HUNGARY

NATIONAL REPORT

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

2017

TABLE OF CONTENTS

Abbreviations

ADR	European Agreement concerning the International Carriage of Dangerous Goods by Road done on 30 September 1957, in Geneva
Act on Atomic Energy	Act CXVI of 1996 on Atomic Energy
ARM	Advanced Reference Material
BCF	Boda Claystone Formation
BRR	Budapest Research Reactor
BUTE	Budapest University of Technology and Economics
BUTE INT	Budapest University of Technology and Economics Institute of Nuclear Techniques
Convention	Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management
CPR	Corporate Peer Review
Fund	Central Nuclear Financial Fund
HAEA	Hungarian Atomic Energy Authority
HAEA SC	Hungarian Atomic Energy Authority Scientific Council
HAS	Hungarian Academy of Sciences
HAS CER	Hungarian Academy of Sciences Centre for Energy Research
IAEA	International Atomic Energy Agency
IDMCC	Inter-ministry Disaster Management Coordination Committee
IDMCC NEMC	Inter-ministry Disaster Management Coordination Committee National Emergency Management Centre
IDMCC SC	Inter-ministry Disaster Management Coordination Committee Scientific Council
INES	International Nuclear and Radiological Event Scale
IRRS Mission	Integrated Regulatory Review Service Mission
IRS	Incident Reporting System
JERMS	Joint Environmental Radiation Monitoring System
MND	Ministry of National Development
MoI	Ministry of Interior
MVM Ltd.	MVM Hungarian Electricity Ltd.
NEIEC	Nuclear Emergency Information and Evaluation Centre
National Policy	National Policy of Hungary on the management of spent fuel and radioactive waste
National Programme	National Programme of Hungary on the management of spent fuel and radioactive waste
NDGDM	National Directorate General for Disaster Management of the Ministry of Interior
NDGDM NEIEC	National Directorate General for Disaster Management of the Ministry of Interior Nuclear Emergency Information and Evaluation Centre
NERMS	National Environmental Radiological Monitoring System
NERP	National Nuclear Emergency Response Plan
NERS	National Nuclear Emergency Response System
NPH	National Police Headquarters

NPHC	National Public Health Centre
NPHMOS	National Public Health and Medical Officer Service
NRDRR NPHC	National Research Directorate for Radiobiology and Radiohygiene of the National Public Health Centre
NRDRR NPHC	National Research Directorate for Radiobiology and Radiohygiene
NRMACS	National Radiation Monitoring, Alert and Control System
NRWR	National Radioactive Waste Repository
OCMO	Office of the Chief Medical Officer
OCMO NPHMOS	Office of the Chief Medical Officer of the National Public Health and Medical Officer Service
OECD NEA	OECD Nuclear Energy Agency
OSART	Operational Safety Review Team
PSR	Periodic Safety Review
PURAM	Public Limited Company for Radioactive Waste Management
RWTDF	Radioactive Waste Treatment and Disposal Facility
SFISF	Spent Fuel Interim Storage Facility
Training Reactor	Training Reactor of the Institute of Nuclear Techniques of the Budapest University of Technology and Economics
TSO	Technical Support Organization
TSR	Targeted Safety Re-assessment
WANO	World Association of Nuclear Operators
WENRA	Western European Nuclear Regulator's Association
WHO	World Health Organization

Section A. Introduction

The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (hereinafter referred to as Convention) was promulgated by an Act [I.10]. (Hereeinafter legal instruments listed in Annex 4 are referred by numbering in brackets). The present National Report has been prepared and submitted in order to fulfil the obligations under Article 32 of the Convention.

Apart from this Introduction (Section A), this National Report contains ten sections and eight annexes in accordance with the Guidelines regarding the Form and Structure of National Reports (INFCIRC/604/Rev.3).

Section B describes the general policy and practice of radioactive waste management and spent fuel management in Hungary.

Section C addresses the scope of application: in Hungary there are not any reprocessing facilities or spent fuel originating from military applications.

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

Section E describes the Hungarian legal background. The basic regulation in force is the Act on Atomic Energy [I.6], provides the national policy relevant to the application of atomic energy. It regulates various basic aspects of radioactive waste management.

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

Sections G and H discuss in detail the questions related to the safety of spent fuel and LLW/ILW management, respectively.

International 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 strengthened and significantly enhanced 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 [I.10]. In Annexes 5 and 6 reference is made to 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 longterm monitoring activity. Annex 8 deals with the spent fuel management and releases of nuclear facilities other than spent fuel management facilities.

This *sixth* National Report prepared in the framework of the Convention [I.10] is a stand-alone document, demonstrating the fulfilment of obligations undertaken under the Convention. The new developments, in comparison with the previous (i.e. the fifth) National Report, are typeset in Italics.

***

Executive summary of the challenges and recommendations set out in the rapporteur report of the fifth National Report.

1. Further exploration of the Boda Claystone Formation (hereinafter referred to as BCF) for the final disposal of high level waste: more precise delimitation of the suitable area.

The research phase launched in 2014 is aimed at the generic site qualification of the rock environment, narrowing the research area and obtaining geological data and information necessary for the safety assessment of the site. Since the last review meeting research has been somewhat slower than originally planned adjusted to the available financial resources, therefore the originally targeted professional objective is expected to be achieved after 2018 (see Section G.2).

2. Increasing the interim storage capacity of spent fuel elements based on the service life extension programme of the Paks Nuclear Power Plant.

The Spent Fuel Interim Storage Facility (hereinafter referred to as SFISF) can be expanded modularly, and the planned expansions also take into account the storage needs of the 20 year service life extension of the Paks Nuclear Power Plant (see Section G.1). Based on current plans, the SFISF extension milestones are as follows:

2019-2023	*construction of modules 25-28.*
2026-2030	*construction of modules 29-32.*
2032-2036	*construction of modules 33-36.*

3. Radioactive waste storage issues

- *Capacity of the National Radioactive Waste Repository (hereinafter referred to as NRWR)*

The NRWR is being expanded according to the generation rate of low and intermediate level waste originating from the nuclear power plant (see Section H.3). Based on current plans, the NRWR expansion milestones are as follows:

2020	*commissioning and beginning of delivery to chamber I-K3*
2022-2028	*construction and commissioning of chamber I-N1 and I-N2*
2037	*commissioning and beginning of delivery to chamber I-K4*
2062	*beginning of delivery of decommissioned waste to chamber I-N1*

- *Storage of very low level waste*

The elaboration of the legal framework concerning the storage of very low level radioactive waste, that will be generated primarily by the decommissioning of the Paks Nuclear Power Plant (~22,000 m^3) has begun in line with the timetable contained in the national policy of Hungary on the management of spent fuel and radioactive waste (hereinafter referred to as National Policy).

4. Remediation programme for the elimination of the environmental damage caused by uranium mining and ore processing in the Mecsek mountains.

As a result of the underground cavity system of the mining facilities being completely filled up, the purification of a significantly higher volume of uranium contaminated mining water is required – that is expected to begin in 2019-2020.

The capacity of the mining water purification system was insufficient to handle the anticipated volume of water and the uranium contained in it, therefore the system must be expanded. The expansion of the water purification system is being carried out in several steps over a period of several years with the immediately necessary activities being prioritized. These developments concern the mine shafts and the connecting pipelines, the expansion of the mining purification technology, the pipelines for discharging purified water as well as electrical and instrumentation and control systems. The design and implementation of the developments aimed at the treatment of surplus uranium contaminated water resulting from the filling-up of the mining surge and under the spoil heaps began in 2014.

Modifications planned in the mine water purification plant and the related modifications in the water management system have been completed:

- *3 sorption and 2 elution columns have been added to the ion exchange unit of the mine water purification unit,*
- *new drying and dusting screw control system has been installed in addition to the existing dryer,*
- *the expansion of the elements of the water control system has been carried out taking into account the increased volume of water.*

In addition to the existing pipelines, the construction of a new pipeline between the former enrichment facility and the tailings pond has been completed.

With these developments the capacity of the mine water purification plant increases to a maximum of 1.8 m^3/year.

5. Ensure adequate resources, trainings, competencies of the Hungarian Atomic Energy Authority (hereinafter referred to as HAEA)

As stipulated in the Act on Atomic Energy [I.6.], the resources required to perform the fundamental tasks of the HAEA are ensured through the central budget, the supervisory fees paid by the licensees of nuclear facilities to the HAEA and the fees of administrative services performed by the HAEA.

In 2016, the HAEA doubled the number of its staff members (expanded to 164 members), most of whom possess a graduate degree. Training of the new and existing staff members is based on the systematic method introduced earlier.

The additional cost of the staff increase was covered by a significant increase in the budgetary support.
The HAEA carries out its activities independently and impartially of the licensees of nuclear and radioactive waste facilities. Its funding ensures that it can perform its tasks effectively (see Section F.2.1.1).

6. Finalization of the National Policy on the closing of the fuel-cycle

In 2015, the Parliament adopted its resolution on the national policy on spent fuel and radioactive waste management [IV.1] (see Section B).

7. In order to increase long-term safety, the recovery of long lived sources from the disposal pools of the Radioactive Waste Treatment and Disposal Facility (hereinafter referred to as RWTDF).

A multi-stage programme was launched in 2002 aimed at modernizing and enhancing the long term safety of the RWTDF (see Section H.2 and K.2). The demonstration phase of the enhancement programme was completed in 2008. The planned milestones of the programme are as follows:

2017-2022	*construction of the lightweight building and infrastructure required to carry out the safety enhancing activities (pool row I. chambers A01-A24 – waste retrieval, processing, qualification)*
2023-2029	*retrieval of the contents of pool row II. (chambers A25-A48), processing, re-deposition of the waste and restoration of the environment surrounding of pools I-II.*
2030-2037	*Conditioning and space-filling of the contents of pool rows III and IV*

8. Finalization of the national programme in accordance with Council Directive 2011/70/EURATOM on establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste

The National Programme on the management of spent fuel and radioactive waste (hereinafter referred to as National Programme), which meets the requirements set out by the National Policy was adopted by the Government in August 2016 in a resolution [V.6].

9. Additional steps for the establishment of the so-called integrated monitoring system

As per the 2013 amendment of the Act on Atomic Energy [I.6] after 30 June, 2014 the HAEA took over the regulatory tasks of the safety oversight of radioactive waste facilities from the health authorities. In parallel with the takeover of the administrative duties a review of the legal environment containing the safety requirements [II.35] has been carried out. The new government decree also includes the adaptation of the relevant reference levels developed by the Western European Nuclear Regulators' Association (hereinafter referred to as WENRA). In order to carry out the licensing, control and evaluation tasks of the radioactive waste repositories, the HAEA has implemented the principle of graded approach, essentially applying the same methods and tools which have been used effectively in the case of nuclear facilities for a long time.

As a result of the amendment of the Act on Atomic Energy, in force as of 1 January 2016, the Hungarian radiation protection authority system has changed and the HAEA took over the majority of the regulatory tasks from the health authorities, both in the case of facilities as well as other users. Modification of the legal environment took place in parallel with the takeover of the administrative duties in this case as well. The newly published peaces of legislation have also transposed into the Hungarian legal system the provisions of the Council Directive 2013/59EURATOM on laying down the basic safety standards for protection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom and have taken into account the recommendations of the Integrated Regulatory Review Service Mission (hereinafter referred to as IRRS Mission) carried out in Hungary in 2015. In the development of the oversight activities, the HAEA sought to take advantage of synergies between the various areas overseen (nuclear safety, radiation protection, physical protection, radioactive material inventory record keeping system), to apply the same regulatory, licencing and inspection principles, to introduce probabilistic risk assessment based inspection, planning and protocols (graded approach), to improve the efficiency of inventory systems, to utilize and expand the technical support organizations, and to develop the equipment. The main results are: centralized licensing, reduced number of license types and the introduction of the regional inspection system for more than 4500 licensees.

Upon the above mentioned changes, the development of the integrated safety and security monitoring system for the peaceful uses of atomic energy in Hungary has been completed.

10. Establishment of a resource strategy in the nuclear capacity maintenance programme

The human resource policies of the HAEA are determined with a view that unit 5 of the Paks Nuclear Power Plant can be put into operation in 2025, while unit 6 in 2026. The HAEA conducted a survey regarding the expertise and staff needs of the licensing and construction oversight tasks, the results of which was forwarded to the relevant governmental bodies. Based on this, the HAEA was given the opportunity to hire a significant number of new staff members in 2015 in view of the new units and tasks (oversight activities regarding the radioactive waste repositories and radiation protection). With the hiring of 80 new staff members, the HAEA practically doubled the total number of its staff. Recruitment was aided by the amendment to the Act on Atomic Energy which improved the level of income of HAEA employees. In line with the results the HAEA will have the opportunity to hire 40 more people in 2017.

11. Safety assessment of spent fuel and radioactive waste repositories after the Fukushima accident

In its closing resolution of the comprehensive inspection of the SFISF in 2013, the HAEA ordered the licensee, the Public Limited Company for Radioactive Waste Management (hereinafter referred to as PURAM) to study the experiences gained from the Fukushima accident and produce an assessment report thereof, investigating and evaluating the protection of the SFISF of external threats by quantifying the margins beyond its design basis. PURAM has forwarded the report to the HAEA, however the official assessment of it (due to order for supplying missing information) has not yet been completed.

In the case of the radioactive waste repositories, when developing the new legislative framework in 2014, the HAEA took into consideration the lessons learned from the Fukushima accident, in particular concerning the siting requirements. The licensee has revised the safety *reports of the facilities based on the new legislation, when applying for a new operating license to the HAEA. Review of the license application and evaluation of the safety reports are still in progress for both repositories.*

12. Examining the compliance of the radioactive waste repositories with the safety requirements set forth by law, and the preparation of action plans as needed.

The government decree [II.35] in force since 2014 required the storage facility operator to carry out a review on the compliance of the government decree's provisions relevant to the facility. PURAM has conducted the review in the case of both operating radioactive waste repositories and has submitted the report on the results to the HAEA in the spring of 2016. In its resolution during the summer of 2016, the HAEA, on the basis of deviations identified, for a definite period of time exempted the licensee from certain requirements and ordered the implementation of corrective measures. The evaluation and implementation of these corrective measures are currently in progress. In 2016, the PURAM submitted the first Periodic Safety Review for the RWTDF as set out by legislation. Evaluation of the review is still in progress.

13. Completion of the IAEA recommendations concerning the recultivation efforts of the former uranium mine

The review carried out by the IAEA international expert group in 2010-2011 contains several recommendations, the implementation of which can be summarized as follows.

The expert group recommended that a 30-year long-term strategic plan be developed, defining the necessary tasks, activities, equipment and services. This strategic plan was drawn up in 2012 and planning of the remediation activities takes place on its basis – in addition to the environmental licence.

Further recommendations were made about the need to expand the mine water purification plant and the revision of technology. A feasibility study was carried out in 2012, which in addition to the expansion of the water purification plant and examination of its technology, includes preliminary plans for the complete transformation and expansion of the water management system as well as the underlying calculations. This document was the basis of the future water licensing plans for each facility. Works on the expansion began in 2014.

The extreme radon fluctuation is continuously monitored. The phenomenon can be explained as a result of the filling-up of the mining cavity surge and seasonal meteorological fluctuations.

A recommendation was made concerning the short term reparation of the erosion damage of the cover layer of the tailings ponds which was completed and the extent of the damage has been significantly reduced with the growth of vegetation.

As a partial realization of the recommendation concerning the remediation and monitoring of underground water, hydraulic and pollutant transport modelling of the cavity of the surroundings of the tailings ponds and mine I have been completed in 2014 (based on the models elaborated in 2007 and 2003). Current pollution conditions will be specified in the surroundings of the tailings ponds by geophysical examinations (using geoelectric sections) in 2017.

Concerning the underground water monitoring activity in line with the recommendation, the hydrogeological monitoring of the limestone located north of the northern mine continued and in the case of several mining well drilling, depth selective sampling has been implemented. During 2017 the hydrogeological reambulation of the entire impact area will be completed. In addition to the 5 year environmental reviews the monitoring programme is updated during the development of the annual monitoring plans, which is also in line with the recommendations of the review team.

In order to increase the efficiency of the remediation of the tailings areas the expert report recommended to enhance the removal of the most contaminated water mass from shallow depth. As a result, three new production wells are currently being deployed at tailings pond I. whose water will be connected to the chemical water treatment plant.

Remediation activities – primarily in the case of the tailings ponds – affect the neighbouring Pellérd and Tortyogó water bases, therefore in accordance with the recommendation a cooperation agreement has been drawn up between the waterworks operator and the Mining Property Utilization Company in the Public Interest for the continuous exchange of data, information and for the harmonisation of sampling.

***

The compilation of the report was finalized on 31 March 2017; the inventory data herein, unless otherwise indicated, describes the conditions as of 31 December 2016.

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 legislation alongside the efforts of the regulatory body and operators;

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

- appropriate measures have been 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, October 2017

Gyula Fichtinger
Director General of the Hungarian Atomic Energy Authority

Section B. Policies and Practices

Council Directive 2011/70/EURATOM establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste requires Member States of the European Union to establish and maintain national policies on spent fuel and radioactive waste management.

The Parliament adopted the National Policy in a resolution [IV.1] in 2015.

The National Policy summarizes the principles applicable to the management of spent nuclear fuel and radioactive waste. Most of these principles already existed in the Hungarian legal system, mainly in the Act on Atomic Energy [I.6] and its implementing decrees, before the adoption of the National Policy, but have also been recast according to the requirements of the Directive in a systematic way.

The National Policy formulates the policies for the back-end of the fuel cycle, the management of radioactive waste and the decommissioning of nuclear facilities as the boundary conditions of the National Programme, moreover, the requirements and methods for the engagement of the citizens in decision-making, i.e. the policy of ensuring publicity.

The National Policy on radioactive waste management is based on the following three pillars. Regarding the back-end of the fuel cycle a final decision has not yet been made, rather the principle of "do and see" is being applied, which allows for the possibility of following domestic and international developments, technological advancements to be integrated into the back-end policy as necessary. In addition, as a reference scenario an open fuel cycle has been developed that includes the direct, domestic disposal of spent fuel originating from nuclear power plants. According to the second pillar of the radioactive waste management, low and intermediate level radioactive waste generated in Hungary is to be disposed in radioactive waste disposal facilities in Hungary. This policy is in the implementation phase, as facilities for this purpose already exist. Emerging needs must be met by further development, safety advancements and continuous expansion of these facilities. Implementation of the decommissioning policy of nuclear facilities will become a current issue in the future. The decommissioning plan must include the decommissioning schedule, if necessary including the period of protected preservation, and in line with the long term utilization concept of the site the final state of decommissioning. Regular review and, if necessary, updating the decommissioning plan is also a fundamental requirement for its content to follow changes in safety requirements and technological developments.

