HUNGARY

NATIONAL REPORT
Seventh Report
prepared within the Framework of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management

2020

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ABBREVIATIONS

Act on Atomic Energy	Act CXVI of 1996 on Atomic Energy
BCF	Boda Claystone Formation (before 2011 Boda Aleurolit 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
CPO	*Crew Performance Observation*
Fund	Central Nuclear Financial Fund
EU	*European Union*
HAEA	Hungarian Atomic Energy Authority
HAEA SC	Hungarian Atomic Energy Authority Scientific Council
HLW	*High level and/or long-lived radioactive waste*
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
MoI	Ministry of the Interior
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
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
NPHC RBRHD	National Public Health Centre, Radiobiology and Radiation Health Department
NPHI	*National Public Health Institute*
NPHI PHD RHD	*National Public Health Institute, Public Health Directorate, Radiation Health Department*

NRWR	National Radioactive Waste Repository
NSC	*Nuclear Safety Codes promulgated as the annexes of the Govt. decree 118/2011. (VII.11.) on nuclear safety requirements of nuclear facilities and the related regulatory activities*
OCMO NPHMOS	Office of the Chief Medical Officer of the National Public Health and Medical Officer Service
OECD NEA	OECD Nuclear Energy Agency
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
WANO	World Association of Nuclear Operators

A. INTRODUCTION

The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (hereinafter Convention) was promulgated by Act LXXVI of 2001 [I.10]. (Hereafter the references to legal instruments listed in Annex 4 are used by numbering in brackets). The present National Report has been prepared and submitted in order to fulfil the obligations of Article 32 of the Convention.

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

Section B describes the general policies and practices of radioactive waste management and spent fuel management in Hungary.

Section C addresses the scope of application: there are no reprocessing facilities in Hungary or spent fuel originating from military applications.

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

Section E describes the Hungarian legal background. The basic regulation in force at present, the Act on Atomic Energy [I.6], expresses the national basic principles of the application of atomic energy. It regulates the various 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 special problems related to the safety of spent fuel and ILW/LLW management, respectively.

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 A, 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 long term monitoring activity. Annex 8 deals with the spent fuel management and releases of nuclear facilities other than spent fuel management facilities.

This seventh 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 sixth) National Report, are typeset in Italics.

OVERVIEW MATRIX

	Policy on long-term management	*Financing of obligations*	*Current practice/Facilities*	*Planned facilities*
Spent fuel	*a) Deep geological disposal of the spent fuel from Paks Nuclear Power Plant (the reference scenario is the direct disposal; however, decision on the back-end of the fuel cycle has not yet been made)* *b) Repatriation of the spent fuel from research reactors to the manufacturer's country*	*a) For the spent fuel from Paks Nuclear Power Plant: from the Central Nuclear Financial Fund (payments by Paks Nuclear Power Plant during the period of operation)* *b) For the spent fuel from research reactors: from the Central Nuclear Financial Fund (payments by the operating institute when the cost arisen; the source of the payment is ensured by the central budget in its annual budget)*	*a) Spent fuel of Paks Nuclear Power Plant: storage at the Spent Fuel Interim Storage Facility in Paks* *b) Spent fuel of research reactors: Repatriation/Storag e on-site*	*High activity radioactive waste / spent fuel disposal facility to be constructed in the future*
Waste from nuclear fuel cycle	*Underground disposal at the National Radioactive Waste Repository (in Bátaapáti) / Deep geological disposal*	*Central Nuclear Financial Fund (payments by Paks Nuclear Power Plant)*	*Disposal in the National Radioactive Waste Repository*	*The construction of additional chambers in the National Radioactive Waste Repository, in parallel with operation / High activity radioactive waste / spent fuel disposal facility to be constructed in the future*
Waste from non-energy applications	*Near surface disposal at the Radioactive Waste Treatment and Disposal Facility (in Püspökszilágy)/ Deep geological disposal*	*Central Nuclear Financial Fund (payments by licensees requesting the disposal of the waste)*	*Storage and disposal in the Radioactive Waste Treatment and Disposal Facility (in Püspökszilágy)*	*In the Radioactive Waste Treatment and Disposal Facility (free capacity is to be ensured in the frame of the safety improvement programme of the facility) / High activity radioactive waste / Spent fuel disposal facility to be constructed in the future*
Liability for decommissio ning facilities	*Underground disposal at the National Radioactive Waste Repository (in Bátaapáti) / Subsurface disposal at the Radioactive Waste Treatment and Disposal Facility (in*	*Central Nuclear Financial Fund (payments by Paks Nuclear Power Plant during the period of operation) / for research reactors from the Central Nuclear Financial Fund (payments by the operating institute when*		*The construction of additional chambers in the National Radioactive Waste Repository, in parallel with operation / At the Radioactive Waste Treatment and Disposal Facility (free capacity is to be ensured in the frame of the safety*

