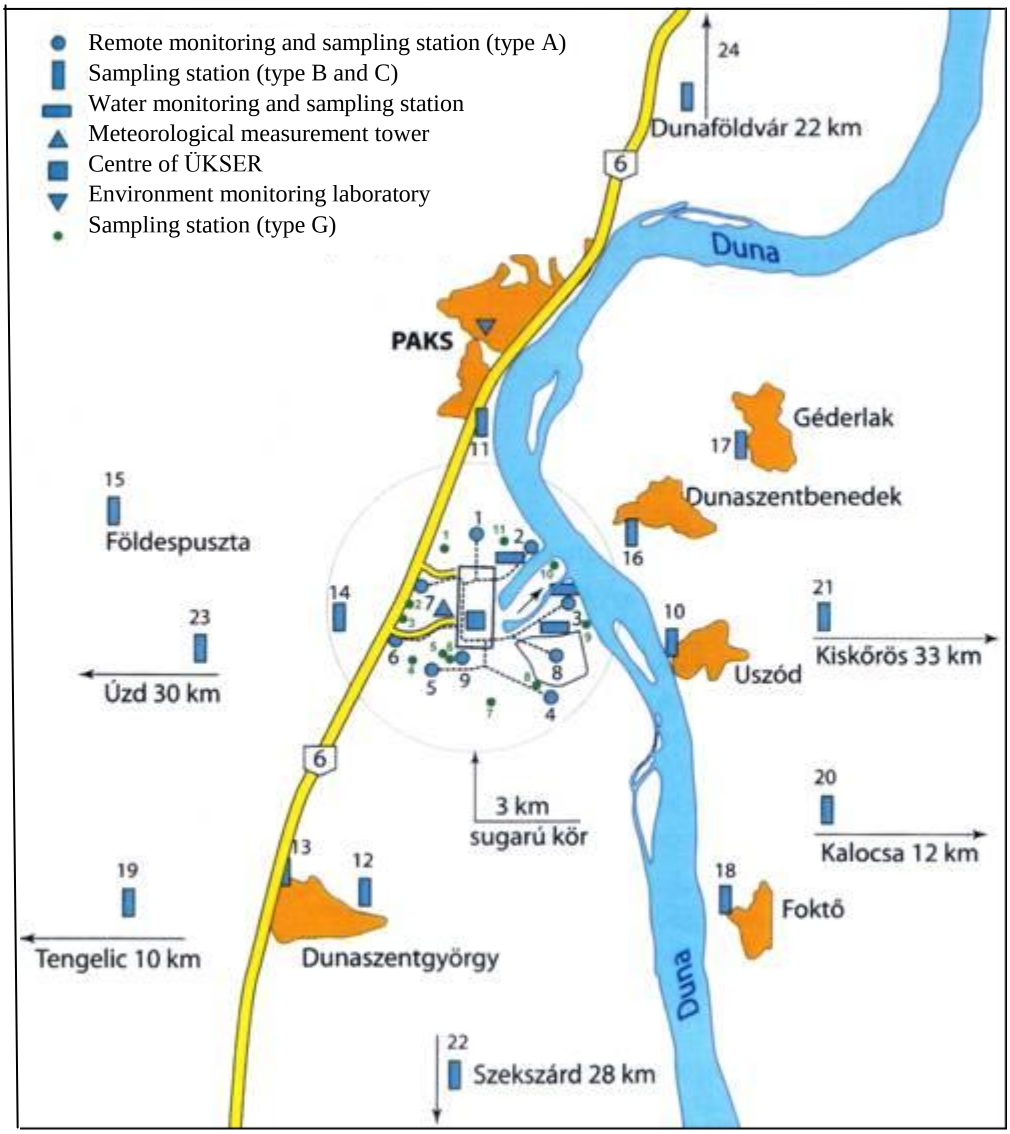
The remote detectors installed along the discharge routes are used for preventing discharge of liquids in an unauthorized way, without laboratory sample analysis.

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 1.5 km), 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 3 km):
   - gamma-radiation dose rate (on-line).



Note: ÜKSER = Operational Environmental Radiation Monitoring System

Figure An.8.1.2 – 1: Environmental Radiation Protection Monitoring System

Intervention levels

On the basis of values specified below, the radiological leader of the Emergency Preparedness Organization 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 manager of the Emergency Preparedness Organization, it is also possible to order the application of a protective measure at values lower than those specified in the following:

Sheltering:	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 the case of a nuclear accident:

Sheltering: 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.

Discharge data for the years between 2011 and 2013

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".

$\frac{R_{ij}}{El_{ij}}$ usage of limits for discharge pathway "j" and radionuclide "i".