Pursuant to the provisions of Council Directive 2011/70/EURATOM transposed into the Act on Atomic Energy [I.6] in 2013, the Government shall adopt and regularly update the National Programme. The National Programme shall contain the following:

a) the overall objectives of the Member State's National Policy in respect of spent fuel and radioactive waste management;

b) the significant milestones and clear timeframes for the achievement of those milestones in light of the over-arching objectives of the national programme;

c) an inventory of all spent fuel and radioactive waste and estimations for future quantities, including those with origin from decommissioning, clearly indicating the location and amount of the radioactive waste and spent fuel in accordance with appropriate classification of the radioactive waste;

d) the concepts or plans and technical solutions for spent fuel and radioactive waste management from generation to disposal;

e) the concepts or plans for the post-closure period of a disposal facility's lifetime, including the period during which appropriate inspections are to be maintained and the means to be employed to preserve institutional knowledge of that facility in the longer term;

f) the research, development and demonstration activities that are needed in order to implement solutions for the management of spent fuel and radioactive waste;

g) the responsibilities for the implementation of the National Programme and the key performance indicators to monitor progress towards implementation;

h) an assessment of the National Programme costs and the underlying basis and hypotheses for that assessment, which must include a profile over time;

i) the financing scheme(s) in force;

j) a transparency policy or process;

k) if any, the agreement(s) concluded with a Member State or a third country on management of spent fuel or radioactive waste, including on the use of facilities for final disposal.

In accordance with the above requirements, the National Programme was adopted by the Government in August 2016 in the form of a resolution [V.6].

The National Programme falls within the scope of 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 as well as the government decree on the promulgation of the Protocol on Strategic Environmental Assessment, adopted in Kiev, on 21 May 2003 [II.20] to the Convention on Environmental Impact Assessment in a Transboundary Context adopted in Espoo, on 26 February, 1991. Consequently, in line with the transposed legislation [II.39], a strategic environmental assessment was carried out in 2015-2016.

In accordance with international and EU regulations, the impact assessment of possible transboundary environmental and health impacts was also carried out (during the first half of 2016) in accordance with the provisions of government decrees [II.40], [II.39] and Council Directive 2011/70/EURATOM. By doing so, Hungary ensured the right of Austria, Slovakia, Ukraine, Romania, Serbia, Croatia and Slovenia to participate, as potentially affected parties, in the strategic environmental assessment procedure exploring the transboundary environmental impacts of the National Programme.

In accordance with the relevant legal provisions, Hungary has taken into account the comments received in the programme's decision making process.

Dynamism of the National Policy and the National Programme is ensured by the fact that Hungary has stipulated in the Act on Atomic Energy [I.6] the revision of the National Policy and National Programme every five years. Thus, Hungary can integrate the best available technical solutions and research results into the National Policy, and can implement them in practice in the National Programme.

B.1 Spent nuclear fuel and high level waste

B.1.1 Applied practice

Since all the feasible scenarios of the back-end of fuel cycle 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 (hereinafter referred to as BRR) in the Centre for Energy Research of the Hungarian Academy of Science (hereinafter referred to as HAS CER), and the Training Reactor (hereinafter referred to as Training Reactor) of the Institute of Nuclear Techniques at Budapest University of Technology and Economics (hereinafter referred to as BUTE INT).

HLW is also generated during the operation of Paks Nuclear Power Plant and is temporarily stored in purpose-designed storage tubes (wells) 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 the decision regarding the back-end of the fuel cycle.

In 1995 a programme was launched as a means of solving the disposal of high level and long lived radioactive wastes, focusing mainly 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 BCF at 1100 m depth (accessible from the former uranium mine) during 1996-1998. 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 investigations were completed by the end of 1998 and summarised in a documentation. According to the final report there were no circumstances questioning the suitability of the BCF 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 BCF 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 the 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 study entitled “Updated concept of the long term research programme of the BCF 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 final disposal of the high level waste and spent nuclear fuel.

Professional review of the study was carried out by the Swiss radioactive waste management organization, NAGRA. The review 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 a problem oriented approach that is based on safety assessment, as well as to the need of establishment of a strong leader and manager group within PURAM in order to assure the harmonization and the 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 into account the results of the review by NAGRA, PURAM is prepared to professionally manage the site selection of a deep geological disposal facility of HLWs (see the organigram of PURAM in Figure F.2.2.1-1). During 2012-2013 PURAM prepared its geological research plan for the next stage of the investigation of the BAF, which was approved by the competent authority (Pécs Mining District Authority).

The aim of the research phase launched in 2014 is the generic classification of the host rock environment, narrowing down the research area and obtaining geological data and information necessary for the safety assessment. Research has been somewhat slower than originally planned adjusted to the available financial resources, therefore the originally targeted professional objective is expected to be achieved after 2018.

The long term programme will inevitably need to be updated from time to time in the light of new knowledge and circumstances.

The investigations have been supported by the nine municipalities in the surrounding.

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 the Russian Federation for the entire life-time of the nuclear power plant. To date, Hungary did not have to take back radioactive waste or other residuals resulting from reprocessing the spent fuel elements shipped back.

The major part of the spent fuel was shipped back to the Soviet Union (later the Russian Federation) 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 asked Hungary to take back the radioactive waste and other by-products resulting from 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 facility were started in 1993. Paks Nuclear Power Plant trusted the British-French company GEC Alsthom to build a dry storage facility of MVDS (modular vault dry storage) type. One of the advantages of this type of construction and storage technology is that the number of storage chambers can be increased in a modular system.

Currently the facility contains 16 modules on the Western side (each having a storage capacity of 450 fuel assemblies) and 4 modules on 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 SFISF is in the immediate vicinity of Paks Nuclear Power Plant. It is situated at a distance of 5 km south of Paks town.

Further details of the facility are given in Annex 1; its safety is dealt within 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 (hereinafter referred to as: BRR) and the Training Reactor contributes to the spent fuel generation.

The spent fuel of the BRR is stored in two tanks. Assemblies removed from the zone must first be stored in the internal repository, which has a capacity of 786 fuel assemblies of which 114 are currently occupied. Following a one-year storage period they can be transported to the external spent fuel repository, which has a capacity of 2256 fuel assemblies and currently all of them are empty. In short term, storage is carried out in wet tubes. Based on previous experience, fuel assemblies stored in such conditions for 30 years have not become in-hermetic. For longer storage, the operator has developed a semi-dry storage technology. This means that the spent fuel assemblies are dried and are placed into a hermetically sealed capsule filled with nitrogen, which is then placed in a water-filled tank providing biological protection. The licensee possesses a licence for both methods of storage (see Section B.1.2)

The Training Reactor is operating with the fuel assemblies that were placed in the core at the start of the operation and after the reconstruction in 1980. The burn up rate of the reactor fuel assemblies 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 Long term Policy

Spent fuel from Paks NPP

The Act on Atomic Energy [I.6] defines spent fuel as nuclear fuel irradiated in a nuclear reactor, which has been permanently removed from the reactor and which, because it can be reprocessed outside the reactor, is not considered as waste or if it is not reprocessed upon decision, it is considered as radioactive waste, its final disposal shall be provided.

In line with the statutory definition, according to the National Policy, the final decision concerning the back-end of the fuel cycle of power reactors is not yet necessary to be made, but it is necessary to state that the country must address the management of high level radioactive waste regardless of the chosen back-end option. The most suitable and most widely accepted solution to this is final disposal in a deep geological disposal facility.

The policy concerning the back-end of the fuel cycle follows the “do and see” principle, meaning that an open fuel cycle i.e. direct, domestic disposal of spent fuel originating from nuclear power plants has been determined as the reference scenario, which provides the basis of the relevant cost estimates concerning the currently operating four units. Domestic and international developments concerning the back-end of the fuel cycle must be followed (“see”) and if necessary must be incorporated into the policy of the back-end of the fuel cycle, while at the same time progress must be made on the site selection of the domestic deep geological disposal facility (“do”).

Spent fuel from the BRR and from the Training Reactor

The policy of the back-end of the fuel cycle for spent fuel from domestic non-power generating reactors is defined by a contractual agreement [II.41] to return them to the Russian Federation in such a way that the secondary wastes generated during the reprocessing remain in the Russian Federation.

Management of high level waste

According to the National Policy, the final disposal of high level radioactive waste must be done in Hungary, in a repository to be established in a stable, deep geological formation. The primary consideration in the selection of the storage site as well as in the construction of the repository shall be that the site, the bedrock and the technical solutions adopted, matching the properties of the deposited waste, jointly provide isolation of the waste from the living environment, until the required period of time.

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 their temporary storage at the plant in limited quantities is also possible. 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 RWTDF was commissioned in 1976. It is situated at Püspökszilágy 40 km north-east of Budapest (see Figure B.2.1-1). The repository is a typical near-surface facility, composed of concrete trenches (vaults) and shallow wells for spent sealed sources.

Figure B.2.1-1 Sites of importance in Hungary

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

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

According to the geological investigations, it is not possible to expand the RWTDF in Püspökszilágy for the disposal of the waste originating from the operation and decommissioning of Paks Nuclear Power Plant. So 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 RWTDF was increased with the financial support of the power plant. The total capacity of the repository is now 5040 m^3.

In its decision of 3 June 2014, the Public Health Professional Administration Organization of the Government Office of the Capital City Budapest granted permission to PURAM to operate a final radioactive waste repository at the Püspökszilágy facility until 3 June, 2024, and to *operate a temporary storage facility until 3 June, 2019. From 1 July, 2014 regulatory oversight of radioactive waste storage facilities is carried out by the HAEA. At the same time, the safety requirements have changed, requiring the RWTDF to request the HAEA to issue a new, uniform operating license in 2016. The regulatory assessment of the license application has not yet been concluded.*

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. This way the repository – which reached full 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 in Section H and K.

National Radioactive Waste Repository

Since the expansion of the RWTDF to the extent that would satisfy the total needs of the Paks 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 relevant requirements. 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 a part of solid waste from Paks Nuclear Power Plant in 2008. The competent Radiation Health Centre of the National Public Health and Medical Officer Service (hereinafter: NPHMOS) granted license for commissioning the NRWR on 25 September 2008; the scope of the license also covered the operation of the above surface facilities.

The first two disposal chambers were completed by the end of 2011 (I-K1, I-K2), the licensing authority granted the operating license for the above surface facilities and the I-K1 shaft. The license became legally binding on 10 September, 2012. Since then, further construction of the underground structures has been going on in parallel with the final disposal of waste into chamber I-K1. The currently available storage capacity of the repository is 4833 drums, while the surface buffer storage can hold 3000 pieces of 200 litre drums.

Expansion of the NRWR is carried out simultaneously with the operational activities in the controlled area on the basis of the license issued by the Public Health Professional Administration Organization of the Tolna County Government Office. *Both, the construction and operation activities are supervised by the HAEA since 1 July, 2014. Construction of the reinforced concrete basin with the related technology systems in chamber I-K2 will be completed in 2017.*

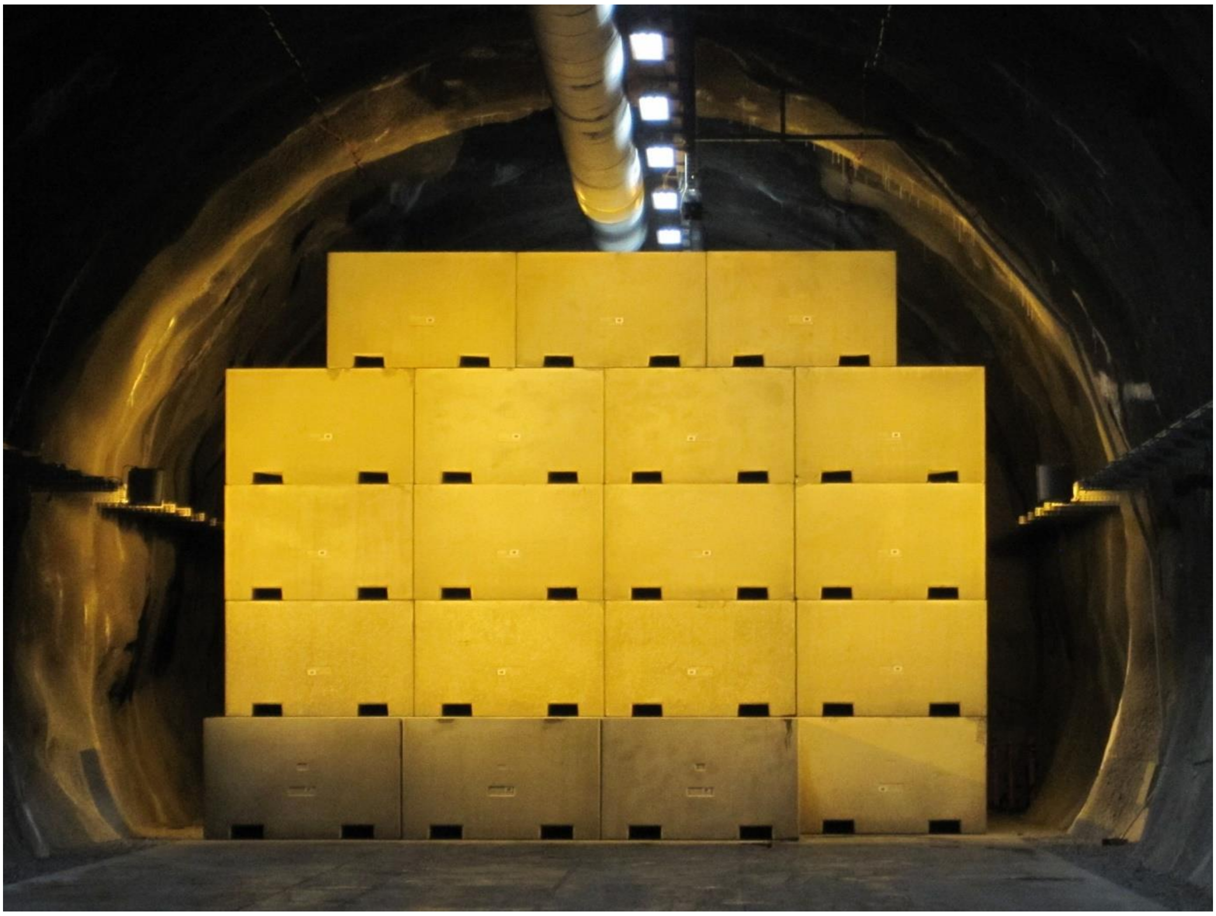


Figure B.2.1 – 3. Containers disposed in the I-K1 chamber of the National Radioactive Waste Repository

Further details about the repository as well as the construction works are given in Annex 2 and in Section H.

B.2.2 Long-term policies

According to the National Policy, the final disposal of low and intermediate level radioactive waste generated in Hungary is to be carried out in radioactive waste storage facilities in Hungary.

Radioactive Waste Treatment and Disposal Facility

Improvements made to the storage capacity and safety of the storage facility will enable the final disposal of institutional waste for several more decades.

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 NRWR. Closure of the repository is not planned prior to decommissioning of 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 2001 by an act [I.10] that requires the fulfilment of all the obligations of the Convention.

As to the scope of application – referred to as 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 primarily as a consequence of the operation of Paks Nuclear Power Plant. In addition, the BRR and the Training Reactor contribute to the generation of spent fuel.

In Hungary, a single facility is used for the temporary storage of nuclear spent fuel, the SFISF. 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 spent fuel originating from the Paks Nuclear Power Plant*

The four units of Paks Nuclear Power Plant are fuelled with fuel assemblies of VVER-440 type. *The typical enrichment rate is 3.82%, 4.2% and 4.7%.* Based on our present knowledge, along with the consideration of the 20 year service life extension, *as well as the introduction of a 15-months fuel cycle*, 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 17,717, with approximately 2,101 t heavy metal content. Previously, between 1989 and 1998, altogether 2,331 spent fuel assemblies with 273 t heavy metal content were shipped back to the Soviet Union (later to the Russian Federation).

As a result of improvements made to the nuclear fuel used by the Paks Nuclear Power Plant, the burn-up level of the fuel could be increased, along with the length of the fuel cycle, thus reducing the estimated number of spent fuel assemblies generated during the planned life time of the plant.

On 31 December 2016, 1,800 fuel assemblies were stored in the spent fuel pools of the Paks Nuclear Power Plant while 8,707 fuel assemblies were in the SFISF.

At the end of 2016, the total capacity of the SFISF was 9,308 assemblies in 20 chambers. The extension of the storage facility is in progress with preparation for the commissioning of four new chambers. In order to provide storage capacity for every spent fuel assembly remaining in the country, the storage capacity must be increased. At the end of 2016 the amendment of the valid construction license was in progress, which as a result of a denser the grid layout, containing the planned commissioning of 33 chambers instead of the originally planned 36 (see Section K.1 and G.1)

68 storage canisters stored in the spent fuel pool of Unit 2 were transported to the Russian Federation in 2014 (these canisters contained the parts of the 30 fuel assemblies that were damaged during the cleaning process in April 2003).

Activities are in progress on extending the planned 30-year life-time of the Paks Nuclear Power Plant by 20 years. *The HAEA granted the operation license for Unit 1 in December 2012, for Unit 2 in December 2014, and for Unit 3 in December 2016, which are valid until the end of 2032, 2034 and 2036 respectively.* The service life extension and the introduction of a 15-months fuel cycle have an effect on both the amount and the management of radioactive waste and spent fuel. In harmony with the 16th Medium and Long Term Plan of PURAM (see Chapter

E.1) the present national report takes into consideration the consequences of the service life extension as well as the 15-months fuel cycle.

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

Currently, the BRR operates using 190 VVR-M2 type fuel assemblies with an enrichment of 19.75%. The fuel with an enrichment level of 36% was repatriated to the Russian Federation.

In total 114 spent fuel assemblies are stored on site having about 29 kg of heavy metal. *The reactor currently has an operating license valid until 2027; thus, from the end of 2016 until the end of the license, approximately an additional 600 VVR-M2 spent fuel assemblies can be expected (approximately equivalent to 150 kg heavy metal content).*

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 radioactive waste management facilities, these are the RWTDF and the NRWR. The main characteristics of these facilities are described in Section B, their safety in Section H and Section K; further details are contained in Annex 2.

D.2.1 Classification of radioactive waste

The relevant ministerial decrees [III.9] and [III.13] 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 specify more detailed categorization for the low, intermediate and high level radioactive wastes.

Further 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 government decree [II.36] in accordance with the regulations of the European Union. The procedure of clearance from regulatory control is also regulated by this government decree [II.36]. The referenced government decree distinguishes three cases, according to which, substances containing radionuclide can be released from regulatory control, if:

- activity concentration decreases below the general exemption value, or
- activity concentration or activity decreases below the specific exemption value, provided that the mass of the radioactive material is less than 1 ton, or
- its reprocessing, reuse or disposal as non-hazardous waste (including burning) does not induce an individual annual dose to any member of the public exceeding 30 μSv effective dose.

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 2016, approximately 102 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 however 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. Therefore, it is expected that between 2030 and 2035 storage capacity will need to be freed up by removing the low and intermediate level waste content from high level waste containing such material.*

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, 3783 shipments were carried out from 643 different consignors to the RWTDF. The low and intermediate level radioactive waste generated by the non-fuel-cycle producers and accepted until the end of 2005 occupied 2,540 m^3 repository volume. Between 1983 and 1996 the Paks Nuclear Power Plant shipped 1,580 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; storage pools for final disposal of waste became full at the end of 2005. Between 2005 and 2013 the wastes were primarily stored in the interim storage area constructed in 2004, *where 159 m^3 wastes were stored at the end of 2016.* In order to further increase the capacity of temporary storage, the classification of Type-A storage pools 65 and 66 was changed to temporary storage, *where at the end of 2016, 44 m^3 waste was stored. At the end of 2016 the total activity of the radioactive wastes in the repository was 313 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 RWTDF 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 SFISF 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 Paks 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 residue produced *up to 31 December 2016 was 7,134 m^3, of which 160 m^3 was generated during 2016*. There are 6,614 m^3 of evaporation residue at the site of the Paks Nuclear Power Plant, as the processing of 520 m^3 evaporation residue took place over the last few years, using Liquid Waste Processing (LWP) technology. The total volume of evaporation residues includes the *2119 m3* evaporation residues – containing alpha emitters – produced *until 31 December 2016* in consequence of the serious incident at Unit 2 in April 2003, the temporary storage of which takes place in separate tanks from the other concentrates. The expected annual volume of evaporation residue based on the current generation rate will be 250 m^3/year, which, over the originally planned 30 year lifetime result in 7,400 m^3 of evaporation residue. Considering the 20 year service life extension, altogether 11,950 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 *2016*; *thus as of 31 December 2016* 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 481 m^3.