	Püspökszilágy)/ Deep geological disposal	*the cost arisen; the source of the payment is ensured by the central budget in its annual budget)*		*improvement programme of the facility) / High activity radioactive waste / spent fuel disposal facility*
Disused sealed radioactive sources	*Near surface disposal at the Radioactive Waste Treatment and Disposal Facility (in Püspökszilágy)/ Deep geological disposal*	*Central Nuclear Financial Fund (financed by the licensee requesting the disposal of the waste)*	*Storage and disposal at the Radioactive Waste Treatment and Disposal Facility (in Püspökszilágy)*	*In the Radioactive Waste Treatment and Disposal Facility (free capacity is to be ensured in the frame of the safety improvement programme of the facility)/ High activity radioactive waste / spent fuel disposal facility*

EXECUTIVE SUMMARY OF THE CHALLENGES AND RECOMMENDATIONS SET OUT IN THE RAPPORTEUR REPORT OF THE SIXTH NATIONAL REPORT

Challenges

1. Continue according to planned steps for increasing SFISF storage capacity

The Spent Fuel Interim Storage Facility (hereinafter SFISF) can be expanded modularly. The planned expansion also takes into account the storage needs of the 20 year service life extension of the Paks Nuclear Power Plant (see Section G.1). In the last three years, the module containing vaults 21-24. were commissioned, the Hungarian Atomic Energy Authority (hereinafter HAEA) granted the construction license for the further construction of the facility, and the building license for the next module (Stage III Phase 3). The construction plans for Stage III Phase 3 were elaborated, the construction of vaults 25-28. started following the successful completion of the public procurement. It can be concluded that the expansion of the SFISF shows good progress, in harmony with the transfer of spent fuel from Paks Nuclear Power Plant. According to current plans, the milestones of the expansion of the SFISF with increased capacity vaults are as follows:

2020-2024. *construction of vaults 25-28.*
2025-2030. *construction of vaults 29-33.*

2. Start safety upgrade of RWTDF (implementation of infrastructure for enabling enhancement of safety: vault content recovery and reconditioning) according to set milestones (2017-2022)

A multi-stage programme was launched in 2002 aimed at modernizing and enhancing the long term safety of the Radioactive Waste Treatment and Disposal Facility (hereinafter RWTDF) (see Sections H.2 and K.2). In the frame of the safety improvement programme, the retrieval, processing, selection, re-qualification and re-packaging of the wastes in pool row I are planned. In order to ensure safe working conditions, lightweight building and an internal containment moving over 4 pools on rails were constructed. The containment is equipped with a ventilation system and a lifting structure required for waste manipulation; currently, the realization of the radiation protection monitoring system is in progress. It can be concluded that the infrastructure needed for the continuation of the programme is available; other supporting technological conditions will be provided, in line with plans, by 2021. Major milestones of the continuation of the safety improvement programme are:

2021-2025. *opening of vaults A01-A24 of pool row I – retrieval, radioactive waste processing, qualification, renewal of pools, re-disposal of waste;*
2026-2031. *retrieval and processing of the content of pool row II (vaults A25-A48), re-disposal of waste, then remediation of the environment of pool rows I-II;*
2032–2039. *conditioning and volume filling of the content of pool rows III and IV.*

3. Commission disposal chambers in the National Radioactive Waste Repository according to set milestones

The National Radioactive Waste Repository (hereinafter NRWR) is expanded according to the generation of low and intermediate level waste at the nuclear power plant (see Section H.3). The filling of the first disposal chamber (I-K1) with radioactive waste was completed. The reinforced concrete vault composing a part of the engineering barrier system of the new disposal concept was completed in the second disposal chamber (I-K2), together with completion of the installation of the connecting technology systems. In parallel, the construction of the reinforced concrete vault started in the third disposal chamber of the repository (I-K3). The compilation of the application for amending the construction license in support of the modification segment size of the western side chambers (I-N1 and I-N2) of the NRWR and the further expansion of the facility, which is based on the safety report supporting the construction. The expansion of disposal capacity is in line with the demands raised by Paks Nuclear Power Plant. According to current plans, the milestones of the expansion of the NRWR are:

2024.	*Putting chamber I-K3 into operation, commencement of its filling;*
2030.	*Putting chambers I-N1, I-N2 into operation, commencement of their filling;*
2037.	*Putting chamber I-K4 into operation, commencement of its filling;*
2062.	*Commencement of transporting decommissioning waste to chamber I-N1.*

4. *Remediation – Enlargement of the water treatment plant in order to manage the volume of mine water that will be increased after the complete flooding of certain underground mining openings in the former uranium mine according to set milestones (2019-2020)*