Table An8.1.2. -1 Discharge data for Paks Nuclear Power Plant for the period between 2011 and 2013

Isotope groups	Total discharge for 2011 [Bq]	Discharge limit usage*	Total discharge in 2012 [Bq]	Discharge limit usage	Total discharge in 2013 [Bq]	Discharge limit usage*
Airborne discharges						
Corrosion and fission products	8.76×10^{8}	1.03×10^{-4}	1.05×10^{9}	1.69×10^{-4}	1.19×10^{9}	1.93×10^{-4}
Radioactive noble gases	3.72×10^{13}	4.34×10^{-4}	3.82×10^{13}	4.60×10^{-4}	2.86×10^{13}	3.46×10^{-4}
Radioiodine	1.05×10^{8}	1.26×10^{-5}	5.40×10^{7}	1.90×10^{-5}	7.37×10^{7}	3.29×10^{-5}
Tritium	3.69×10^{12}	2.13×10^{-5}	3.45×10^{12}	1.99×10^{-5}	4.05×10^{12}	2.34×10^{-5}
Radiocarbon	3.49×10^{11}	1.12×10^{-4}	5.51×10^{11}	1.77×10^{-4}	6.39×10^{11}	1.81×10^{-4}
Total	-	6.83×10^{-4}	-	8.46×10^{-4}	-	7.77×10^{-4}
Liquid discharges						
Corrosion and fission products	1.64×10^{9}	5.23×10^{-4}	2.51×10^{9}	8.76×10^{-4}	2.91×10^{9}	1.00×10^{-3}
Tritium	2.31×10^{13}	7.95×10^{-4}	2.48×10^{13}	8.57×10^{-4}	2.24×10^{13}	7.73×10^{-4}
Alpha emitters	1.83×10^{5}	2.54×10^{-7}	1.50×10^{5}	2.18×10^{-7}	1.87×10^{6}	1.93×10^{-6}
Total	-	1.32×10^{-3}	-	1.73×10^{-3}	-	1.77×10^{-3}

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

An8.2 Budapest Research Reactor

An8.2.1 Management of the spent fuel assemblies

Regulatory framework

Handling of spent fuel is part of the operation of the reactor, so it is regulated by the national Nuclear Safety Codes.

Systems managing spent fuel elements (removal of decay 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 Budapest Research Reactor fuel elements is so low that the decay heat is removed by wet storage. After one year of cooling there is no technical objection against fuel transport. During the internal transport of spent fuel, the decay heat does not cause a problem for the same reason and because of the short time.

Highly enriched uranium spent fuel elements located in the spent fuel store of the KFKI Atomic Energy Research Institute were repatriated to the Russian Federation in 2008 and 2013 (see chapter B.1.2). The repatriation was preceded by a thorough planning process. The service hall (providing the location for the technology operations required for the preparation for repatriation), the support systems, the radiation monitoring and physical protection equipment were constructed with the permit and under the supervision of the Hungarian Atomic Energy Authority.

An individual emergency response plan to carry out the repatriation had been submitted to the authority by the KFKI Atomic Energy Research Institute (and its successor, the HAS Energy Research Centre).

An8.2.2 Discharges

Regulatory framework

Decree [III.7] on radioactive discharges and their control is authoritative for radioactive discharges to air and water during the use of atomic energy, 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

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, and it 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 built-in 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 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 storage tanks.

The acid neutralizing shaft collects the water from the chemical laboratory of the reactor building and from the water preparation unit. 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 through the normal sewage system 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 of the liquid radioactive waste are measured; then, after cleaning by ion exchangers, the discharge into the sewage system takes place. During discharge, the Environmental Control Group has to check the water from the ion exchangers daily, 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 and continuously operating detectors of the Radioprotection Measuring and Control System, partly by periodic sampling.

The ventilation system of the Budapest Research Reactor is connected via aerosol and iodine filters to the 80 m stack. 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 Budapest Research 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.

Results of the measurements

The measured values of the discharges of the Budapest Research Reactor were very low between 2011 and 2013 as usual. For example, the following results were obtained in the period:

	2011	***2012***	***2013***
atmospheric discharge:			
Noble gas (only ^{41}Ar)	*52.6 TBq*	*48.9 TBq*	*42.3 TBq*
Iodine	*under detection limit (<5 Bq/m^3)*	*under detection limit (<5 Bq/m^3)*	*under detection limit (<5 Bq/m^3)*
Aerosol	*under detection limit (<3.7 Bq/m^3)*	*under detection limit (<3.7 Bq/m^3)*	*under detection limit (<3.7 Bq/m^3)*
liquid waste discharge:			
^{60}Co	*not occurred*	*not occurred*	*196 MBq*
^{137}Cs	*not occurred*	*not occurred*	*1.22 MBq*

An8.3 Training Reactor

An8.3.1 Management of the spent fuel assemblies

Until now, no spent fuel was generated in the Training Reactor. 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

Owing to 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.12], 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.