The total quantity of resins used up to *31 December 2016 was 226 m^3, of which 9.2 m^3 was generated during 2016.* 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 taking also into account the final unload of the ion exchange columns, the total volume till the end of the 50 year service life will be 459 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 2003 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.

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).

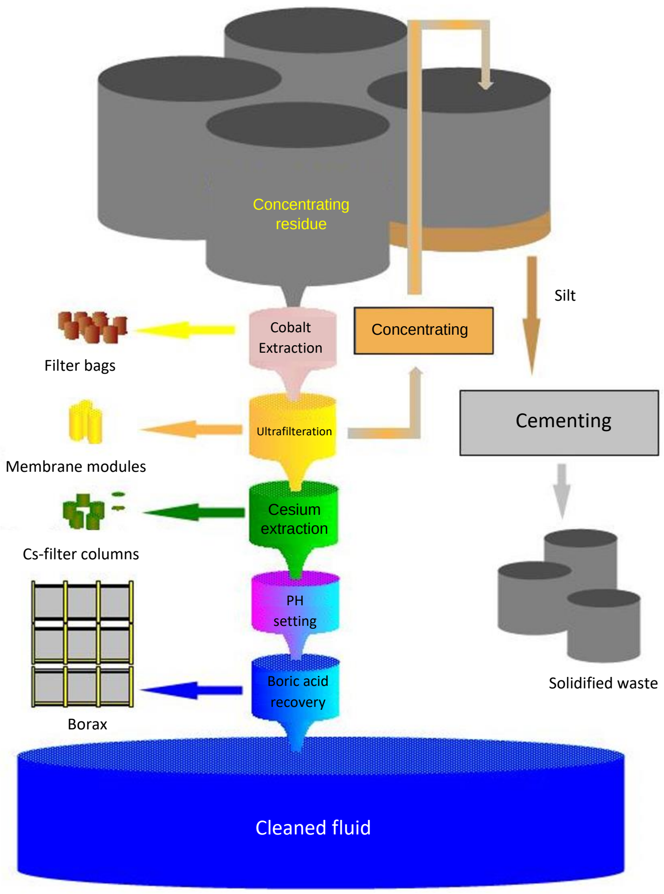


Figure D.2.4 - 1. Steps of the LWP technology

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. Based on the experience gained so far, some 80-85% of the total solid radioactive wastes can be compacted.
- To reduce the volume of compactable radioactive waste, a 500 kN press is used, achieving an average reduction factor 5.
- 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.
- Solid waste, including aerosol filters and solidified sludge, is loaded uniformly into special 200 l metal drums (internally coated with plastic).

Figure D.2.4 – 2. Waste compressor machine

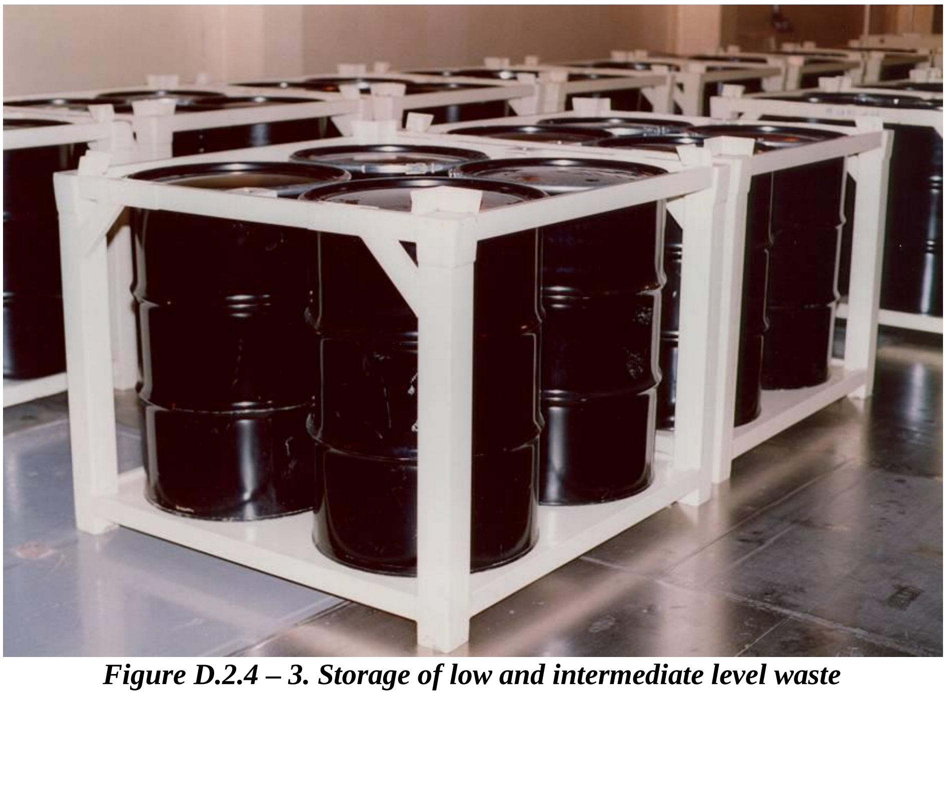


Figure D.2.4 – 3. Storage of low and intermediate level waste

Until 31 December 2016, a total of 6,536 drums were transported from the Paks Nuclear Power Plant to the NRWR. Of these, 4383 were put into chamber I-K1 for final disposal. As of 31 December 2016, 9175 drums of low and intermediate level solid radioactive waste are stored in the interim stores of the power plant. Based on the current rate of waste generation, the annual volume is expected to be 850 drums of 200 l capacity.

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 *1.8* m^3 size containers	number of *3.6* m^3 size containers
20 year long protected preservation of the primary circuit	9,147	2,846

The estimated gross volume of decommissioning and operational HLW to be disposed in the deep geological repository is 300 m^3.

Section E. Legislative and Regulatory System

E.1 Legislative and regulatory framework

The Hungarian Parliament adopted the Act on Atomic Energy [I.6] in December 1996, which entered into force on 1 June 1997. The codes and guides of the IAEA provided the basis for the establishment of the Act, and recommendations of the European Union and the OECD Nuclear Energy Agency (hereinafter referred to as OECD NEA) were also considered.

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

- 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 HAEA and the responsible ministers;
- defines the regulatory competences of the HAEA and of the minister responsible for health in 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 HAEA;
- 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 HAEA 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 (required 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 a national interest – an organisation responsible for the final disposal of radioactive waste, the interim storage of spent fuel assemblies, the back-end of the nuclear fuel cycle, and for the decommissioning of nuclear facilities;
- provides the establishment of a Central Nuclear Financial Fund (hereinafter referred to as CNFF) intended solely for financing the final disposal of radioactive waste, the interim storage of spent fuel assemblies, back-end of the fuel cycle, and for the decommissioning of nuclear facilities;
- provides 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.

The Act on Atomic Energy [I.6] states that radioactive waste management facilities (e.g. repositories) are by definition, not considered as nuclear facilities.

Concerning radiation protection, the Act on Atomic Energy [I.6] continues to share regulatory responsibilities among several ministries, *but from 1 January 2016, radiation protection* *functions and statutory provisions ([I.6], [II.10], [II.18], [II.21], [II.30], [II.36], [III.2], [III.3], [III.4]) related to the regulatory systems have been amended, which define the scope of radiation health and radiation protection tasks. The primary oversight functions of radiation protection have been assigned to the competence of the HAEA, while radiation health remained in the competence of the Minister responsible for public health. Therefore the competent radiation health authorities of the capital city and county government offices (hereinafter referred to as government offices) continue to act in matters of radiation protection related to radiation health and health services. However, radiation protection of workers and the general population is carried out by the HAEA in accordance with the new legislation [II.36]. Protection of the environment, including the general regulation of releases, belongs to the minister responsible for environmental protection. The Operational Limits and Conditions, approved by the HAEA, include the derived limits of radioactive releases from the operation of nuclear facilities. Tasks related to the radioactivity of the soil and flora belongs to the scope of the minister responsible for agriculture.*

The changes in the competence of the HAEA resulted in numerous changes in the legal system. Three new government decrees [II.36], [II.37], [II.38] entered into force related to radiation protection tasks. These regulations were necessary in order for the fulfilment of tasks transferred from the competence of the Minister responsible for public health, as well as to ensure compliance with Council Directive 2013/59/EURATOM on laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom. National regulations must comply with the latter Directive by 6 February 2018.

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]. 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.

Hungary is party 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

Hungary is nearing the completion of the 20 year service life extension of the units of the Paks Nuclear Power Plant.

The environmental protection license was issued by the competent authority in 2006. Following an appeal, on 31 January 2007 in its ruling, the National Inspectorate for Environment, Nature and Water upheld the first instance decision. The Baranya County Court ruled on the request to a judiciary redress on 5 December 2007, and the environmental permit became legally binding. In accordance with the government decree [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 for an additional 20 years. The HAEA accepted the programme in a decision and continuously monitors its implementation until the final conclusion of activities related to the service lifetime extension. One year prior to the end of the design service life the licensee had to 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.24], 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.

Continued operation of Unit 2 of the Paks Nuclear Power Plant until 31 December 2034 was requested by the licensee in October 2013 in its submission. *The 20 year service life extension of Unit 2 was approved by the HAEA in November 2014. Continued operation of Unit 3 of the Paks Nuclear Power Plant until 31 December 2036 was requested by the licensee in December 2015. The 20 year service life extension of Unit 3 was approved by the HAEA in December 2016.*

The design service life of Unit 4 expires on 31 December 2017. The licensee applied for the 20 year service life extension in November 2016. The documentation supporting the application is now under assessment by the HAEA. The duration of the proceedings is 6 months, which may be extended one time by the head of the acting authority by up to 90 days. Certain procedural actions (e.g. co-authority proceedings, supplementation) do not count towards the proceeding's deadline. The environmental protection authority participates as co-authority in the proceedings. The HAEA also holds public hearing as part of the procedure. The procedure is expected to close in December 2017.

The licensee also holds a producer license for Units 1-3 valid for an additional 20 years, issued by the Hungarian Energy and Public Utility Regulatory Authority.

E.1.1 Spent fuel management

The nuclear safety code entitled "Interim Storage of Spent Fuel" was issued in the government decree [II.24] which entered into force in 2011. The application of the safety code is supported by guidelines. There are 10 guidelines to the nuclear safety code that relates to the spent fuel storage facilities with dry storage; additional guidelines are elaborated as appropriate.

E.1.2 Radioactive waste management

Interim and final storage of radioactive storage is regulated by the government decree [II.35], which entered into force in 2014. There are 8 guidelines available to support the application of the decree and additional guidelines will be elaborated as required.

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 HAEA (see government 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.

Independence of the HAEA is guaranteed by the provisions of the Act on Atomic Energy; decisions made in its oversight competence cannot be altered or annuled. *Taking into account the recommendations of the 2015 IRRS mission, the Government strengthened the independence of the HAEA through the following measures in the Act of Atomic Energy [I.6]:*

- *The income of the HAEA, except for those from fines shall be used for its operation and it shall not be diverted for other purposes.*
- *The salary of government officers working at the HAEA was made more competitive.*
- *The Act authorized the Director-General of the HAEA to define the fringe benefits of the government officers of the organization.*

Overall, the HAEA as an authority independent from the organization responsible for the management of spent fuel and radioactive waste is ensured.

Regulatory licensing (at facility, system and system-component level), inspection and evaluation and analysis of the nuclear safety of nuclear facilities and radioactive waste repositories, regulatory licensing and inspection of civil structures connected to nuclear facilities and radioactive waste repositories, and regulatory licensing of elevators of these civil structures, designation and review of the safety area of nuclear facilities and radioactive waste repositories, regulatory licensing and inspection of design, operation and modification of physical protection systems of nuclear facilities, radioactive waste repositories, radioactive sources and radioactive wastes, inventory for and control of nuclear and other radioactive materials as well as the licensing of related shipments and packaging designs, participating as co-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 most significant form of communication activities of the HAEA is the annual report on the safe use of nuclear energy, submitted annually to the Hungarian Parliament. The HAEA engages the public about the most important aspects of the safe use of nuclear energy in Hungary through regularly updated Hungarian and English language website (www.haea.gov.hu), press conferences and press releases.

The HAEA is constantly striving to provide full information to the professional as well as lay audiences interested in nuclear safety issues. As part of this process, the HAEA regularly makes known its resolutions, publishing their short, concise summaries. A list of the resolutions is available on the HAEA's website. The HAEA is committed to inform the general public about issues of nuclear safety of public interest. To this end, the HAEA publishes the results of the regulatory assessment of incidents registering as Level 1 or above on the International Nuclear and Radiological Event Scale (hereinafter referred to as INES) and of other reporting events relevant to the press. The HAEA keeps regular contact with media representatives; over 50 journalists and media participants attend the annual press conferences held at the beginning of the year.

To facilitate transparency of the regulatory proceedings, the Act on Atomic Energy [I.6] obliges HAEA to organise public hearings during proceedings related to the life cycle of nuclear facilities and radioactive waste repositories, i.e. siting, commissioning, operation and decommissioning. During the public hearings, the public can acquaint themselves with the subject, purpose and procedure of the licensing process; can pose questions about the proceeding, to which answer must be given, otherwise the proceeding cannot be concluded.

The Association of Hungarian Professional Journalists organized, in cooperation with the HAEA, the Nuclear Journalist Academy, which aimed at supporting the participating journalists giving objective and professional information on the peaceful use of nuclear energy. The HAEA pays particular attention to the work of the Association.

The HAEA continued its long-standing tradition of organizing, the semi-annual conference entitled "About nuclear energy to everybody" together with the TIT Studio Association. In 2016, the HAEA reviewed the format of the conference and in order to make the event more successful and provide a better experience to students altered its image and content. Starting in 2017 the conference will be held on the basis of this new concept.

The HAEA strives to provide more information about its activities, annually publishing a colourful, illustrated information booklet about the safe use of nuclear energy in Hungary. Furthermore, every six months it also prepares a bulletin in English about current industry news, which is available on the website of the HAEA. *Starting from 2017 the bulletin will also be available in Hungarian.* In addition, the HAEA also informs the public on key issues related to the safe use of nuclear energy through organizing press conferences and issuing press releases.

Continuously developed internet based information service is a key part of the HAEA's public information policy, both through its own website and on Facebook. In addition to other information materials, English and Hungarian versions of National Reports are also available on the HAEA's website.

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 HAS CER, the BUTE INT, the Nuclear Safety Research Institute, and with the SOM System Ltd.

In accordance with the Act on Atomic Energy [I.6], the work of the Authority is also supported by a Scientific Council that is composed of members 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.

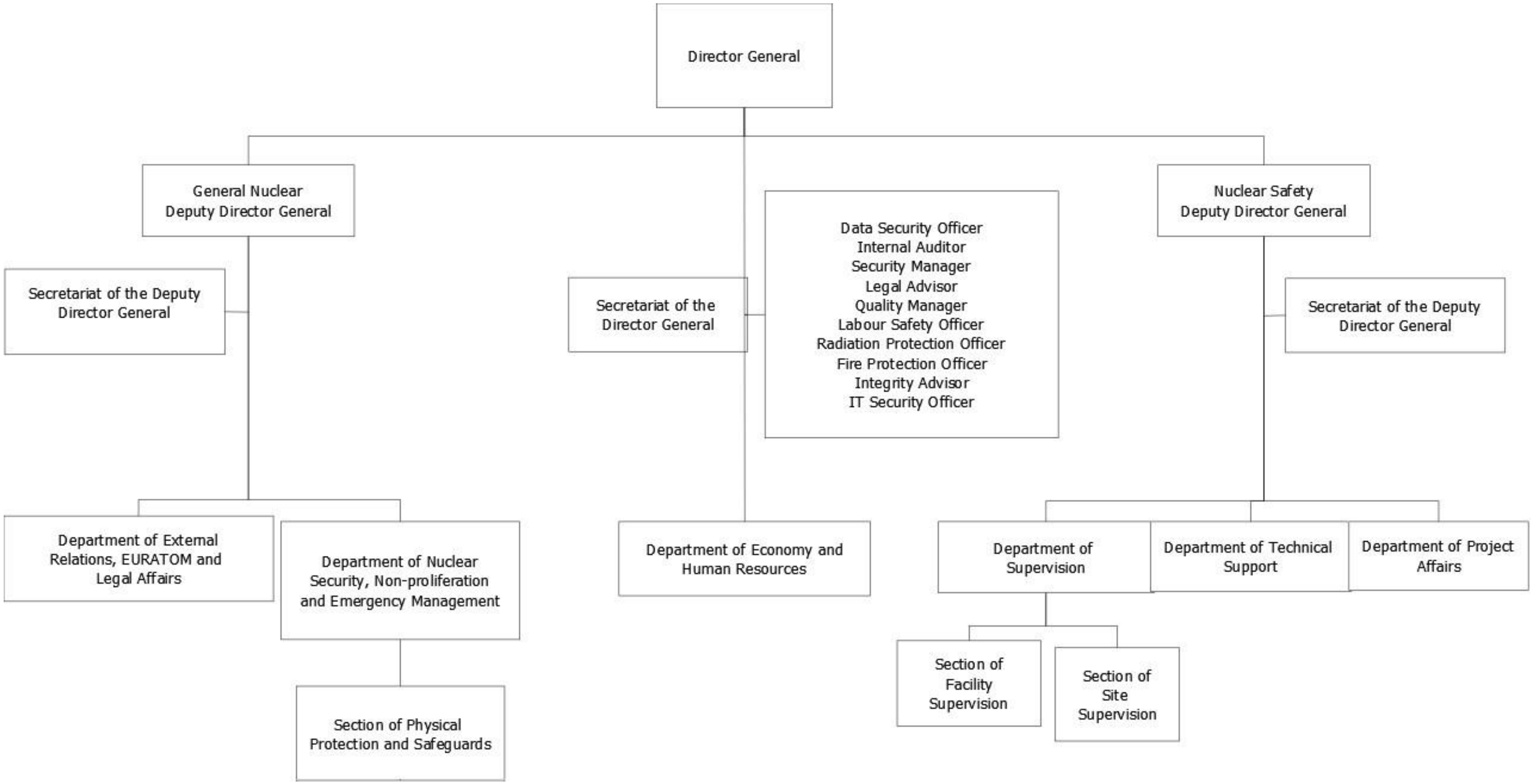


Fig. E.2.1-1 Organisational structure of the Hungarian Atomic Energy Authority

E.2.2 The public health administration bodies

Until 31 December 2015, functions related to radiation health (radiation protection of the general population and workers, public health and radiation health related functions) were being carried out by the Radiation Health Centres of the regionally competent capital or county government offices working within the Public Health Administration Organization (as of 1 April 2015, the regional radiation health authorities of the National Public Health Departments of the capital or county government office) and the Office of the Chief Medical Officer of the National Public Health and Medical Officer Service (hereinafter referred to as OCMO NPHMOS) according to the relevant government decree [II.30] and ministerial decrees [III.3 and III.9].