After the termination of the mining activities and the water pumping from disused underground mine volumes on the former uranium ore mining and ore processing impact area, located in the Mecsek mountain, in 1998, the mine cave system of about 18 million m^3 fills up with uranium-contaminated water. The underground cave system of the Northern mine plants (plants II, IV and V) is not in direct contact with the mine volumes of plant III that had been filled up in already in 2015; its filling up follows a different timing. Based on actual monitoring data as foreseen, the filling up process will reach the Northern caves after 2023, which will necessitate the annual treatment of about 500 000 m^3 additional water volume, leaking out by gravitation, having expectedly 6-8 mg/l uranium content and high total solved material content. In order to protect the drinking water bases, located in South-East-South-South-West direction from the impact area, playing essential role in the drinking water provision to Pécs town and the surrounding settlements, the removal of the water having 3-5 mg/l uranium content from the mine volumes of plant I, located in the South side of the impact area, is in progress. The water volume to be treated, together with the water from the North mine plants, will expectedly increase to 1 500 000 m^3 in a year. The expansion works of the water treatment system started in 2014 were completed by 2020.

5. New NPP units – Step-by-step integration into the Hungarian spent fuel and radioactive waste management

5.1 Spent fuel management

- *The quantity of spent fuel generated during the operation of new nuclear power plant units is determined in the National Programme on the management of spent fuel and radioactive waste (hereinafter National Programme). Accordingly, the active core of the new reactors will include 163 pieces of fuel assemblies. After their operating time, the weight of the heavy metal in each spent fuel assembly will be about 450-455 kg, while the weight of fission products will be about 15-20 kg. After the initial 12 month campaigns the units will follow 18 month refuelling cycles. In this latter case, 72-73 pieces of spent fuel assemblies will be removed from a reactor in each campaign, which means 144-146 assemblies for the two units every 18 months. Based on conservative estimation, with altogether 6,100 pieces of spent fuel assemblies can be calculated until the end of the 60 year long service life of the two units.*
- *The spent fuel assemblies are moved from the reactor to the spent fuel pool, where the removal of the residual heat is ensured until it decreases to a value, which allows dry interim storage of the fuel element. The fuel assembly may stay 10 years, at a maximum, in the spent fuel pool. After this period the fuel elements are transferred to interim storage.*
- *The environmental impact assessment served as a basis for the environmental license of Paks II. Ltd, taking into account the planned service life of the new units and the time frames established in the intergovernmental agreements, considers the interim storage of spent fuel assemblies in Hungary, on the site of the units or its close vicinity. The solutions applied for interim storage of spent fuel assemblies in the world were analysed in the environmental impact assessment, and based on the advantages described thereof the dry storage in containers was chosen.*
- *The date of commencing the construction tasks in connection with the interim storage of the spent fuel elements of Paks II. Ltd. is dependent on the lengths of the period required for the construction of the storage facility and the maximum 10 years period of storing the spent fuel in the spent fuel pool.*
- *The Government assigned the Public Limited Company for Radioactive Waste Management (hereinafter PURAM) as the organisation responsible for construction.*
- *The environmental impact assessment of Paks II. Ltd assumes the direct domestic disposal of the spent fuel assemblies, after their interim storage.*

5.2. Management of low and intermediate level radioactive wastes

- *The processing and conditioning of the low and intermediate level wastes generated during the operation of the new Paks units shall be provided by the operator of the units in a way that complies with the waste acceptance criteria system. In accordance with the provision established in the National Policy on the management of spent fuel and radioactive waste (hereinafter the National Policy)"the long term programmes for the disposal of radioactive wastes generated by the new nuclear power plant units shall be elaborated taking into account existing facilities", the disposal of low and intermediate level radioactive wastes shall be solved with the appropriate expansion of the NRWR.*

- *Data on amount of waste to be generated by the new Paks units were first developed in the environmental impact assessment and the National Programme. In the frame of the on-going technical design process of the new units, the waste amount data were revised in comparison with the National Programme; accordingly, the generation of 62 barrels of solid waste and 25 pieces of small reinforced concrete containers containing conditioned liquid waste might be calculated for each unit in a year.*
- *Based on these input data, postulating 60 years of service life of both new units, altogether 7440 barrels (1,488 m^3) of solid waste and 3,000 pieces of concrete containers (4,500 m^3) containing conditioned liquid waste might be forecasted.*
- *Taking account of the international recommendations, an essential requirement for the design of new nuclear power plant units is to generate as low amount of radioactive waste during the decommissioning of the nuclear power plant as possible. In line with the international practice, the National Programme considers the immediate decommissioning option for the decommissioning of the new units. Based on the currently available data, 25,000 m3 very low level, 11,070 m^3 low level and 2,870 m^3 intermediate level radioactive waste should be expected during the decommissioning of the two Russian designed VVER-1200 type pressurized water nuclear power plant units.*

5.3.Management of high level waste and/or long-lived wastes

- *In the current phase of the preparation of the construction license application, the amount of high level and/or long-lived radioactive wastes (hereinafter HLW) generated during the 60 year service life of the new nuclear power plant units is estimated as ~0.5m^3/unit/year, in harmony with the National Programme. Accordingly, a total volume of 60 m^3 HLW will be generated during the 60 year service life of the two new units. The estimated volume of HLW generated during the decommissioning of the new units is 200 m^3.*
- *The numbers above well show that the total amount of HLW generated during the operation and decommissioning of the new units is 260 m^3[1], which is a magnitude lower than the volume of HLW from the spent fuel generated in the new units or that generated by their processing.*
- *As stated in the National Policy, the disposal of high level radioactive wastes shall be provided in a repository constructed in Hungary, within a stable deep geological formation. In line with the uniform international standpoint, such a repository is suitable to directly dispose spent fuel, and it is also suitable to host wastes generated during the processing of the spent fuel, depending on the chosen fuel cycle closure strategy. At this point, the policy on radioactive waste disposal is linked with the policy on fuel cycle closure; the deep geological radioactive waste repository shall be designed and constructed in a way that allows disposing high activity and long-lived radioactive wastes, as well as spent nuclear fuel.*

[1] Note: this amount does not include the volume of the spent fuel.

6. Management of very low level radioactive waste

The separation of the management and disposal of radioactive wastes qualified as very low level radioactive waste from the low and intermediate level radioactive wastes would significantly reduce the amount of radioactive wastes requiring long term management, taking into account that the very low level waste, after a period shorter than in the case of other radioactive waste classes due to its relatively shorter half-life, allows realizing a disposal solution that is similar to the solution applied for non-radioactive industrial wastes. This aspect is important, since the amount of generated very low level waste is significant, especially during the decommissioning of nuclear facilities.

Pursuant to the IAEA GSG-1 guide, the repository disposing very low level wastes requires lower level protection and nuclear safety provisions and conditions, less rigorous than those applied for the repositories disposing wastes of greater activity concentration.

Consequently, the development of the legal framework, being in line with the international practice and EU requirements, and fitting to the national regulatory system, for the construction and operation of a repository serving for the disposal of very low level radioactive wastes shall be continued.

Suggestions

1. ***Consolidate plan for creating a deep disposal facility for SF and HLW (site selection, URL, conception, construction and commissioning) in considering regulatory decisions, technical skills and requirements, and public consultation will be needed at each step of the process.***

The detailed requirements for the investigation and evaluation of the site of a deep geological repository are established in Annex 3 of the Govt. Decree [II.35], which entered into force in 2018. Pursuant to the legal provisions, the PURAM elaborated the site investigation frame programme for the surface research of the Boda Claystone Formation (hereinafter BCF), which was approved by the licensing authority, namely the HAEA in 2019. According to the frame programme, the area of a few km^2 has to be defined with a graded concentration, based on 3 surface research phases, within an area about 87 km^2, where at first the underground research laboratory, then the repository itself can be constructed (See section G.2). Each action planned to be performed in each research phase requires a site survey license, which shall be justified by a site survey plan. Clients may participate in the licensing procedure in the frame of a public hearing. Currently, the site survey plan for the first phase is under compilation.

2. ***To elaborate in the next National report on the policy of VLLW and clearance criteria and operational procedures***.

The development of the legal background for the large amount (~22000 m^3) of very low activity waste to be generated during the decommissioning of Paks Nuclear Power Plant has been commenced. The new classification system of radioactive wastes and the procedure releasing from regulatory control are established in Govt. decree [II.36] (see Section D.2.1). The law *establishing requirements for the repository serving for the disposal of very low level radioactive wastes is currently under development.*

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The compilation of the report was finalized on 31 March 2020; the report, unless otherwise indicated, describes the conditions as of 31 December 2019.

Declaration

Hungary declares that:

- priority is given to the safety of spent fuel management as well as the safety of radioactive waste management, and both are achieved by way of legal regulation alongside the efforts of regulatory body and operators;
- appropriate measures are taken to ensure that, during all stages of spent fuel management and radioactive waste management, there are effective defences against potential hazards in accordance with the objectives of the Convention;
- appropriate measures 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 2020

B. POLICIES AND PRACTICES

Council Directive 2011/70/EURATOM (July 19, 2011) establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste [hereinafter Council Directive 2011/70/EURATOM] requires Member States of the European Union (hereinafter EU) to establish and maintain national policies on spent fuel and radioactive waste management.

The Parliament adopted the National Policy in a decision [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 were promulgated in the Hungarian legal system, mainly in the Act on Atomic Energy [I.6] and its implementing decrees, before the adoption of a National Policy, but have also been summarized according to the requirements of the Council Directive 2011/70/EURATOM in a systematic manner.