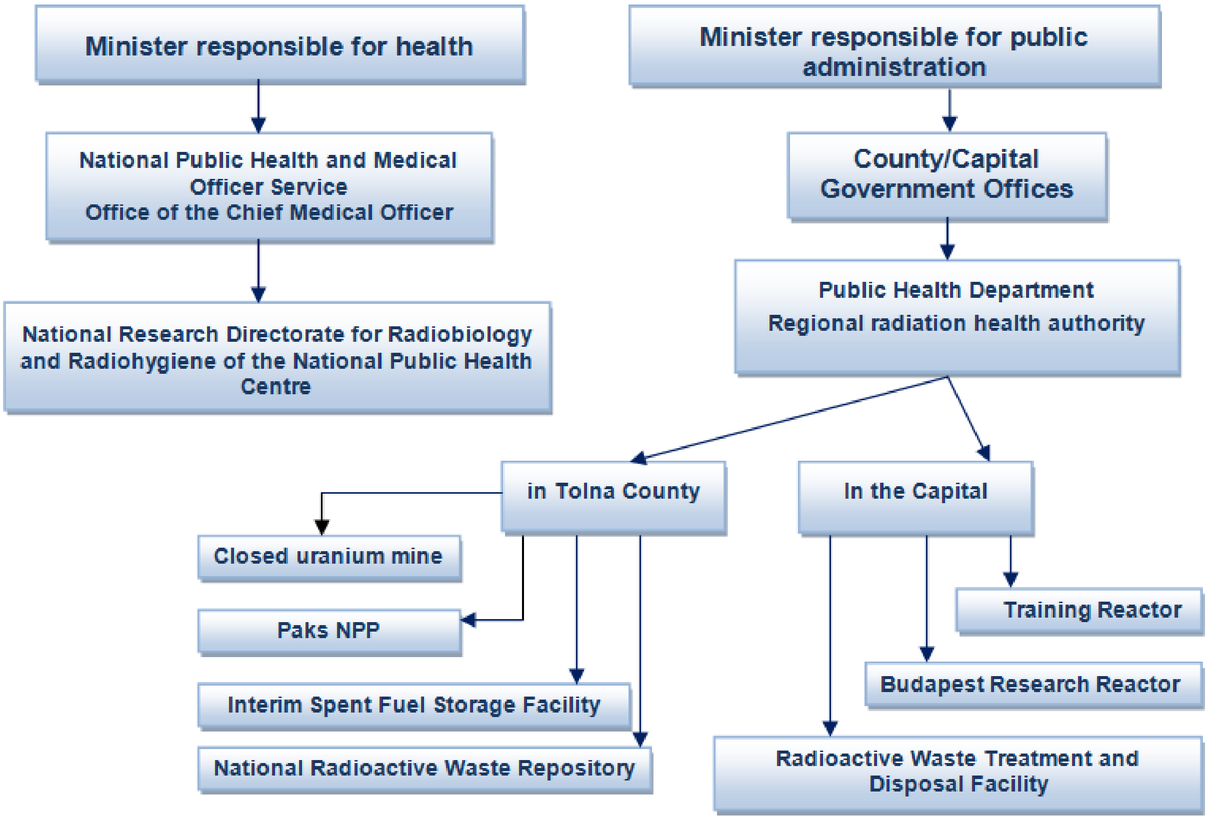


Figure E.2.2-1 Structure of the radiation health authorities and their supervisory system until 31 December 2015

The national expert and regulatory body, the Office of the Chief Medical Officer (hereinafter referred to as OCMO), was the licensing authority of the radiation protection regulation and of the radiation health departments of special facilities until 31 December 2015. OCMO continues to participate in the nuclear safety licensing procedure as the co-authority of matters related to radiation health. One of the institutions of the NPHMOS, the "Frédéric Joliot-Curie" National Research Institute for Radiobiology and Radiohygiene (since 3 April 2015, the National Research Directorate for Radiobiology and Radiohygiene of the National Public Health Centre (hereinafter referred to as NRDRR NPHC) maintained the personal dosimetry service until 31 December 2015 (this includes the evaluation of the compulsory authority personal dosimeters and operation of the national personal dosimetry register, the coordination of this task was overtaken by the HAEA on 1 January 2016, and the activity is *carried out by the NRDRR NPHC as a contractual partner of the HAEA). Until 31 December 2015 the regional radiation health authority of the Tolna County Government Office Public Health Department was authorized to supervise correspondence (including inspections as well) to radiation health rules and regulations during 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] (see also E.3.2). The HAEA 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

Until 30 June 2014, the regionally competent Radiation Health Centres working within the Public Health Professional Administration Organizations of the Capital and County Government Offices, and the OCMO NPHMOS, with expert advice and technical assistance provided by the National Research Directorate for Radiobiology and Radiohygiene performed the licensing procedures.

On the basis of the amendments of the Act on Atomic Energy [I.6] and its related implementing decrees, from 1 July 2014, in the case of radioactive waste repositories, the regulatory system in matters related to safety aligned to those for nuclear facilities, and the main licensing and supervisory authority in the case of these facilities, too became the HAEA.

A nuclear safety license must be obtained for the site assessment, construction, installation, operation, closure, transition to institutional monitoring of the radioactive waste repository, as well as for the modification of the systems and system components of the storage facility.

Furthermore, the regulatory body issues construction and occupancy licenses for buildings and structures.

In the licensing procedure several other relevant public administration organisations participate as co-authorities. *The co-authorities and the issues to be addressed by them are determined by the annex of a government decree [II.21]*.

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 (hereinafter referred to as NPH) takes part as a co-authority.

E.4 Oversight

The Act on Atomic Energy stipulates that nuclear energy can be deployed only in the way defined by law, and with regular oversight 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 HAEA is entitled to perform inspections either with or without advance notice.

In addition to the HAEA's inspection activities, the special co-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 HAEA annually evaluates the safety performance of the licensees of nuclear facilities and radioactive waste repositories 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 and radioactive waste repositories 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 (hereinafter referred to as PSR) process, which is mandated by Act on Atomic Energy. 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 HAEA (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 sized bigger than 10^{14} Bq total activity and for spent fuel interim storage facilities.

In the field of radioactive waste management, *until 30 June 2014, regular inspections and surveillance of licensees were carried out by the regionally competent Radiation Health Centres working within the Public Health Professional Administration Organizations of the Government Offices. Since 30 June 2014, these tasks are carried out by the HAEA.*
Furthermore, HAEA checks the licensed modifications and any extraordinary events. The objectives of inspection and surveillance are to:

- check compliance with *nuclear* safety;
- check compliance with the specified conditions;
- perform in situ radiation surveys;

Results of environment monitoring of nuclear facilities and radioactive waste repositories are also published in the annual reports of the National Environmental Radiological Monitoring System (hereinafter referred to as NERMS) set up by government decree [II.20]. (These annual reports are accessible on the internet, on the websites of the NRDRR NPHC and HAEA.)

Legislation [II.20] governing the operation of the NERMS was amended on 1 January 2016, according to the new government decree [II.37] coordination activities of the NERMS is performed by the HAEA.

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.13] that entered into force 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 [I.11], in the Penal Code [I.2], and in government decrees [see Annex IV Section II].

In order to enforce the requirements of the regulations the authority is entitled to initiate a procedure of its own motion 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

The Act on Atomic Energy [I.6] and its implementing decrees make the licensee responsible for the safe use of atomic energy and the fulfilment of safety related requirements. In the context of the Convention [I.10] this means that primary responsibility for the safety of spent fuel and radioactive waste management rests with the licensee of the relevant operating licences of the spent fuel and radioactive waste management facilities, i.e. PURAM.

PURAM 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 CNFF each year;
- development of proposals on the National Policy and National Programme related to the 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 interim and final storage and disposal of radioactive wastes and their establishment;
- construction (extension) and operation of the SFISF for interim storage of spent nuclear fuel;
- 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 RWTDF;
- operation and expansion of the nuclear power plant originated low and intermediate level waste repository, the NRWR;
- informing the public and maintaining of public relations.

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

- to establish the technical, technological, financial and human conditions for the safe operation of the facilities;
- to elaborate a safety policy which reflects implementation of the principle that safety prevails over all other considerations;
- to elaborate, introduce and maintain an appropriate 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 harming 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 service which plans and controls all actions and measurements necessary to meet the basic principles of radiation protection;
- to maintain (regulatory and/or its own) system of dosimetry control;

- to define 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 HAEA;
- to determine the planned discharges for normal operation;
- to ensure compliance with the annual discharge limits;
- to continuously monitor radiation levels and concentrations of the radionuclides in the environment and provide the general public with relevant information;
- to maintain an appropriate organisation which is capable of accomplishing each and every specified periodic and event reporting obligation in due time (including categorisation of all events according to INES);
- to ensure that the evaluation, the qualifications, and health of the employees are in line with the specified requirements;
- to carry out continuous activities in order to maintain the highest possible level of safety through continuous improvements, including evaluation of all relevant own and international 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 the existence of a quality management system described in the Act on Atomic Energy 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 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, and multilateral and bilateral agreements.

As a means of regulating responsibilities and measures for *all missing, found or* seized nuclear and other radioactive materials (spent fuel and radioactive wastes included) a government decree [II.9*, as of 1 January 2016: [II.38]* is in force to regulate competences and activities.

According to the government decree [II.29] the licensee should:

- 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 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 HAEA *has doubled in 2016, reaching 164 people*, *95%* of whom 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 *82%* of them have state level certificate from one or more foreign languages.

A systematic education plan has been introduced by the HAEA for training their inspectors. The plan is based on individual training profiles, consisting of three basic training types: tutorial training, level training, and advanced courses, external 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 HAEA, the Act on Atomic Energy [I.6] designates three 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 HAEA in the way and to the extent defined in the Act on Atomic Energy [I.6].
- administration fee shall be paid for the procedures carried out by the HAEA.

For the year 2016 it can be stated that the HAEA received a substantial amount of budgetary support to cover the additional cost of the staff increase. In 2016, the ratio between budgetary support and revenue generated almost equalled (40%-60%).

The HAEA performs its regulatory activities impartially, independently of the nuclear facilities, and its funding ensures that it can carry out its duties efficiently.

F.2.1.2 The public health administration bodies

In Hungary, the licensing and oversight of radioactive waste management fell under the competence of the regionally competent Radiation Health Centres working within the Public Health Professional Administration Organizations of the Government Offices and the OCMO NPHMOS (health administration organizations) [II.30] until 30 June 2014.

The public health administration bodies – as authorities – are independent from the sphere of the licensees. In 7 regional radiological centres some 43 well-qualified experts were employed in the field of radiation protection. Each centre was supplied by appropriate radiation measurement instruments and well-equipped laboratories.

In 2015, based on the government decree [II.30] tasks related to radiation protection and radiation health in the workplace were performed by the national public health departments of the government offices, as the regional radiation health authorities (previously Radiation Health Centres). The expert management of the national public health departments of government offices was carried out by the OCMO NPHMOS also involving the NRDRR NPHC.

The regulatory tasks are supported by the National Research Directorate 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.

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 carry out tasks related to the final disposal of radioactive waste, interim storage of spent fuel, back-end of nuclear fuel cycle and the decommissioning of a nuclear facility. Based on this, the Government authorized the Director General of the HAEA to establish such an organisation (see Section B). The so established PURAM performs the public tasks as listed in the Act on Atomic Energy 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].

The central offices of PURAM are located in Budaörs, close to Budapest. The management and administrative activities within each directorate are performed at Paks. The NRWR is located in Bátaapáti, while the RWTDF in Püspökszilágy. *215* employees work at four sites, including *86* security guards. The operation and maintenance of the SFISF is performed by the staff of the Paks Nuclear Power Plant on a contractual basis under the direction of PURAM.

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

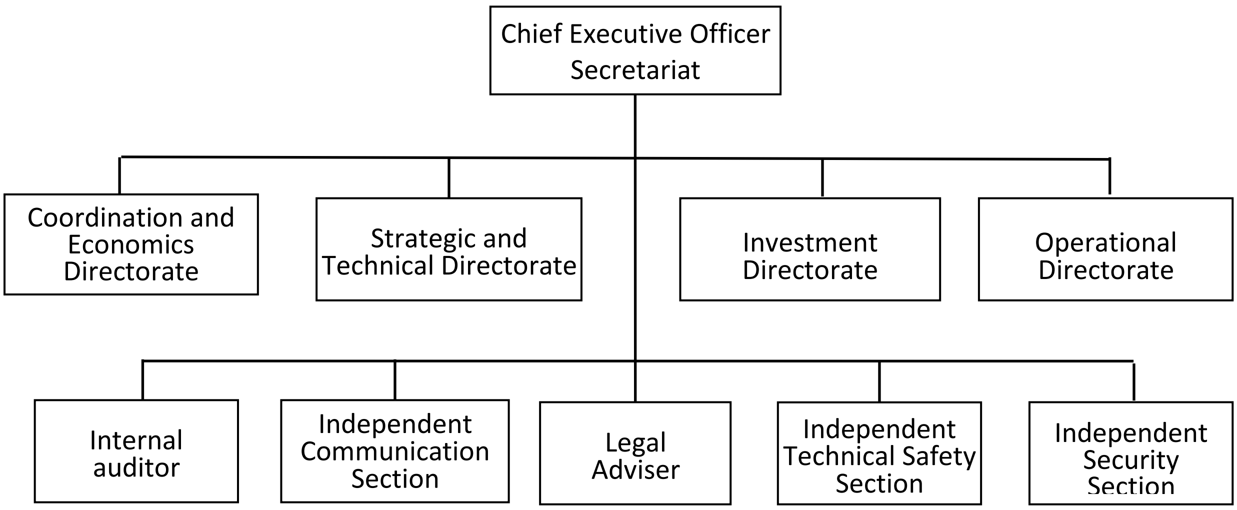


Figure F.2.2.1-1 Organizational chart of PURAM

The special professional education and training of the employees working at the SFISF is governed by a *ministerial decree [III.16]*.

F.2.2.2 Financial resources

As required by the Act on Atomic Energy [I.6], the Minister supervising the HAEA disposes over the use of the CNFF 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 31 December 2013 the HAEA 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 PURAM 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 Nuclear Power Plant to the Fund are proposed by the minister supervising the HAEA. Due payments are based upon submittals prepared PURAM preliminary assessed by the HAEA from a professional aspects, to which the Central Nuclear Financial Fund Special Committee, supporting the work of the Minister shall develop a preliminary opinion.

The institutes disposing radioactive waste in the RWTDF 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 BRR and the Training Reactor), the sources required to cover payments into the Fund are provided by the central budget, when necessary.

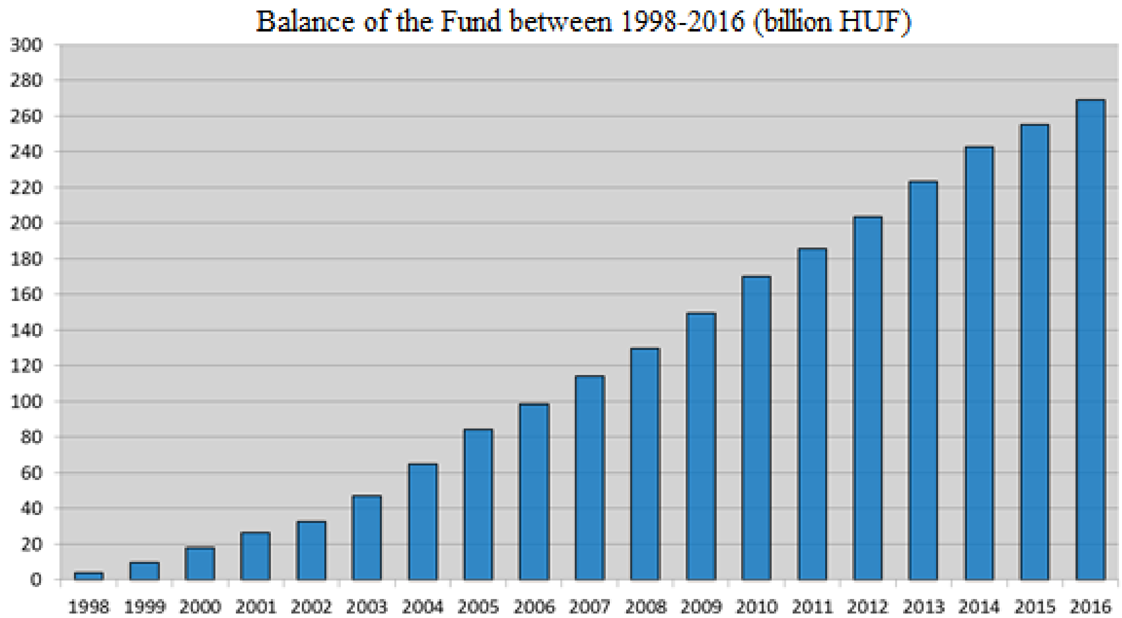
The rate of payments into the Fund shall be specified in such a way as to provide appropriate sources for all costs of management of radioactive wastes and spent fuels and of the decommissioning of nuclear facilities. These sources also provide coverage for supporting the municipal associations aimed 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 municipal associations aimed at public control and information purpose.

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 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 2016*

	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
2014	*32 226.2*	*12 493.2*	*19 733.0*
2015	*27 629.0*	*15 491.3*	*12 137.7*
2016	*26 774.0*	*12 874.1*	*13 899.9*



Change of the balance of the CNNF

The assets of the Fund amounted to 269.0 billion HUF as of 31 December 2016 (please note the exchange rate on 31 December 2016: 1 Euro = 311 HUF).

F.3 Quality assurance

All organizations dealing with spent fuel management and the temporary or final storage of radioactive waste are obliged by the Act on Atomic Energy [I.6] and the relevant governmental decrees [II.24, II.35] to operate under an appropriate quality management system. The requirements for the operation of the integrated quality management of nuclear facilities are included in Volume 2 of the Nuclear Safety Code, published as annex to government decree [II.24]. In the case of for radioactive waste repositories the requirements are included in Volume 1 of the Repository Safety Code, published as annex to government decree [II.35]. 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 HAEA is authorized 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).

PURAM developed a Quality Management System based on ISO 9001:2009 and an Environmental Management System based on ISO 14001:2005 standards, into which it already integrated the relevant requirements of Volume 2 of the Nuclear Safety Code and continuously integrates the relevant requirements of government decree [II.35]. Their introduction and continuous operation is regularly audited by an accredited auditor organization.

Furthermore it is worth mentioning that the HAEA was one of the first Hungarian public administration bodies to introduce and certify its own quality management system based on the MSZ EN ISO 9001:2001 (ISO 9001:2000) standards. Certification of the standard must be renewed every three years and a supervisory audit is also carried out. *As a result of the successful renewal audit in 2015, the certificate is valid until March 2018.*

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 Section E demonstrated above, 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 [III.3] *(until 31 December 2015) and government decree [II.36] (from 1 January 2016).* 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.6] 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 define the annual release limits as well as the planned release levels from the dose constraint specified by the OCMO or the HAEA. In accordance with the characteristics of the facilities, the dose constraint for Paks Nuclear Power Plant and for the planned new units is 90 μSv/year separately, 10 μSv/year for the SFISF, 100 μSv/year for the RWTDF and the NRWR, 50 μSv/year for the BRR, 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 (hereinafter referred to as 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 statuses of the NERS. It can be concluded that an up-to-date decree was created, and it provides a basis for the more effective operation of the NERS.

NERS 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 (hereinafter referred to as 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 leaders of the central state administration bodies participate as advisors in the meetings of the Committee.

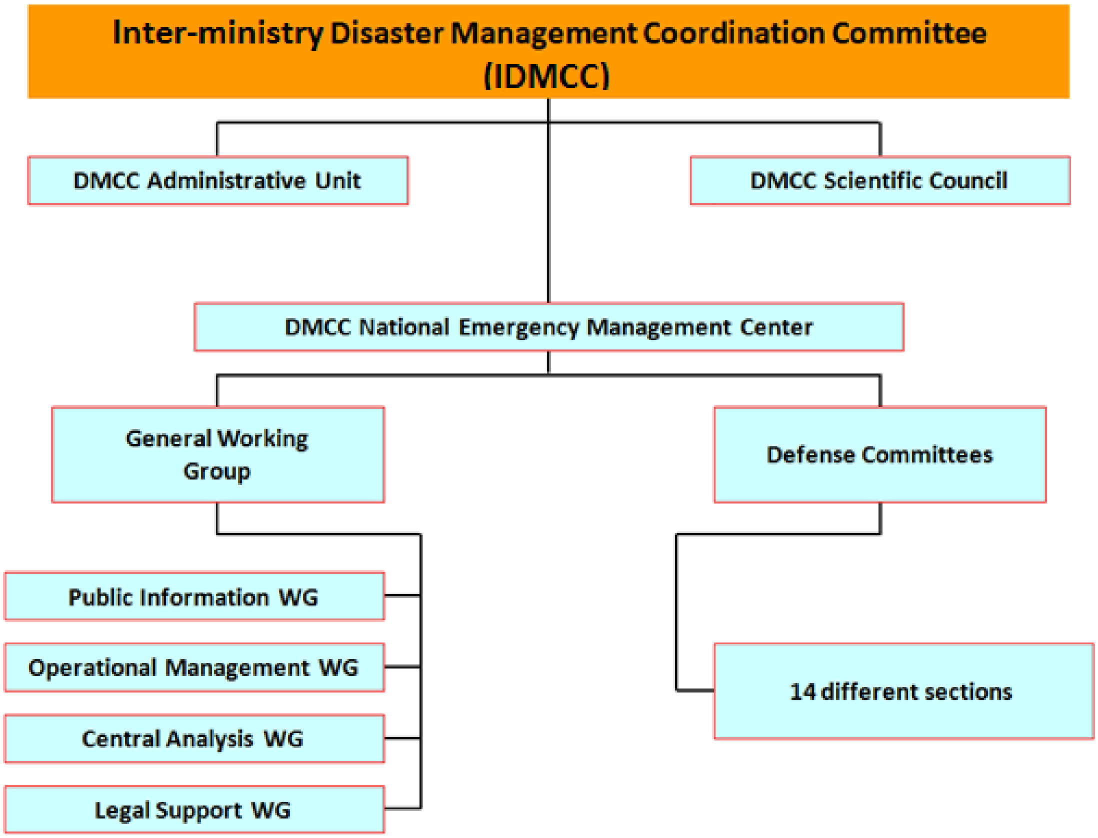


Figure F.5.1 – 1. Organizations participating in emergency management

The scientific task force of the IDMCC is the IDMCC Scientific Council (hereinafter referred to as IDMCC SC); the operative task force is the IDMCC National Emergency Management Centre (hereinafter referred to as IDMCC NEMC). The IDMCC NEMC 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 (hereinafter referred to as NDGDM).

Should a threat of a disaster or a declared emergency occur the IDMCC NEMC 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 NEMC shall make – in line with the emergency decisions of the Government and the IDMCC – appropriate, fast decisions to be implemented immediately.

Members of the IDMCC SC are invited by the Director General of the HAEA. Members of the IDMCC SC consist of senior experts from Hungarian research institutes.

The IDMCC SC operates the Nuclear Emergency Response Scientific Section, whose main task is monitoring of the technological level of nuclear facilities, continuous assessment of Hungary's nuclear vulnerability, development of the proposal for the mid-term nuclear emergency preparedness and response plan, as well as establishing the technical-scientific background of the IDMCC's decisions on matters concerning extraordinary events with environmental impacts and on mitigating nuclear emergencies and their consequences.

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 NERS 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 is determined by the ministers and the heads of central administration organizations concerned. Formation of special organs 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 NERS.

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

In 2006, a High Level Working Group was established for the revision and maintenance of the National Nuclear Emergency Response Plan (hereinafter referred to as 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 Nuclear Power Plant in 2003, the relevant new legislations and the new international recommendations. Version 2.0 of the NERP was issued in 2008 as a result of the two-year-long efforts of the High Level Working Group. The IDMCC approved version 2.0 of the NERP and ordered the bodies responsible for developing and maintaining emergency response plans to revise their own plans and if necessary prepare new ones based on the new NERP. 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 NERP.

The legal background of the High-level Working Group was strengthened in 2010 by the promulgation of a new government decree [II.29].

The current version (version 2.3) of the NERP came into force in November 2015. This version takes into account, among others, governmental changes that took place in 2014, and it has *been supplemented to include the task of handling an emergency during the air transport of fresh fuel, and the scope of the official communication samples used in various emergencies has been expanded.*

The High Level Working Group continuously develops and reviews guidelines related to the NERP. Guidelines and technical guides issued so far:

- Legal basis of the NERP,
- Accidents of domestic and foreign nuclear and radiological facilities,
- 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 (hereinafter referred to as NRMACS),
- 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 System of emergency preparedness in facility level

F.5.4.1 Spent Fuel Interim Storage Facility

The Paks Nuclear Power Plant and the SFISF have an integrated emergency preparedness system and response organization, as their sites are next to each other. 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 Paks 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 SFISF shall be regularly reviewed by the operator and approved by the HAEA.

F.5.4.2 Radioactive Waste Treatment and Disposal Facility

In 2016 the RWTDF introduced a new Nuclear Emergency Response Plan in line with the new Hungarian legal background [II.35] and with international requirements. The new plan was approved by the HAEA.

F.5.4.3 National Radioactive Waste Repository

In 2016 the NRWR introduced a new Nuclear Emergency Response Plan in line with the new Hungarian legal background [II.35.] and with international requirements. The new plan was approved by the HAEA.

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 are performed according to annual plans that are developed on the basis of the NERP. 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.

F.5.6 International cooperation

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 NDGDM took over the responsibilities of the National Warning Point (NWP) from the predecessor of the current Ministry of Foreign Affairs and Trade, the Ministry of Foreign Affairs, so besides the HAEA this organization performs the notification and informational tasks toward the IAEA.

Hungary, signed the Joint Protocol relating to the Application of the Vienna Convention and the Paris Convention on Civil Nuclear Liability in 1990.

In 1991 Hungary agreed to utilize INES, introduced by the IAEA.

Hungary has been a member of the harmonization project of the IAEA on nuclear accident prevention and emergency response since its beginning. This project significantly contributed to the renewal of the NERP.

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 Emergency Information and Evaluation Centre (hereinafter referred to as NEIEC) operated by the NDGDM serves as a 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 NEIEC 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 exchange 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), the Republic of Slovenia (1995), Romania (1997), Ukraine (1997) Croatia (2000) *and Serbia (2014).*

F.5.7 RESPEC support

As a member of the OECD NEA, Hungary regularly participates in the INEX international nuclear emergency exercises and is a regular participant of the various CONVEX nuclear emergency response exercises organized by the IAEA. Since 2003, as a full member of the European Union's nuclear emergency information exchange agreement, Hungary also takes part in the ECURIE exercises.

The HAEA first signed the RESPEC (Radiological Emergency Support Project for the European Commission) contract at the end of 2006, in the framework of which HAEA 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 HAEA 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 and third three-year periods (2010-2013 and 2013-2016) of the contract, 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 fourth time until the end of 2019. According to the latest contract, between 2016 and 2019, the HAEA will organize the annual ECUREX (ECURIE exercise) international nuclear emergency response exercises under the leadership of the European Commission.*

F.6 Decommissioning of nuclear facilities

Decommissioning is covered in the Hungarian legislation as the final phase of the life-cycle of nuclear 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 HAEA published the requirements for decommissioning of nuclear facilities as a separate volume. The new requirements are based upon WENRA decommissioning reference levels.

General regulations concerning decommissioning can be found in the Act on Atomic Energy [I.6]. Special regulations concerning decommissioning are contained in Volume 8 of the Nuclear Safety Code, published as annex to government decree [II.24]. The HAEA is mandated to periodically review the implementation of the government decree and of the Nuclear Safety Codes.

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. During the decommissioning, decontamination and other steps, an ongoing task of the authority is the control of the radiation situation within the facility and in its surrounding, 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.

For all nuclear facilities, i.e. the Paks Nuclear Power Plant, the BRR, the Training Reactor and the SFISF, the safety codes contain a provision that decommissioning must be considered 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 HAEA. 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. 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 1990's 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 HAEA in relation to Unit 1. The following five year period thus began with the 2011 decommissioning plan and in line with this the *Paks Nuclear Power Plant submitted the updated version of its decommissioning plan in 2016 to the HAEA. Review of the decommissioning plan will be carried out by the HAEA during 2017.*

In the case of the BRR 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 BRR. At the time of the compilation of this report, both facilities had a preliminary decommissioning plan which approved by the HAEA *(the decommissioning plans were updated most recently in 2014 for the Training Reactor and in 2015 for the BRR).*

The SFISF 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 PSR conducted in 2008, *the 2011 document was updated in 2016 to align itself with the decommissioning plan of the Paks Nuclear Power Plant, and was submitted to the authority. Review of the updated decommissioning plan will be carried out by the HAEA during 2017.*

Section G. Safety of Spent Fuel Management

The safety of spent fuel in the Paks Nuclear Power Plant and in the BRR is dealt with in Annex 8.

G.1 Spent Fuel Interim Storage Facility

Siting

The facilities of the SFISF were constructed 500m south of the geometric centre of the Paks Nuclear Power Plant. By design the foundation of the SFISF was set at an elevation so that the facility would not be flooded even taking into account the Danube's maximum flood level that may occur at a frequency of 10^{-2}/year. The structure of the basement prevents the release of radionuclides into the ground and groundwater. Legislation [III.17] forbids air traffic in a 3 km radius up to an altitude of 5950 m around the SFISF and the 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 SFISF 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 (hereinafter referred to as US NRC) guideline (Regulatory Guide 1.60) and the attenuation values specified in the requirement 4/86. of the American Society of Civil Engineers.

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 chambers. Storage capacity of the 20 constructed and operating chambers is 9.308 spent fuel assemblies. Currently the module housing chambers 21-24. is under construction and commissioning. Through this the storage capacity will increase to 11,416 spent fuel assemblies. Further expansion of the facility will take place in parallel with its operation. The rate of expansion is determined by the needs of the Paks Nuclear Power Plant, thus taking into account the 20 year service life extension and the annual rate of spent fuel generation, the construction of 36 chambers was originally planned. Starting from chamber 17 a square arrangement has been used for the storage tubes instead of the triangular arrangement that is used in chambers 1-16.; 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 chambers. *At the end of 2016, the modification of the valid construction license was in process, which, through a denser grid arrangement allow for the maximum required storage capacity to be reached with just 33 chambers (see Section K.1).*

Figure G.1-1 Spent Fuel Interim Storage Facility

A description of the layout of the facility is given in Annex 1.

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

- min. 3 years and 10 months cooling before placing into the store,
- maximum of initial enrichment: 4.7%,
- average burn-up level: 50.7 GWday/tU,
- maximum burn-up level: 58 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 purpose of the safety assessments of the SFISF – the results of which are contained in the Final Safety Report of the facility – is to demonstrate the safety of the facility over the entire lifetime of the facility in connection with the operational phase. Among the underlying safety assessments the most important ones are the subcritical, thermal PSA based malfunction analyses as well as radiation protection analyses which include the dose rates for the operator as well as the general population under normal and in emergency situations. The analyses demonstrate that in case of safety-relevant events, the facility remains safe and under control; chain reaction cannot occur in the storage facility, efficient cooling of the spent fuel is achieved, releases remain under the legislation mandated limits set for the installation and neither *workers nor the general population in the surrounding areas is exposed to doses higher than the limit.*

Aging management

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 SFISF.

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 SFISF is PURAM.

The operation and maintenance of the SFISF are performed on a contractual basis by the personnel of Paks Nuclear Power Plant, while PURAM supervises the operation and maintenance works.

The operation licence issued by the HAEA in relation to chambers 1-20 of the SFISF 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 SFISF. This document was approved by the HAEA 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 SFISF. The licensee has the obligation to review/update the Final Safety Assessment Report annually.

The safety criteria applied to the SFISF are in full accordance with internationally accepted principles, because the limits and conditions specified in the national regulations are based on 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.

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.

The BCF in the Western-Mecsek Mountain is capable 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 BCF 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 BCF 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, in 2003 a Research Programme was launched that was divided into surface and underground phases started.

PURAM prepared Phase I Section 2 of the BCF 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) approved the plan in 2013. In parallel, PURAM has initiated the licensing process of the research facilities and has contracted for the research activities.

The plan, running until 2017 contained extensive field activities, but due to financial restraints it had to be rescheduled. Of the planned research facilities two boreholes (BAF-1 and BAF-2) as well as the B-3 trench were implemented until 2016. Transport tests taking several months have begun on the core of the drillings.

In 2016, the operation of the complex observation system (environmental, geodynamic and radiological) in the West Mecsek area continued.

Spent fuel of non-nuclear power plant origin

Transportation to the Russian Federation or final domestic disposal of the low-enriched spent fuel from the BRR shall be arranged for and implemented in the future.

In the case of the Training Reactor, the technology and for the removal of the spent fuel assemblies from the building and the conditions for their interim storage must be developed. Transportation of the irradiated fuel assemblies to the Russian Federation should be carried out together with the BRR’s spent fuel transport.

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 unsealed and sealed radioactive sources began during the second half of the 1950's. 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 of (first of all due to the unfavourable impermeable properties of the soil and the disadvantageous hydrogeology of the site), the waste repository operating between 1960 and 1981 in Solymár was completely closed at the beginning of the 1980's. During the next two decades the competent authorities monitored the radiological conditions in the area. In addition, restrictions are in place for the utilization of the site and to ensure additional sampling as required.

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 RWTDF 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 the 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 was completed in 2005. Subsequently, 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 inspection;
- 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.

Compliance with the requirements of government decree [II.35]

The government decree [II.35], which entered into force in 2014 required the licensees of storage facilities including the operator of the RWTDF to review compliance of the facility with the relevant requirements of the government decree. The operator had completed this review and submitted the report of the results to the HAEA in April 2016. On the basis of discrepancies identified, in its resolution issued in June 2016, the HAEA, waived certain requirements for a definite period of time, and ordered the implementation of corrective measures. The evaluation and implementation of these measures is currently underway.

Application for a single operating licence

Activities carried out in the facilities are currently subject to individual licenses, which are valid until 2019 and 2024. In accordance with the new requirements, the operator intends to carry out operation of the storage facility on the basis of a single operating license. To this end, PURAM prepared and submitted a unified safety report encompassing all activities, documentation on all operating conditions and constraints as well as emergency operating procedures to the HAEA in June 2016 as part of the unified operating license application. Regulatory assessment of the license application and the supporting documents is currently underway.

Periodic Safety Review

The PSR of the RWTDF in accordance with Act on Atomic Energy [I.6] on the basis of the provisions of the government decree [II.35] was initiated in 2016 for the first time. The operator of the facility submitted the Periodic Safety Report summarizing the results of the review to the HAEA in December 2016, which began its assessment.

Refurbishment

From the beginning of the 2000's refurbishments and modernizations have been carried out in several phases and areas. The most important ones are:

- modification of the operational building, installation of radioactive waste management technologies (hot chamber, compressor, cementing equipment etc.);
- soil stabilization works of pool rows III and IV;
- further modernization of the physical protection system (construction of a new external fence according to the latest requirements, installation of a modernized sensor alarm system, expansion of the office laboratory building). Installation of certain elements of the visual control system (cameras and detectors) took place under the agreement between the HAEA and DoE (US Department of Energy) on joint counter-terrorism efforts, in which the DoE financed some parts of the equipment to be installed. Refurbishment and technical enlargement of the physical protection system began in 2013 *and finished in 2015.*
- modification of the ventilation system (installation of backflow prevention dampers and fire dampers);
- improvements to the work instructions and waste inventory record keeping systems;

- reconstruction of the ventilation network, including the construction of a new ventilation chimney, a new ventilation system and a new electric power supply.

Incident event

On December 2, 2013 three employees were processing four pieces of 200 l drums of radioactive waste containing ^{241}Am. The aim of opening the drums was to separate and compact 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, caused by the sputtering of the radioactive waste contaminated with ^{241}Am alpha emitting isotope.

The internal investigation revealed that, in addition to the direct cause, the indirect causes of the incident were the following:

- inadequate packaging of the radioactive waste,
- inappropriate handover process of the radioactive waste,
- inappropriate use of conditioning technology of the radioactive waste.

In its decision issued on 29 April 2014, the competent authority ordered a ban from performing radiation hazardous works until 31 December 2018 in the case of two, and until 31 December 2014 in the case of one of the affected workers. According to subsequent examinations the radiation exposure of the workers was much lower than initially assumed, thus one of the workers already returned to his previous job, while in the case of the other two workers PURAM requested the authority's position regarding their reinstatement into a radiation hazardous position.

Based on the experiences of the investigation of the incident on 2 December 2013, significant organizational, personnel changes and technical improvements have been made at the RWTDF. On 1 June 2014, the Independent Technical Safety Section, directly headed by the Managing Director was established to enforce PURAM's safety policy. The quality and control of the professional work has increased, and safety oversight became more effective and the overall safety culture increased.

Site contamination resulting from the incident on 2 December 2013 was successfully removed in the beginning of 2014.

H.3 National Radioactive Waste Repository

After the development of an increased new disposal capacity, the RWTDF is able to receive the radioactive wastes produced in research, medical and industrial institutions for years, but for low and intermediate level waste coming from the operation and decommissioning of the Paks 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 gained 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. According to 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 continued.

By October 2004, the co-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 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, following the completion of the first phase of construction the competent Radiation Health Centre of the NPHMOS granted an operation license for the NRWR, which was renewed on 5 October 2010. In possession of the operation license, 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 on the eastern part of the storage joint cut (see figure H.3-3) 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 NRWR came into force on September 10, 2012 valid until 7 September 2017. The inauguration ceremony and the final disposal of the first reinforced concrete container took place on December 5, 2012. Since the inauguration final disposal of the reinforced concrete containers in chamber I-K1 have been carried out regularly on a planned basis.

Following the construction of the first two chambers, the introduction of a new waste disposal technology necessitated the development of a new chamber geometry, primarily to be able to use the available storage space in the most efficient way.