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 public participation in decision-making, i.e. the policy of transparency are also presented.

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 to follow domestic and international developments, technological advancements to be integrated into to 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 National Policy, 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 there are already facilities for this purpose. 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 topical in the future. The decommissioning plan must include the decommissioning schedule, if necessary including the period of safety enclosure, 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 [I.13] transposed into the Act on Atomic Energy [I.6] in 2013 from the Council Directive 2011/70/EURATOM, 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 estimates for future quantities, including those from decommissioning, clearly indicating the location and the amount of 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 controls are maintained and the means to be employed to preserve knowledge of that facility in the longer term;

f) the description of such 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 disposal facilities.

In accordance with the above requirements, the National Programme was adopted by the Government in August 2016 in the form of a government 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 Govt. Decree [II.40] on the promulgation of the Protocol on Strategic Environmental Assessment, adopted in Kiev, on 21 May 2003 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 by the Ministry of National Development.

In accordance with international and EU legal 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 Govt. 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 effective National Policy and National Programme every five years[2]. 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. *The review of the National Policy and the National*

[2] *The review process established in the Act on Atomic Energy is due in 2020 for the National Policy and in 2021 for the National Programme.*

Programme will start in 2020. Taking into account the reference date of the report, information on the actual state of the revised documents will be provided in the next report.

B.1 Spent nuclear fuel and high level wastes

B.1.1 Applied practice

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

Hungary has three nuclear facilities producing spent fuel: Paks Nuclear Power Plant, the Budapest Research Reactor (hereinafter BRR) in the Centre for Energy Research of the Hungarian Academy of Sciences (hereinafter HAS CER) [3], and the Training Reactor of the Institute of Nuclear Techniques at Budapest University of Technology and Economics (hereinafter Training Reactor).

High level waste 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 high level waste in the future. The decommissioning of the other two nuclear facilities will also produce radioactive waste, but to a much smaller extent, and *according to the current decommissioning plans, high level wastes will not be produced during their decommissioning.*

The high level wastes generated in Hungary shall be disposed in Hungary, 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. Between 1996-1998 a research shaft was established (then operating) from the uranium mine located in the Mecsek mountain that reached the BCF at the depth of 1,100 m. The programme was limited to three years because of the closure of the mine in 1998; the reason for this was that the existing infrastructure of the mine could be economically maintained only during this time period.

The studies were completed by the end of 1998 and summarised in a documented form. According to the final report there were no circumstances *identified* that question the suitability of the *assessed rock* for the purpose of high level waste disposal. 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 and research works aimed at the exploration of the *rock potentially hosting the repository* and the selection of a suitable site continued since 2004. The primary objective of the re-started research was to select the location of an *underground* research laboratory. The preparations, however, continued more slowly than

[3] *Since September 1, 2019 the HAS CER does not belong to the Hungarian Academy of Sciences; it has been functioning in the frame of the Eötvös Loránd's Research Network, based on the Act LXVIII of 2019 amending the Act LXXVI of 2014 on scientifc research, development and innovation. HAS CER abbreviation is used in the text as reference.*

expected because of the preferential importance of the NRWR for the final disposal of low and intermediate level radioactive wastes of Paks Nuclear Power Plant, hence the schedule of the project aiming at selection of site for an underground research laboratory had to be revised.

At the beginning of 2008 a document entitled "Updated concept of the long term research programme of the 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 aiming at the domestic 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 supported by safety assessment, as well as to the establishment of a strong leader and manager group within PURAM in order to assure the harmonization, and successful accomplishment of research activities. This group should be responsible for programme planning and strategic issues, as well as for integration of results coming from various fields of expertise.

Taking 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 high level wastes (see the organization structure of PURAM in Figure F.2.2.1-1). During 2012-2013 PURAM prepared its geological survey plan for the next stage of the investigation of the BCF, which was approved by the competent authority (former Pécs Mining District Authority).

The aim of the research phase launched in 2014 was 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 was somewhat slower than originally planned adjusted to the available financial resources, *and it paused at 30% completion in 2018*.

Pursuant to the provisions of Govt. decree [II.35] that entered into force in 2014, research frame programme shall be developed for the investigation and evaluation of the site of radioactive waste repositories; the programme shall be submitted for authorization. The new safety code issued as an Annex to the Govt. decree in 2018 (Annex 3 of Govt. decree [II.35]) provides detailed requirements. Beyond the geological investigation, the frame programme extends over the characterization of radioactive wastes, the conceptual design of the repository, and other examinations required for the justification of safe operation and long term safety. The frame programme shall be regularly updated in the light of new information and circumstances.

In 2018 the research frame programme of the BCF was elaborated by PURAM, which was approved by the HAEA in 2019. The frame programme considers 3 surface research phases, and it schedules the commencement of the construction of the underground research laboratory after 2032.

The drills of the geological research of BCF is expected to continue. The execution of the geological research works are supported by the local governments of eleven settlements affected by the research area.

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 after the spent fuel elements had been 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 residual radioactive waste and other by-products created during reprocessing. At present Hungary does not have the capability to final dispose of high-level or long lived radioactive waste.

That was the reason why the licensing and construction of an interim spent fuel storage were started in 1993. MVM Paks Nuclear Power Plant Ltd commissioned the British-French company GEC Alsthom to build a modular vault dry storage type facility. One of the advantages of this type of construction and storage technology is that the number of storage vaults 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 *eight* 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 *about* 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 BRR and the Training Reactor also contributes to 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 *226* are currently occupied (on December 31, 2019). Following a 3-5 year storage period they can be transported to the external spent fuel repository, which (on December 31, 2019) has a capacity of 2256 fuel assemblies and currently all of them are empty. In the 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 in a hermetically sealed capsule filled with nitrogen, which is then placed in a water-filled tank providing biological protection. The licensee possesses a license for both methods of storage (see Section B.1.2)

The Training Reactor is operating with the fuel elements that were placed into the core at the start of the operation and after the reconstruction in 1980. The burn up rate of the reactor fuel elements is slow as a result of the low maximum power and the carefully planned operation in connection with student training and research activities. Adequate fuel cladding condition was confirmed by analyses. Consequently, the reactor can further operate for many years 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 recycled (reprocessed) outside the reactor, is not considered as waste or, if it is not reprocessed according to a respective decision then thereinafter it is considered as radioactive waste and 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 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, 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

In the reporting period, the policy of the back-end of the fuel cycle for spent fuel from domestic non-power generating reactors is defined by an intergovernmental agreement [II.41] to return them to the Russian Federation, until the termination of the agreement (August 31, 2018) in such a way that the secondary wastes generated during the reprocessing remained in the Russian Federation. As a result of the modification (conversion) of the BRR (change of the highly enriched fuel elements [HEU] to low enriched [LEU]), from the beginning of 2013 the reactor core is only composed of low enriched fuel elements, The HEU fuel assemblies and other nuclear materials were transported back to the Russian Federation. The last repatriation was completed in 2013; thus, repatriation did not occur in the period between 1 January, 2017 and December 31, 2018. The decision on future actions regarding the spent fuel element from the BRR and the Training Reactor will be made by the Government in the frame of the current review process of the National Policy and the National Programme.

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 wastes

B.2.1 Applied practice

The solid and liquid radioactive wastes that are generated during the operation of the nuclear power plant are processed and 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 some 40 km north-east of Budapest (see Figure B.2.1-1). The repository is a typical near-surface facility, composed of concrete vaults and shallow wells for spent sealed sources.

Figure B.2.1-1 Sites of importance in Hungary

The competent authority issued the final operating 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.

Judging from the geological investigations, it is not possible to expand the RWTDF for the disposal of the waste originating from the operation and decommissioning of Paks Nuclear Power Plant. The low-level, solid waste from Paks Nuclear Power Plant was transported to the repository in Püspökszilágy only as a provisional solution. At the same time the capacity of the RWTDF was increased with the financial support of the nuclear power plant. The total capacity of the repository is now 5040 m^3.

From 1 July, 2014 regulatory oversight of radioactive waste storage facilities is carried out by the HAEA. Simultaneously with the transfer of competences, the safety requirements have changed. Accordingly, PURAM submitted an application for obtaining a new operating license to the HAEA. *The actual operating license of the RWTDF was granted by the HAEA on August 19, 2019. The operating license is valid until December 31, 2067 with the condition that a periodic safety review [hereinafter PSR] has to be carried out every 10 years, and the modification of the license has to be requested in the case of modifications having significant impact on safety.*

The results of the safety assessments *justified the safety of the repository during its service lifetime*. At the same time, they indicated that certain *disposed* radioactive wastes 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 from certain vaults and then the rest are – as far as possible – compacted before re-disposal in the vaults. This way, *in addition to improvement of long term safety, the disposal capacity is also increased*. So, 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 within Section H and K.

National Radioactive Waste Repository

Since the expansion of the RWTDF to the extent that would ensure the total needs of the Paks Nuclear Power Plant is impossible, a national programme was launched in early 1993 with the aim of finding a solution for the final disposal of low and intermediate level waste of the nuclear power 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. The license for commissioning was granted to NRWR on 25 September 2008, the scope of which 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 chamber. 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.