In the third stage of the construction of the storage facility, by 2016 in accordance with the new layout concept construction of chambers I-K3 and I-K4 were completed, as well as test chamber No.3, required for the selection of the final closure concept of the Western exploration cut and the facility (see figure H.3-3).

In parallel with the construction of chambers I-K3 and I-K4, the final disposal of waste packages were being carried out in such a way that there was always at least one empty chamber (i.e. chamber I-K2) between the chamber being filled and the chamber being mined to ensure seismic safety.

In addition to the spatial development works, in line with the new waste disposal concept, construction of a reinforced concrete basin in I-K2 began in 2016. Commissioning of the new storage chamber is expected in 2017.

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

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.

These approximately 1700 m long shafts with a slope of -10% ensure access to the planned disposal depth (0 mBf), while the cross drifts located at every 220-270 m provide 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 NRWR 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 Paks Nuclear Power Plant. 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 was planned with a section dimension according to the new layout concept. Shaft I-K2 will protect the operating Shaft I-K1 against the unfavourable 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, modification of the operating license was issued by the competent authority in the middle of 2014.

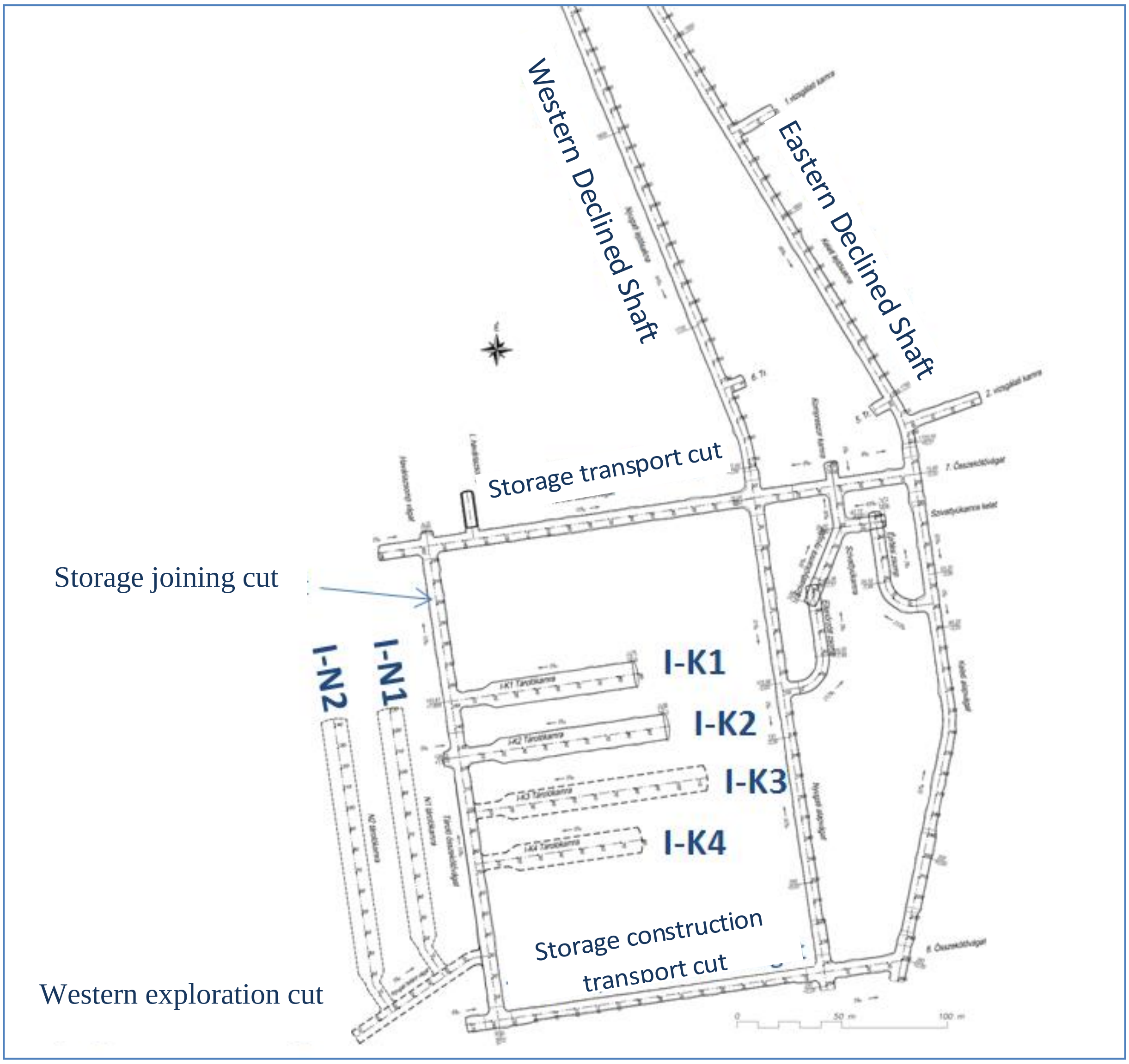


Figure H.3 – 3. Arrangement of the shafts of the National Radioactive Waste Repository

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 HAEA 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 HAEA in these acts are supported by NPH and by the OCMO NPHMOS as co-authorities.

Government 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 listed in its Annex 3.. 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 [I.10], 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 government decree [II.36] in order to ensure safety. All sealed radioactive sources are recorded in a central inventory, operated by the HAEA. HAS CER assists the HAEA in the establishment of conditions for inspection of radioactive materials (receipt, evaluation and computer processing of data supply). The central registry system has been in operation since the end of the 1960's 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.13] 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. 13] 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 shall be disposed of in repositories. The reporting system specified 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 RWTDF 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 recycled or disposed of in the RWTDF 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.

The new government decree [II.38] adopted at the end of 2015 regulates the tasks of the licensee in case of missing sources (preliminary preparation, performing searches, notification of authorities).

Section K. Planned Activities to Improve Safety

K.1 Spent Fuel Interim Storage Facility

The design work of the SFISF was performed in the 1990's, thus the facility is considered to be up to date. With regard to the modifications of the existing systems of the facility and safety enhancements, improvements made to the physical protection, modernisation of the nitrogen gas supply system and leak-detection of the storage tubes, and the updated monitoring systems of the discharges and the environment must be mentioned. In 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 first PSR, mandated by the Act on Atomic Energy [I.6] was carried out by PURAM in 2007, and at the beginning of 2008, in order to support the further operation of the SFISF, submitted the respective Periodic Safety Report to the HAEA.

Based on the Periodic Safety Report, in 2008 in its decision closing the review, the HAEA ordered the modernization of the instrumentation and control systems of the safety function of the SFISF. For safety enhancements – after the modification authorization plans have been drafted – the license for the modification of the systems has been issued first. *The licensee completed reconstruction of the instrumental and control system of the refuelling machine, and by the end of 2016 modernization of technology of the reception building was completed as well.*

In 2016, PURAM began preparation for the next PSR, to which the related report must be sent to the HAEA by 30 November 2017.

In 2013, the HAEA issued a resolution to PURAM, requiring it to review and process the experiences gained from the Fukushima accident and produce an assessment report thereof Similarly to the Targeted Safety Reassessment (hereinafter referred to as TSR) carried out at the Paks Nuclear Power Plant, PURAM also concluded the safety reassessment of the SFISF. *Over the past two years, the review of the site characteristics has been carried out for possible extreme parameters, as well as the examination of the impact of these extreme values on the safety barriers, and the analysis of the protection of the SFISF against external threats. The results of the tests carried out satisfactorily demonstrate that the storage facility complies with the current safety standards and that, there are margins beyond its design basis that ensure compliance with the post-Fukushima requirements.*

In the course of the procedure initiated by the licensee, on 26 June 2015, HAEA granted a construction license for the construction of chambers 21-33. of the SFISF, valid until 31 December 2033. In February 2016, PURAM submitted a "modification of the construction license concerning chambers 25-33. of the SFISF" application. Through the concept for new arrangements of the storage tubes, storage capacity of the SFISF may be increased, while ensuring the same level of safety. When designing the new concept, spent fuel that has been stored in the facility for over 20 years were taken into account instead of the three year cooled ones, which due to the longer cooling period have a relatively small decay heat output. This allows an additional capacity increase inside the chamber, i.e. storing 703 storage tubes in the *same geometry. Spent fuel assemblies that have been cooled for over 20 years in chambers 1-15. will be moved to chambers 25-33. with increased storage capacity. The architectural parameters of these chambers do not change, only the placement of storage tubes will be constructed in a denser configuration, however construction of a new load deck will be necessary. Through the planned storage capacity increase, the SFISF will have enough storage capacity in 33 chambers to ensure the interim storage of spent fuel of the Paks Nuclear Power Plant until the end of its service life, including the 20 year service life extension.*[1]

K.2 Radioactive Waste Treatment and Disposal Facility

As part of the 2002 safety enhancement programme described in Section H.2, a demonstration programme was launched which set out the opening of four pools. During sorting, waste packages were separated into different categories – based on the content of long-lived, alpha emitting nuclides – and were further treated and disposed of in different ways. Particular attention was given to waste packages containing tritium or tritium sources, which were isolated from other wastes and encapsulated to prepare for their disposal.

The demonstration programme launched in 2006 was completed 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^3. The volume of 20 m^3 gained is equal to the waste volume received during two 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.

In line with the plans, re-conditioning of an additional 1000 m^3 of radioactive waste is expected in the mid-term.

[1] *The modified construction license was issued by the HAEA on 31 May 2017.*

Figure K.2-1 Removal of special packages **Figure K.2-3 Storage of re-packed wastes**

The implementation of the safety enhancement measures entails the construction of a light-structure hall, development of appropriate infrastructure systems, tools and equipment needed to carry out the work must be acquired and then retrieval and sorting of the waste packages must begin and be followed by their qualification and disposal.

In mid-2014, government decree [II.35] has moved the construction and modification activities carried out at the RWTDF into the competence of the HAEA. Licensing procedures of constructions and modifications in connection to the safety enhancement measures have successfully concluded, the HAEA authorized these activities.

The planned milestones of the safety enhancement programme (which may change during construction) are as follows:

2017-2022 *Construction of a light-structure hall and infrastructure to be able to carry out the safety enhancement measures and free up capacity, implementation of the safety enhancement measures (free up capacity) on pool row I. chambers A01-A24 (waste retrieval, processing, qualification).*

2023-2029 *Continuation of safety enhancement (free up capacity), retrieval of the contents of pool row II. (chambers A25-A48), processing, deposition of the waste and restoration of the environment surrounding pools I-II.*

2030-2037 *Continuation of safety enhancements (free up capacity), conditioning the contents of pool rows III and IV and space filling.*

K.3 National Radioactive Waste Repository

The NRWR was designed in the early 2000's, in line with international recommendations, thus it is a modern facility. Operation of the above ground area of the facility began at the end of 2008, while operation of the underground part of the facility began in 2012 therefore no safety enhancement measures affecting the operation of the basic systems have so far been required.

The Periodic Safety Review of storage facilities, mandated by the Act on Atomic Energy [I.6] must be carried out every 10 years, which for the NRWR will take place in 2021.

ANNEXES

ANNEX 1: THE SPENT FUEL INTERIM STORAGE FACILITY

An1.1 Description of the facility

The SFISF 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 assemblies. 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 and mechanical protection. 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 create 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 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 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 *determined in the safety assessments*:

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 SFISF 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 Paks Nuclear Power Plant) 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 computerized registration of those accessing the facility. Transport of the spent fuel assemblies of Paks Nuclear Power Plant 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 SFISF.

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 SFISF 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 Paks 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 2016 the amount of actual value of airborne releases was only 0.014%, while the actual value of liquid discharges was only 0.004% of the derived limits. Accordingly, only 0.018% of the derived airborne and liquid discharge limit values were utilized in 2016.*

Since the site of the SFISF and that of the Paks Nuclear Power Plant are adjacent to each other, the environment monitoring system of the SFISF 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 SFISF are processed and assessed in the environmental monitoring laboratory of the nuclear power plant.

Until now, the environmental monitoring system has not shown any increase 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 RWTDF 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.

By December 2004 the 'A-type' vaults containing the solid wastes were practically full 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 are 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 buffer 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, further storage area consisting of 50 tubes of 4 m depth with a dimension of 40-100-200mm, allowing the recovery of sealed sources was created. Storage of nuclear materials takes place in separate compartments.

An2.1.2 Handling and Storage

Review of waste acceptance requirements was carried out in 2016 during the preparation of the Safety Report substantiating the operation created for the unified operating license of the NRWR, which will enter into force following its approval by the regulatory body.

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 handled like the sealed sources, 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 PURAM under its own responsibility, using its own work force and equipment (transport vehicles, containers). Radioactive sources and radioactive waste are transported in accordance with the regulations of the European Agreement concerning the International Carriage of Dangerous Goods by Road (hereinafter referred to as ADR) on 30 September 1957 in Geneva.

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, PURAM operates a radioactive sources and waste registry system in the RWTDF.

In accordance with the regulations, the RWTDF 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.

An2.1.5 Radiation protection and environmental protection

Personal dosimetry control is the task of the Radiation Protection Service of the RWTDF and takes place according to the respective regulation [II.35]. 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 RWTDF. 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 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.

Ecological surveys carried out since 2003 involve soil sampling, plant sampling and animal origin sampling, as well as local measurements on the site of the facility. *The monitoring programme was reviewed in 2016 in connection to the Safety Report substantiating operation and from 2017 surveys will be carried out according to the revised and approved procedures.*

An annual report is prepared for the authority describing the radiation protection and environmental monitoring activity.

In line with the government decree [II.35] operation and modification of the site through administrative means and environmental sampling is carried out by the HAEA 8-10 times a year and by the environmental authority once a year.

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 hydrogeological 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 (hereinafter referred to as WHO) for drinking water.

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.

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 waste is transported to the controlled zone, which hosts the buffer storage, treatment, transport to the underground storage 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.

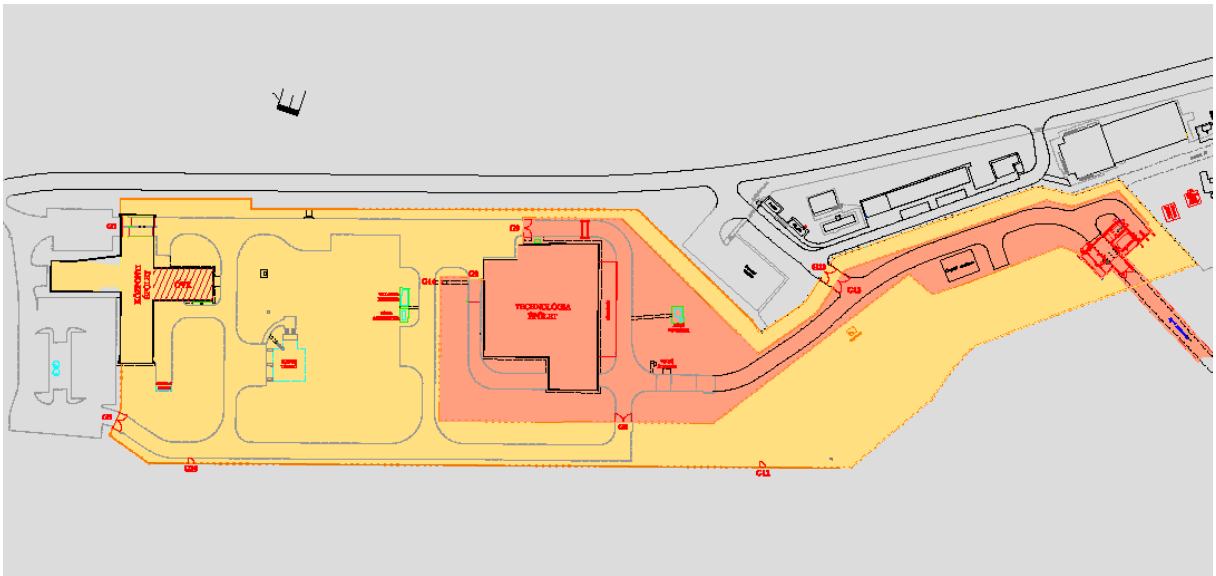


Figure An.2.2.1 – 1: Division of the site of the National Radioactive Waste Repository into zones (the controlled zone of the site *is indicated by the dark colour*)

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 in parallel to the disposal of wastes; it has a role in the proper ventilation of subsurface areas as well as 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 Paks Nuclear Power Plant in the presence of the representatives of PURAM. 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 NRWR allows the buffer 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 Paks Nuclear Power Plant to the NRWR 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 legal requirements,* ordered that the wastes shall be retrievable, if the retrieval is justified by future operating experience or a regulatory procedure.

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.6] 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.13].

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 2016, 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 ten-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 investigation level; the annual exposure did 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 NRWR, 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 RWTDF 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 geological 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 RWTDF as of 31 December 2016.