The 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 Authority 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 vault with the related technology systems in chamber I-K2 *was completed in 2017. The new operating license (extending over chamber I-K2) was issued by the HAEA on September 5, 2017. Prior to granting the authorization, as a legally required part of the proceeding, a public hearing was held in Bátaapáti on 8 June 2017. The disposal of the first, new type waste packages will be commenced, in harmony with the schedule of transportation from Paks Nuclear Power Plant, in 2021.*

In 2017, in parallel with the commissioning of chamber I-K2, the PURAM initiated the construction works of the reinforced concrete vault and the expansion of the technological systems to be built in vault I-K3, which activities were continued in 2019.
In quarter I of 2018, the PURAM performed the deepening of two view drills, in order to further clarify the expansion concept of the NRWR.

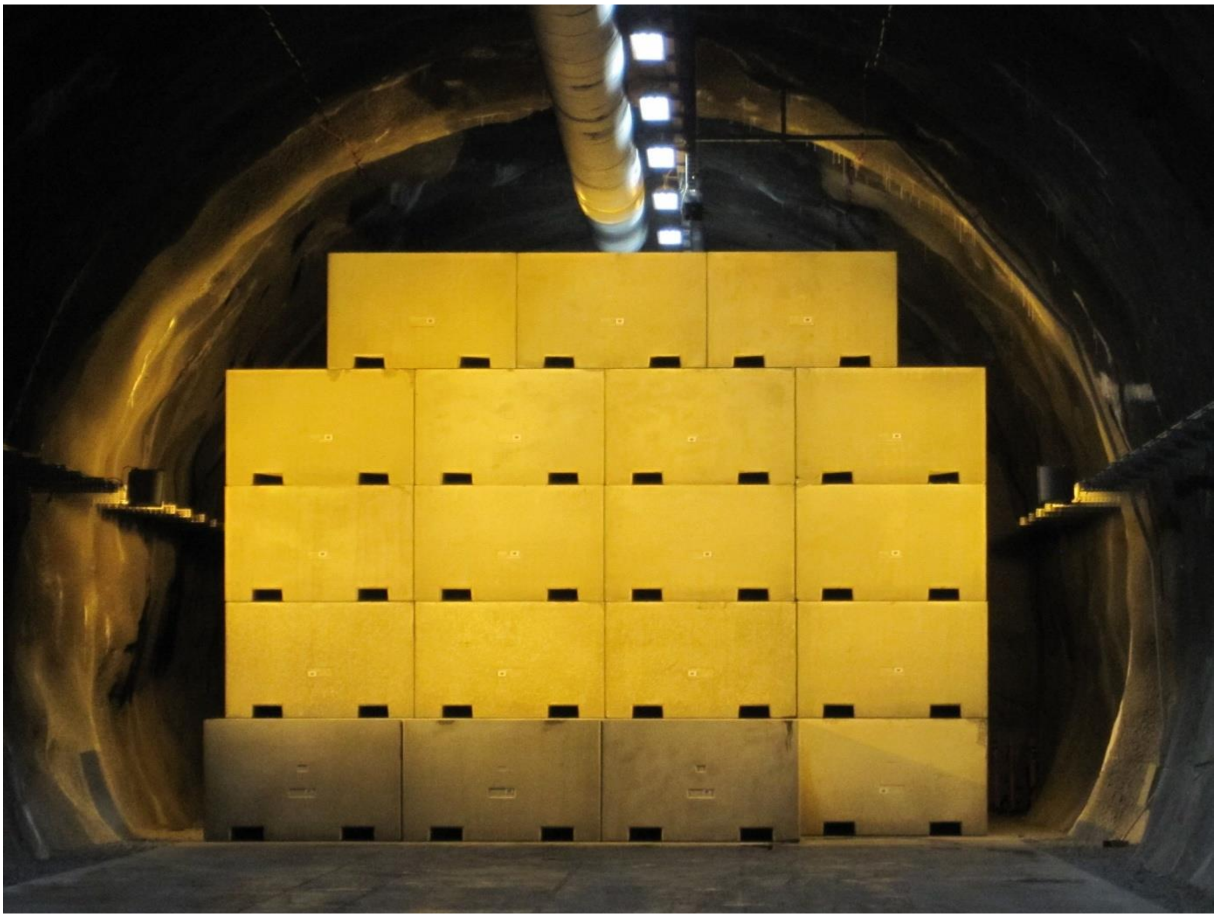


Figure B.2.1 – 3. Containers disposed in the I-K1 vault of the National Radioactive Waste Repository

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 policy

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 RWTDF 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 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.

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 in 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 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 point of view 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.

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 installation is used for 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 average enrichment rate is 3.82%, 4.2% and 4.7%. The so-called fuel optimised for water-uranium ratio will be introduced from 2022. In the coming years, transferring to the use of so called optimised geometry assemblies is planned in the case of assemblies enriched to 4.2% and 4.7%, what will enhance positively the future use of assemblies. Taking account of the introduction of so called optimised geometry assemblies*, along with the consideration of the 20 year service life extension, as well as *the introduction of a 15-months fuel cycle and the optimised geometry assemblies*, 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 17,483, with approximately 2,138 t heavy metal content*.