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

	Waste volume (m^3)	*Total activity of waste (Bq)*
Storage	*225**	*1.87E+14*
Disposal	4900**	*1.26E+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 NRWR as of 31 December 2016. 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)	*Total activity of waste (Bq)*
Technology building	*430*	*7.09E+10*
Disposal shaft (I-K1)	*876*	*1.86E+10*

Table An3.2-2 presents the volume and total activity of radioactive wastes originated from the operation of Units 1-4 of the Paks Nuclear Power Plant including the 20 year service life extension, planned to be disposed in the NRWR (only 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)*
Reinforced concrete container	1029
200 l drum	1095
Compact waste package	11129
Large size waste	800
Cemented ion exchanger resin	1785
Cs-column storing container	51
Total:	***15889***

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 endorsed 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	on 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 endorsed 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 administrative proceedings and services
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 the right of association, non-profit status and the operation and funding of civil society organisations
I.15	*Act LXXXIX of 2015*	*on the promulgation of Annexes A and B to the European Agreement concerning the International Carriage of Dangerous Goods by Road and on certain issues of their application in Hungary*

II. Government decrees, decrees of the Council of Ministers

II.1	Decree of the Council of Ministers 28/1987. (VIII. 9.)	on the promulgation of the Convention on Early Notification of a Nuclear Accident signed in Vienna on the 26th of September in 1986
II.2	Decree of the Council of Ministers 29/1987. (VIII. 9.)	on the promulgation of the Convention on Assistance in the case of a Nuclear Accident or Radiological Emergency, signed in Vienna on the 26th of September in 1986
II.3	Decree of the Council of Ministers 70/1987. (XII. 10.)	on the promulgation of the Agreement on Regulation of Mutually Interesting Questions Relating to Nuclear Facilities concluded between the Government of the Hungarian People's Republic and the Government of the Austrian Republic, signed in Vienna on the 29th of April in 1987
II.4	Decree of the Council of Ministers 93/1989. (VIII. 22.)	on the promulgation of the Reviewed Complementary Agreement on the technical assistance of the International Atomic Energy Agency to Hungary concluded between the Government of the Hungarian People's Republic and the International Atomic Energy Agency, signed on the 12th of June in 1989
II.5	Decree of the Council of Ministers 24/1990. (II. 7.)	on the promulgation of the International Convention on Civil Liability for Nuclear Damage concluded in Vienna on the 21st of May in 1963
II.6	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 26th 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 20th 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 20th of September in 1989
II.9	Govt. Decree 17/1996. (I. 31.) Korm.	on the actions in connection with the found or seized radioactive or nuclear materials[2]
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.[3]
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 11th of July in 1995

[2] This Govt. Decree was replaced by [II.38] as of 1 January 2016
[3] This Govt. Decree was replaced by [II.36] as of 1 January 2016

II.12	Govt. Decree 246/2011. (XI. 24.)	on the safety zone of nuclear facilities and radioactive waste repositories
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 atomic 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[4]
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[5]
II.19	Govt. Decree 136/2002. (VI. 24.) Korm.	on the promulgation of the Agreement for Cooperation in the Peaceful Uses of Nuclear Energy and Transfers of Nuclear Material between the Government of the Republic of Hungary and the Government of Australia signed at Budapest, on 8th August 2001
II.20	Govt. Decree 275/2002. (XII. 21.) Korm.	on the monitoring of radiation levels and radioactivity concentrations in Hungary[6]
II.21	Govt. Decree 112/2011. (VII. 4.) Korm.	on the scope of authority of the Hungarian Atomic Energy Authority in relation to European Union obligations and international obligations in connection with Atomic Energy, 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 rules of public communication in nuclear or radiological emergency
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

[4] *This Govt. Decree was replaced by [II.31] as of 1 January 2014*
[5] *This Govt. Decree was replaced by [II.36] as of 1 January 2016*
[6] *This Govt. Decree was replaced by [II.37] as of 1 January 2016*

		Russian Federation of Russian-made (irradiated) spent fuel assemblies
II.24	*Govt. Decree 118/2011. (VII. 11.) Korm.*	*on the nuclear safety requirements of nuclear facilities and the related regulatory activities*
	Annex No. 1 Nuclear Safety Code Volume 1	Nuclear safety authority
	Annex No. 2 Nuclear Safety Code Volume 2	Management systems
	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. 7 Nuclear Safety Code Volume 7	Site survey and assessment of nuclear facilities
	Annex No. 8 Nuclear Safety Code Volume 8	Decommissioning of nuclear facilities
	Annex No.9 Nuclear Safety Code Volume 9	Requirements for the design and construction period of a new nuclear facility
	Annex No. 10 Nuclear Safety Code Volume 10	Nuclear Safety Code definitions
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[7]
II.27	Govt. Decree 267/2006. (XII. 20.) Korm.	on the Hungarian Office for Mining and Geology

[7] *This Govt. Decree was replaced by [II.42] as of 1 April 2015*

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 Emergency Preparedness and Response
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 support to local government associations for oversight and information 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
II.35	*Govt. Decree 155/2014. (VI.30.) Korm.*	*on the safety requirements for facilities ensuring interim storage or final disposal of radioactive wastes and the corresponding authority activities*
II.36	*Govt. Decree 487/2015. (XII.30.) Korm.*	*on the protection against ionizing radiation and the corresponding licensing, reporting (notification) and inspection system*
II.37	*Govt. Decree 489/2015. (XII.30.) Korm.*	*on monitoring radiation conditions relevant for public exposure of natural and artificial origin and on the scope of quantities obligatory to be measured*
II.38	*Govt. Decree 490/2015. (XII.30.) Korm.*	*on reports and interventions regarding missing, found or seized nuclear and other radioactive materials and other actions pertaining to radioactive materials following their report*
II.39	Govt. Decree 2/2005. (I.11.) Korm.	on the environmental assessment of specific plans and programmes
II.40	Govt. Decree 132/2010. (IV.21) Korm.	on the announcement of the protocol adopted on May 21, 2003 in Kiev on strategic environmental assessment related to the Convention on environmental impact assessment in a transboundary context done at Espoo (Finland), on February 26, 1991
II.41	Govt. Decree 204/2008. (VIII.19.) Korm.	on the promulgation of the Agreement on cooperation regarding repatriation of spent fuel of the Budapest Research Reactor concluded between the Government of the Russian Federation and the Government of Hungary

II.42	*Govt. Decree 72/2015. (III.30.) Korm.*	*on the amendment of government decrees on certain investments of special importance from a national economic aspect related to the integration of the capital and county government offices*

III. Ministerial Decrees

III.1	Decree of the Minister of Transportation and Post 20/1979. (IX. 18.)	on the promulgation and inland application of Annexes "A" and "B" of the European Agreement about the International Public Road Transportation of Dangerous Goods[8]
III.2	Decree of the Minister of Public Welfare 23/1997. (VII. 18.)	on the exemption levels (activity-concentrations and activities) of radionuclides[9]
III.3	Decree of the Minister of Health 16/2000. (VI. 8.)	on the execution of certain provisions of Act CXVI of 1996 on Atomic Energy
III.4	Decree of the Minister of Health 30/2001. (X. 3.)	on the operational radiation protection of the outside workers[10]
III.5	Decree of the Minister of Health 31/2001. (X. 3.)	on the protection of the health of individuals exposed to ionising radiation during provision of medical services
III.6	Decree of the Minister of Environment 15/2001. (VI. 6.)	on the radioactive discharges to the atmosphere and into the waters during the use of atomic energy, and on monitoring of the discharge
III.7	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.8	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.9	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.10	Decree of the Minister of Justice 14/2005. (VII.25)	on the operation and administration of the Central Nuclear Financial Fund[11]
III.11	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.12	Decree of the Minister of National Development 61/2013. (X. 17.)	on the inland application of Annexes A and B of the European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR)
III.13	Decree of the Minister of Transportation, Communication and Energy 11/2010. (III.4.) KHEM	on the order of registration and control of radioactive materials and related data supply

[8] The promulgating decree ceased to be in force on 1 July 2013, and was incorporated into the new promulgating Act, see I.15.
[9] This Govt. Decree was replaced by [II.36] as of 1 January 2016.
[10] Not in force since 16 January 2016.
[11] Not in force since 1 January 2014. This Govt. Decree was replaced by [II.31] on 1 January 2014.

III.14	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[12]
III.15	Decree of the Minister of National Development 51/2013. (IX. 6.)	on the shipment, freight and packaging of radioactive materials
III.16	Decree of the Minister of National Development 55/2012. (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
III.17	Joint Decree 26/2007. (III.1) of the Minister of Economy and Transport, the Minister of Defence and the Minister of Environment and Water	on the designation of the Hungarian airspace for air navigation

IV. Parliamentary Resolutions

IV.1	*Parliamentary Resolution 21/2015. (V.4.) OGY*	*on the national policy on the management of spent fuel and radioactive waste*

V. Government Resolutions

V.1	Government Resolution 2085/1997. (IV. 3.)	on discontinuing uranium mining in the Mecsek hills
V.2	Government Resolution 2385/1997. (XI. 26.)	on the investment programme of the remediation tasks for the abandonment of the uranium industry in Hungary
V.3	Government Resolution 2006/2001. (I. 17.)	on the modification of governmental resolution 2085/1997 (IV.3.) on discontinuing uranium mining in the Mecsek hills, and of government resolution 2385/1997. (XI.26.) on the investment programme of the remediation tasks for the abandonment of the uranium industry in Hungary
V.4	Government Resolution 2122/2006. (VII. 11.)	on further tasks related to the abandonment of uranium mining in Hungary
V.5	Government Resolution 1150/2012. (V. 15.)	on the establishment of the Disaster Management Coordination Inter-ministerial Committee, and on the rules of its organization and operation
V.6	*Government Resolution 1459/2016. (VIII. 24.)*	*on the national programme on the management of spent fuel and radioactive waste*

[12] *Not in force since 30 June 2014. This Govt. Decree was replaced by [II.35] at 11 p.m. on 30 June 2014.*

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

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

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

In preparing the report, the HAEA is supported by the other regulatory authorities competent in nuclear applications. The report is subject to intergovernmental discussion and the Government decides on its submission to the 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:

- Summary (major events related to the facilities under the supervision of the HAEA);
- 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 preparedness and response;
- Scientific-technical background;
- International relations;
- Hungary`s role in the European Union;
- Public relations.

The 2013 report on the safety of the application of nuclear energy in Hungary was adopted by the Parliament in 2015; the 2014 report was adopted in 2016, while the 2015 report was adopted in 2017. The reports concluded that the application of nuclear energy in Hungary fulfils the relevant safety requirements.[13]

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 following the Fukushima accident), in 2013 and in *2016*. The Reports are available on the website of the Hungarian Atomic Energy Authority (www.haea.gov.hu).

[13] *The 2016 report on the safety of the application of nuclear energy in Hungary was submitted to the Government in June 2017, and subsequently to the Parliament.*

All of the reports were received favourably in the review meetings. The review of the seventh National Report prepared in 2016 took place in March 2017.

An5.3 Participation in the reporting systems of the IAEA

Hungary, as a Member State of the IAEA, takes part in the international systems [Incident Reporting System (hereinafter: IRS), and 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 IAEA.

Since 2000, this obligation has been extended to the SFISF, but in this facility, due to the favourable operational experiences, no events have taken place which were to be reported in the framework of IRS or INES.

Since 2017, this obligation has been extended to the RWTDF in Püspökszilágy and to the NRWR in Bátaapáti as well.

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

In 2010 preparatory actions were commenced for the next review. The international review organized by the IAEA takes place now in the framework of the IRRS. The experts of the IAEA held a three-day training about the use of software supporting self-assessment [Self-Assessment Tool (hereinafter: 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 concluded in the first half of 2014. Following this, a SWOT analysis was prepared, which was the basis of development for the HAEA's preliminary action plan. Finally, prior to the Mission, the HAEA, together with its partner authorities, prepared the Advanced Reference Material (ARM), based on which members of the expert team could prepare for the implementation phase of the review. The mission took place between 11 and 22 May 2015 and concluded successfully with the participation of the HAEA, the radiation health and the environmental protection partner authorities. National authorities reviewed during the mission received a total of 32 recommendations and 10 suggestions, while in the case of the HAEA 6 good practices were also identified. Following the Mission, the participating authorities divided the tasks arising from the recommendations and suggestions, based on their competences. Finally, the HAEA updated its action plan and began its implementation. The final deadline of its implementation is the end of 2017. The planned date of the Hungarian IRRS follow-up mission as confirmed by the IAEA is Q3 2018.*

An6.2 International missions to the Paks Nuclear Power Plant

An6.2.1 IAEA OSART Mission

Upon on the request of the HAEA, the IAEA Operational Safety Review Team (hereinafter referred to as OSART) conducted a mission at the Paks Nuclear Power Plant between 24 October and 13 November 2014. During the two-and-a-half-week mission, 10 areas related to the safety of the nuclear power plant were reviewed by a team of 12 foreign experts. In addition, three observers were also invited by the IAEA to follow the mission.

The review assessed the performance of the Paks Nuclear Power Plant in comparison with the detailed requirements of the IAEA. The review entailed on-site observations, audit of documents, interviews conducted with employees as well as discussions about the collected information with Paks-based partners. In the 10 major areas of operations reviewed during the mission – ranging from and control to severe accident management – a total of 23 areas were identified for improvement (15 recommendations and 8 suggestions) and 6 good practices were identified that are worthy of being included in the IAEA network to familiarize them with other power plants.

The Paks review identified a number of areas in need of improvement slightly above average. The outcome of the review (in particular taking into consideration the number of on-site observation activities) was influenced by the fact that it took place during the general maintenance of Unit 3.

Looking at the results of the review, it can be stated that the mission did not reveal any operational shortcomings which could call into question the safe operation of the Paks Nuclear Power Plant, but it did identify several issues that need to be addressed to improve the safety performance of the power plant. Following the OSART mission, the MVM Paks Nuclear Power Plant Ltd evaluated the results and developed an action plan, which was approved by senior management, to improve upon the identified areas.

The progress in the implementation of the action plan should be periodically presented in status reports.

An6.2.2 WANO corporate peer review at the MVM Paks Nuclear Power Plant Ltd.

Upon the invitation of the MVM Hungarian Electricity Ltd. (hereinafter: MVM Ltd.) – WANO conducted a corporate peer review (hereinafter referred to as CPR) at the MVM Group between 21 and 29 November 2014. The focus of the review was on the interface between the MVM Group (corporate) and the Paks Nuclear Power Plant. The team of nuclear experts focused on seven areas to find out whether the company effectively provides the nuclear power plant the conditions necessary for the realization of nuclear safety and efficient operation.

Since the licensee of the Paks Nuclear Power Plant is MVM Paks Nuclear Power Plant Ltd., which according to Hungarian legislation is the organization responsible for nuclear safety, the WANO CPR also concerned the Paks Nuclear Power Plant, where experts spent two days.

The CPR team identified two strengths and four areas in need of improvement during their investigation. These areas of improvement encourage MVM Ltd. to engage more robustly in the exercise of supervision and in establishing a higher standard of safety at the Paks Nuclear Power Plant.

During the WANO CPR mission, the review team acknowledged that MVM Ltd. performed well in several areas, as evidenced by the evaluation carried out by the expert team. Among the strengths, group-level support and services as well as group-level human resources have been *highlighted by the experts. As a result of MVM Ltd.'s commitment to nuclear safety, issues concerning nuclear safety are a priority area in decision making, and it has resulted in significant safety improvements in the Paks Nuclear Power Plant in recent years.*

An 6.2.3. WANO peer review

Upon the request of the Paks Nuclear Power Plant, the 4th WANO peer review took place between 18 February and 4 March 2016, during which the power plant again compared its operation to the international nuclear professional standards. The review covered all 4 Units of the Paks Nuclear Power Plant. The review team consisting of experienced nuclear experts reviewed almost the full spectrum of operational activities of the power plant.

The aim of the review was to identify areas in need of improvement as well as those areas in which Paks Nuclear Power Plant is leading. The review was conducted according to the test methodology based on the new performance objectives and criteria, the essence of which was that in addition to the functional areas (operation, maintenance, chemistry, technical background, radiation protection and training) ten cross functional areas also received more emphasis (operational focus, workflow management, reliability of equipment, configuration management, radiation safety, performance improvement, operating experience, organizational efficiency, fire protection, emergency preparedness, severe accident management).

Based on the results of the review it can be stated that the team did not identify any serious shortcomings that would endanger safe operation of the Paks Nuclear Power Plant.

During the review, the team identified 14 areas to be improved, which is a low figure when compared internationally and to the results of the previous WANO peer review. These shortcomings in the activities of the MVM Paks Nuclear Power Plant Ltd. typically point out the need to improve the efficiency of processes, the forms of cooperation, and that certain activities should be carried out with more attention and more targeted management control in the future.

The evaluation team consisting of the company's management, carried out the evaluation of the underlying causes of discrepancies in the areas to be developed using the "stream" method, and determined the scope of the necessary measures to be taken. MVM Paks Nuclear Power Plant Ltd. sent the action plan for the improvement of the 14 identified areas to the Moscow Centre of WANO and began implanting the tasks set out therein.

An. 6.2.4 OSART follow-up mission

The IAEA conducted an OSART follow-up mission covering all 4 Units of the Paks Nuclear Power Plant between 17 and 21 October 2016. The aim of the mission was to evaluate the progress made in relation to the 2014 OSART mission. The five-person team of experienced international experts carried out the follow-up mission in accordance with the IAEA standard review methodology.

The follow-up mission reviewed the implementation of the 15 recommendations and 8 suggestions outlined by the 2014 OSART mission.

Prior to the follow-up mission, MVM Paks Nuclear Power Plant Ltd. prepared a report outlining the implementation of the measures contained in the action plan developed following the 2014 OSART mission. Based on the review of this report and upon consultation with experts at Paks as well as on-site inspections conducted, the OSART team reviewed the safety performance of the power plant. Their assessment was summarized in the follow-up report, which was handed over to the CEO of MVM Paks Nuclear Power Plant Ltd.

The review team found the issues completely resolved in the case of 7 areas, while in the case of the remaining 16 areas noted satisfactory progress. Among these, there are several measures where the review team accepted their adequacy, however due to the relatively short period of time since their implementation, performance improvements cannot yet be measured accurately. The experts identified improvements in all areas, and in several cases suggested the continuation of efforts and developments undertaken. It is important to note that the follow-up mission did not find any areas where progress has not been made or where performance improvements were not sufficient.

An6.2.5 WANO corporate peer review follow-up at MVM Ltd.

WANO conducted a CPR follow up mission at MVM Ltd. and MVM Paks Nuclear Power Plant Ltd between 21 and 26 November 2016. The aim of the mission was to evaluate the progress made in relation to the 2014 WANO CPR.
Based on the 2014 WANO CPR, MVM Ltd. and the Paks Nuclear Power Plant developed a 9-point action plan in relation to the four recommended areas in order to improve operational efficiency and to strengthen cooperation between MVM Ltd. and the Paks Nuclear Power Plant.
The WANO team evaluated the effectiveness of the implemented measures and the performance of the cooperation, by conducting interviews with the management of the MVM Group and Paks Nuclear Power Plant and through on-site inspections.
The review team did not find the measures taken by MVM Ltd. in the field of management to be sufficiently effective and called for further progress in this area. In the field of independent monitoring and communication, the results were better, with the team noting that adequate progress has been made.

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

An7.1 Antecedents

The plots of the underground and surface facilities of Hungarian uranium ore mining and milling 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 [V.1-V.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 [V.4]. The government 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 IAEA, 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 *amendments* issued by the previously competent 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 was the same as included in the national regulation, *which has since been modified to 300 Bq/m^3 [II.36]*. 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

Table An7.2.2-4 Groundwater contamination limits

Isotope	***Discharge limits***
Natural uranium content	*0.4 mg/dm^3*
Radium-226 content	*0.63 Bq/dm^3*

An7.2.3 Other discharge limit values

The radiation protection requirements for discharging industrial and mining water of various origins into surface waters are illustrated in the following tables:

Table An7.2.3-1 Discharge limits for radioelements entering surface waters

Isotope	***Discharge limits***
Ra-226	*7.4 E+09 Bq/year*
U-234	*1.1 E + 11 Bq/year*
U-235	*1.1 E + 11 Bq/year*
U-238	*1.1 E + 11 Bq/year*

Table An7.2.3-2 Radiation protection requirements for discharging to air

Isotope	***Discharge limits***
U-234	*9.1 E + 08 Bq/year*
U-235	*9.6 E + 08 Bq/year*
U-238	*1.0 E + 08 Bq/year*

An7.2.4 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 million m^3*
- *volume of the nine waste rock piles* — *10 million m^3*
- *volume of the two heap leaching piles* — *3.4 million m^3*
- *contaminated industrial area* — *44.9 ha*
- *volume of the two tailings ponds* — *163 ha*
- *volume of the technology solution in the two tailing ponds* — *32 million m^3*

Figure An7.2.4-1: Air shaft IV of the uranium ore mine during operation and after remediation

An7.2.5 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 An7.2.5-1 Schedule of the remediation programme

Facility name	*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.

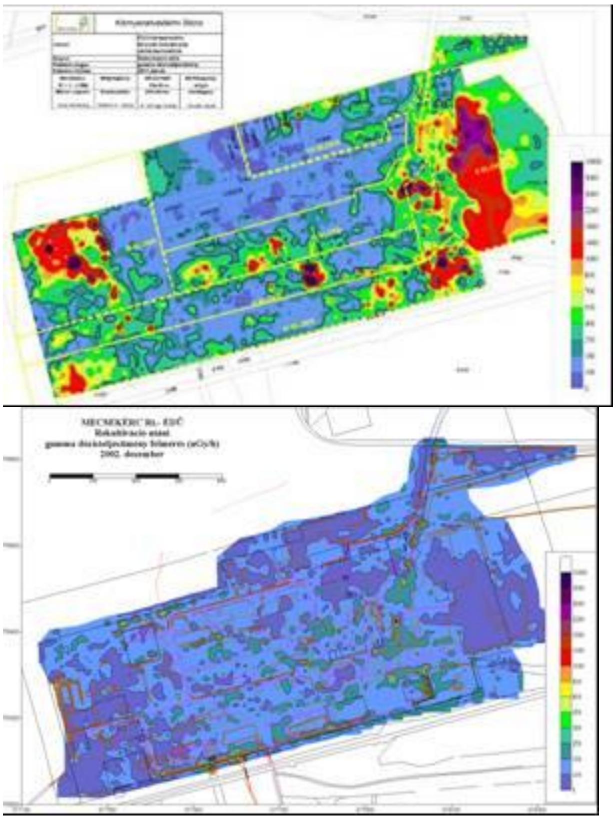


Figure An7.2.5-1: Gamma dose measurement rates results in the Ore Enrichment Plant site before and after the remediation

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 [V.3] included the costs of the so-named long-term tasks (water purification, maintenance, monitoring activities) until 31 December 2002. Since these tasks still exist for environmental, health and water reserve protection reasons, a new government resolution [V.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 has 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 is 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 groundwater *and mining water* (as a result of the underground cavity system of the mining facilities being completely filled, the treatment of a significantly higher volume of uranium contaminated mining water is required – expected to begin in 2019-2020. *Due to an investment in 2014, the annual maximum capacity of the uranium removal facility increases to 1.8 million m^3)*
- desalination of groundwater and *aquifers* (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;
- *operation of a complex monitoring system (hydrogeological, radiological, geotechnical, environmental geological).*

Considerable after-treatment and monitoring activities must to be performed on the tailings ponds, which are the largest and most sensitive objects due to the complexity of the cover layer. Damage to the cover layer may result in additional contaminant to be released through seeping of the rainwater. To protect the drinking water reserves, groundwater and aquifer that has previously leaked into the soil from the tailing ponds, containing a high amount of salts (magnesium sulphate, sodium chloride) is removed and chemically treated.

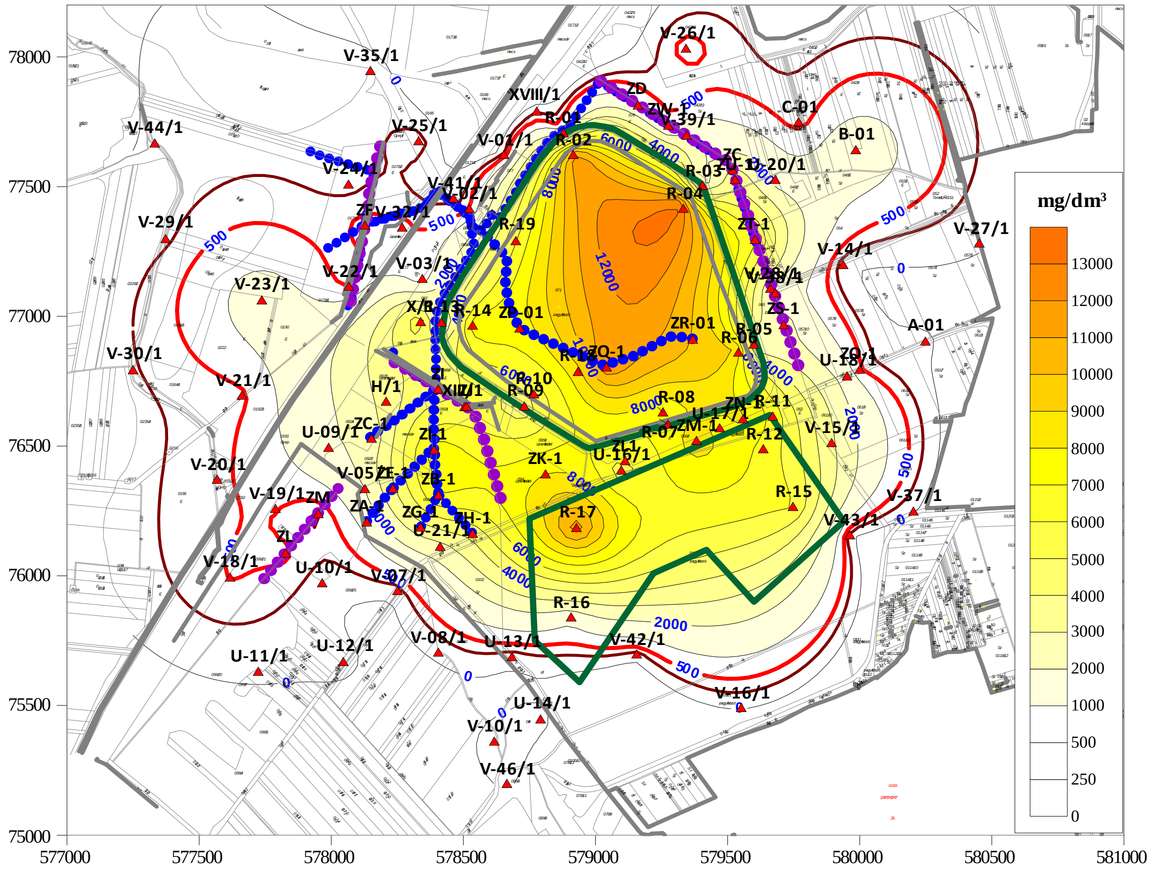


Figure An7.3-1: Sulphate content of ground water in the vicinity of tailings ponds in 2016 (mg/dm³)
(indicating remedial elements; areas in green boundaries show the location of the two tailings ponds)

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

The environmental audit of mining remediation was repeated in 2015. 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. Radiological exposure of the population was found to have significantly decreased, however radon concentration in the open remain above the national average in the region and will continue to do so in the long term.

ANNEX 8: SPENT FUEL ASSEMBLIES OF NUCLEAR FACILITIES

An8.1 Paks Nuclear Power Plant

An8.1.1 Management of the spent fuel assemblies

Regulatory framework

The design and implementation of systems for the management of spent fuel assemblies as well as the elaboration of handling processes were carried out based on the Soviet norms, in accordance with the decrees in force at the time of construction of the Paks Nuclear Power Plant. Legal and technological changes taking place in the meantime made it necessary to renew this regulation. The Government, based on the authorization given in the Act on Atomic Energy [I.6], issued the governmental decree on the proceedings of the HAEA [II.24]. The new Nuclear Safety Codes were published as annexes to this government decree.

Systems managing spent fuel assemblies

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

Spent fuel generated during operation of the nuclear power plant need to be *temporarily* 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 the Paks Nuclear Power Plant, storage at the reactor is ensured under water containing *boron*, in the spent fuel (cooling) pool located in the near vicinity of the reactor. All four units have their own independent spent fuel pool.

In the spent fuel pool belonging to the individual units the *spent fuel* 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 pool. 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.

Removal of the decay heat

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

Proper cooling of the fuel assemblies placed in the transport containers is guaranteed through the design of the container, the maximum burn-up level of the spent fuel, the limitation on the minimum cooling time, and the total decay heat output of the spent fuel assemblies to be transported. During preparations for transporting the spent fuel assemblies in the C–30 containers, the following limiting conditions shall be met:

a) highest average rate of enrichment of the spent fuel assemblies: 4.7%;
b) maximum fuel assembly burnup: 58 GWday/tU;
c) maximum five-year fuel cycle;
d) maximum total output of spent fuel assemblies inside the container: 15 kW;
e) at least 6 months decay period for transportation between spent fuel pools, at least 42 months decay period (if the average enrichment rate is between 3.82% and 4.2%) or 46 months decay period (if the average enrichment rate is 4.7%) for transportation to the SFISF.

Criticality safety

Verification of sub-criticality of the fuel storage systems is based on model calculations. The assessments were accomplished for storage filled with radially profiled fresh fuel assemblies of 3.82% average enrichment rate, containing 120.2 kg uranium. Calculations with the parameters of the new fuel assemblies containing 126.3 kg uranium and gadolinium as burnable poison, with an average enrichment rate of 4.2% and 4.7%, calculations were repeated prior to their introduction. Thus, sub-criticality of fuel assemblies stored in the spent fuel pool is ensured by the design of the storage racks. The storage racks filled up in according to regulations keep the sub-critical state even if they are flooded with clean, i.e. boron-free, water.

Other risks taken into account

- The dropping or any other kind of damage to the fuel assemblies, or the development of unacceptable mechanical stresses are minimized by the transport and lifting technology equipment (with bayonet joint grip, retainers and cranes of specified 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 safety level was assumed simultaneously with re-fuelling and transport manipulations (in case of Paks Nuclear Power Plant 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 however, 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 carried out for the Paks Nuclear Power Plant did not indicate any significant risk in connection with the fuel handling processes.

Compliance with the fuel cycle strategy

From the tasks related to the storage of the spent fuel, MVM Paks Nuclear Power Plant Ltd. 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. Following a minimum set decay period, spent fuel assemblies are handed over to the SFISF for further storage of about 50 years (see Section B.1.2)

Consequences of the incident of April 2003

The incident on 11 April 2003 at Unit 2 of Paks Nuclear Power Plant 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 website of the HAEA (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 68 loaded canisters were transported to the Russian Federation in 2014.* Since then, Unit 2 has been operating in the same way as it had prior to the incident.

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.6] provided for isotope selective limits derived from dose constraints. Based on it, Paks Nuclear Power Plant 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.6] 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.

Airborne discharges

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

Liquid discharges

Sampling of radioactive liquid discharges is performed from monitoring tanks. The qualitative and quantitative determination of the radio-isotopes existing in the waste waters and generated during operation of the nuclear power plant is executed by means of laboratory analysis of the samples taken from the tanks. Only the waste water in the tank that has 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.

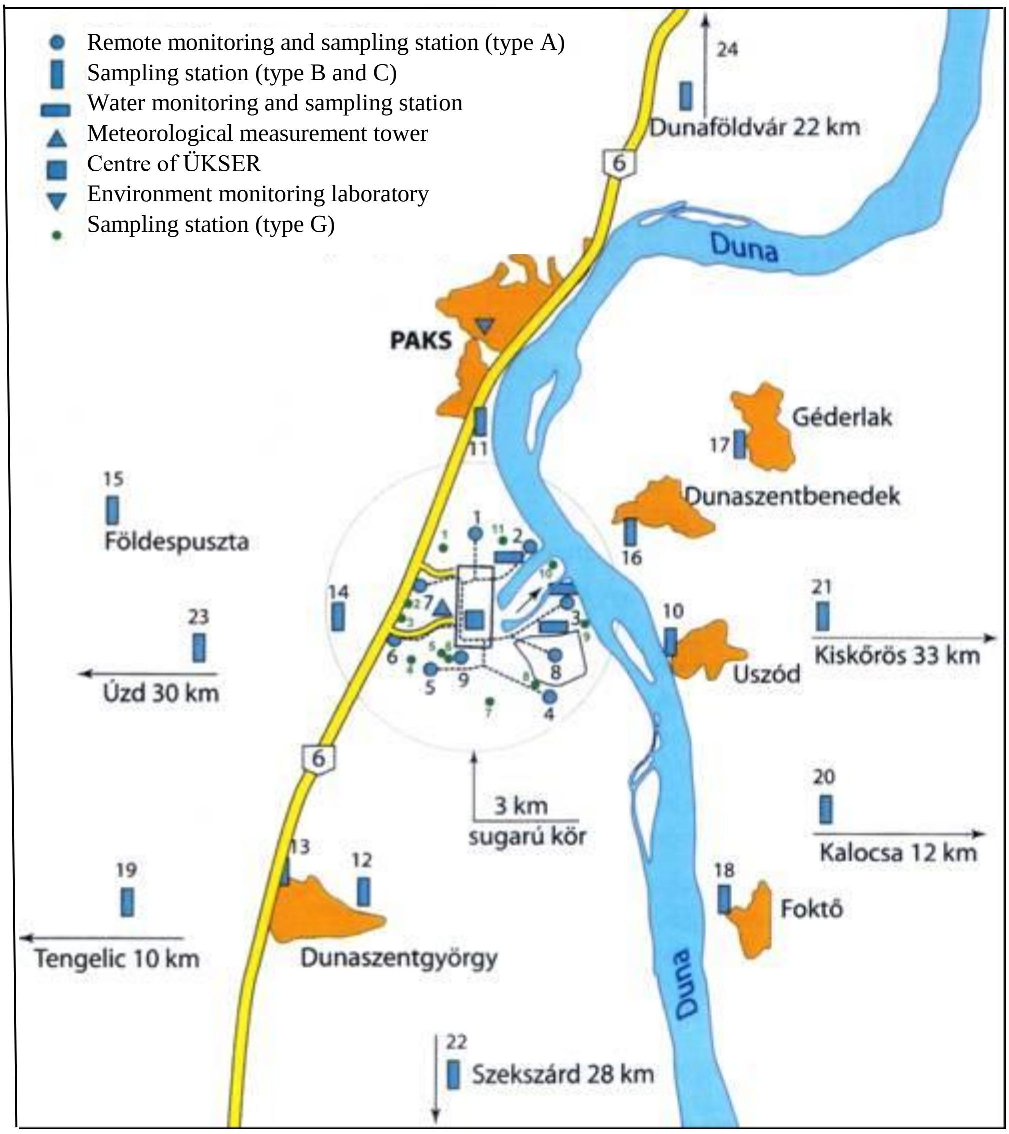
The remote detectors installed along the discharge routes are used for preventing discharge of liquids in an unauthorized way, without laboratory sample analysis.

<u>Environment monitoring</u>

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 2014 and 2016

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 2014 and 2016

Isotope groups	***Total discharge for 2014 [Bq]***	**Discharge limit usage***	***Total discharge in 2015 [Bq]***	**Discharge limit usage**	***Total discharge in 2016 [Bq]***	**Discharge limit usage***
Airborne discharges						
Corrosion and fission products	1.49×10^{9}	1.06×10^{-4}	1.04×10^{9}	6.13×10^{-5}	7.53×10^{9}	4.78×10^{-5}
Radioactive noble gases	2.47×10^{13}	3.45×10^{-4}	2.36×10^{13}	3.24×10^{-4}	2.20×10^{13}	3.50×10^{-4}
Radioiodine	5.32×10^{7}	2.44×10^{-5}	2.51×10^{8}	1.25×10^{-4}	1.55×10^{7}	4.74×10^{-6}
Tritium	3.47×10^{12}	2.00×10^{-5}	4.11×10^{12}	2.37×10^{-5}	4.44×10^{12}	2.56×10^{-5}
Radiocarbon	5.93×10^{11}	1.93×10^{-4}	5.97×10^{11}	1.73×10^{-4}	6.53×10^{11}	1.77×10^{-4}
Total	-	6.88×10^{-4}	-	7.07×10^{-4}	-	6.06×10^{-4}
Liquid discharges						
Corrosion and fission products	1.46×10^{9}	1.38×10^{-3}	1.40×10^{9}	6.69×10^{-4}	1.14×10^{9}	5.87×10^{-4}
Tritium	2.18×10^{13}	7.51×10^{-4}	2.46×10^{13}	8.49×10^{-4}	2.67×10^{13}	9.21×10^{-4}
Radiocarbon	2.18×10^{9}	7.04×10^{-4}	3.57×10^{9}	1.15×10^{-3}	3.42×10^{9}	1.10×10^{-3}
Alpha emitters	1.42×10^{6}	1.49×10^{-6}	3.25×10^{6}	3.33×10^{-6}	2.81×10^{6}	2.85×10^{-6}
Total	-	2.13×10^{-3}	-	2.67×10^{-3}	-	2.61×10^{-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 the BRR 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 transport of the fuel assemblies, criticality safety is provided by limiting the number of fuel elements transported together (the device is not designed to accept more fuel elements). Heat generation of the BRR fuel elements is so low that wet storage is sufficient to remove decay heat. After a one year period of cooling, there is no technical objection against the transportation of the fuel assemblies. During the internal transport of fuel assemblies, the decay heat does not cause a problem due to the above mentioned reason and to the short time.

Spent fuel assemblies containing highly enriched uranium located in the spent fuel storage area of the HAS CER were repatriated to the Russian Federation in 2008 and 2013 (see Section 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 HAEA.

An individual emergency response plan to carry out the repatriation had been submitted to the authority by the KFKI Atomic Energy Research Institute and the HAS CER.

An8.2.2 Discharges

Regulatory framework

The Decree [III.6] 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:

Isotope	Discharge limit [Bq/year]
^{41}Ar	*3.3E+15*
^{85m}Kr	*2.53E+16*
^{87}Kr	*5.24E+15*
^{88}Kr	*5.28E+13*
^{133}Xe	*1.21E+17*
^{135}Xe	*1.63E+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:

Isotope	Discharge limit [Bq/year]
^{3}H	*9.26E+15*
^{46}Sc	*8.76E+11*
^{51}Cr	*7.87E+13*
^{54}Mn	*2.49E+12*
^{60}Co	*1.02E+12*
^{65}Zn	*9.9E+12*
^{110m}Ag	*1.59E+13*
^{124}Sb	*1.14E+13*
^{125}Sb	*3.78E+13*
^{137}Cs	*3.13E+12*

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 Nuclear Analysis and Radiography Department 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 taken immediately and the nuclide specific discharge rate is 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 BRR 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 BRR is connected via aerosol and iodine filters to the 80 m stack. The stack is also used by the Isotope Institute Ltd., therefore during measurements “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 BRR 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. In case of an increase in the level of iodine, the system signals an alarm and the members of the group examine what environmental effects might be caused by the discharge. The Nuclear Analysis and Radiography Department measures the samples taken from the ventilation system by means of gamma spectrometry.

<u>Water discharge</u>

Checking the discharged water is done in the laboratory of the BRR. 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 *2016* as usual. The following results were obtained in the period:

	2011	***2012***	***2013***	***2014***	***2015***	***2016***
atmospheric discharges						
Noble gas (only ^{41}Ar)	*52.6 TBq*	*48,9 TBq*	*42.3 TBq*		*59.7 TBq*	*36.5 TBq*
Iodine	*below detection limit (<5 Bqh/m^3)*	*below detection limit (<5 Bqh/m^3)*	*below detection limit (<5 Bqh/m^3)*	*below detection limit (<5 Bqh/m^3)*	*below detection limit (<5 Bqh/m^3)*	*below detection limit (<5 Bqh/m^3)*
Aerosol	*below detection limit (<3.7 Bq/m^3)*	*below detection limit (<3.7 Bq/m^3)*	*below detection limit (<3.7 Bq/m^3)*	*below detection limit (<3.7 Bq/m^3)*	*below detection limit (<3.7 Bq/m^3)*	*below detection limit (<3.7 Bq/m^3)*
2014						
^{3}H	*did not occur*	*did not occur*	*did not occur*	*did not occur*	*2.15E+11*	*did not occur*
^{60}Co	*did not occur*	*did not occur*	*196 MBq*	*did not occur*	*1.45E+06*	*did not occur*
^{65}Zn	*did not occur*	*did not occur*	*did not occur*	*did not occur*	*7.19E+05*	*did not occur*
^{137}Cs	*did not occur*	*did not occur*	*1.22 MBq*	*did not occur*	*3.03E+06*	*did not occur*

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

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 OCMO NPHMOS issued on 4 January 2005, 50 μSv/year dose constraints was specified for the Training Reactor. Taking this into account, and considering the relevant decree [III.11], 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.