As a result of improvements made to the nuclear fuel used by 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 *2019*, *1,848* fuel assemblies were stored in the spent fuel pools of the Paks Nuclear Power Plant while *9,577* fuel assemblies were in the SFISF.

At the end of *2019*, the total capacity of the SFISF was *11,416* assemblies in *24* vaults. The extension of the storage facility with four new vaults is in progress. In order to provide storage capacity for every spent fuel assembly remaining in the country, the storage capacity must be increased. *In February 2016, the PURAM requested the amendment to the valid construction license related to capacity increase, which will allow the storage of 703 spent fuel assemblies in each vaults from vault 25. In May 2017, the HAEA amended the construction license of the SFISF in relation to vaults 25-33. in a resolution. As a result of a denser of the grid layout, the PURAM plans the construction* of 33 vaults 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 30 fuel assemblies that were damaged during the cleaning process in April 2003).

Actions *were completed* 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, for Unit 3 in December 2016, *and for Unit 4 in December 2017*, which are valid until the end of 2032, 2034, *2036 and 2037*, 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 *planned 20th* Medium and Long Term Plan of PURAM (see Section E.1) the present report takes into consideration the consequences of the service life extension, the 15-months fuel cycle, *as well as the impact of optimised assemblies*.

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.

On December 31, 2019, in total, *226* spent fuel assemblies were stored on site having about 29 kg of heavy metal. The reactor currently has an operating license valid until 2023; thus, from the end of *2019* until the end of the license, approximately *300* additional VVR-M2 spent fuel assemblies can be expected (approximately equivalent to *75* 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 wastes

Govt. decree [II.36] regulates the classification of radioactive wastes.

The high level (high activity) radioactive waste is the radioactive waste, the heat generation of which shall be taken into account during the design and operation of storage and disposal. The radioactive waste with a heat generation higher than 2 kW/m^3 or if it belongs to Category 1 of radioactive wastes according to the Govt. decree [II.33] due to its gross activity shall always be classified as high level waste.

That radioactive waste shall be classified as low or medium level radioactive waste, which cannot be regarded as high level radioactive waste.

Classification viewpoints for low and intermediate level radioactive wastes are as follows:

Classification according to activity concentration of radionuclides in the wastes:

1. *Classification of radioactive wastes to low or medium level class shall be performed based on the activity concentration and specific exemption activity concentration (SMEAK) of the contained radioisotope* (Table D.2.1-1).

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

Radioactive waste class	Activity concentration comparison
Low level	$\leq 10^3$ SMEAK
Intermediate level	$> 10^3$ SMEAK

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

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

Radioactive waste class	Activity concentration comparison
Low level	$\sum_i \left(\frac{AK_i}{SMEAK_i}\right) \leq 1000$
Intermediate level	$\sum_i \left(\frac{AK_i}{SMEAK_i}\right) > 1000$

where
AK_i is the activity concentration of radioisotope i,
$SMEAK_i$ is the isotope specific exemption activity concentration of radioisotope i.

Classification based on the half life of the radionuclides in the waste:

1. *Short lived radioactive waste shall be that low or medium activity radioactive waste, which contains limited quantity of radionuclides (averaged to the whole quantity) with a half life (rounded to a complete year) greater than 30 years, according to the formula below:*

$$\sum_i \left(\frac{AK_i}{SMEAK_i}\right) \leq 1$$

where
AK_i is the activity concentration of radioisotope in the radioactive waste that has a half life (rounded to a complete year) greater than 30 years,

$SMEAK_i$ is the isotope specific exemption activity concentration of radioisotope i in the radioactive waste that has a half life (rounded to a complete year) greater than 30 years.

2. *Long lived radioactive waste shall be that low and medium activity radioactive waste, in which the concentration of radionuclides with a half life (rounded to a complete year) greater than 30 years exceeds the limits related to short lived radioactive waste.*

Very low level radioactive waste shall be that for which the contained activity concentration of the isotope, the half life of which is not greater than 30 years (rounded to a complete year), is not greater than 50 times the specific exemption activity concentration (SMEAK), and for the isotope, the half life of which (rounded to a complete year) is not greater than 30 years, is not greater than the general exemption activity concentration (ÁMEAK). If the radioactive waste contains more types of radioactive isotopes, then the classification shall be performed according to the formulas below.

a) for the isotopes, the half life of which (rounded to a complete year)is not greater than 30 years:

$$\sum_i \left(\frac{AK_i}{SMEAK_i}\right) \leq 50$$

b) for the isotopes, the half life of which (rounded to a complete year)is greater than 30 years:

$$\sum_i \left(\frac{AK_i}{\acute{A}MEAK_i}\right) \leq 1$$

where
AK_i is the activity concentration of radioisotope i in the radioactive waste,
$SMEAK_i$ is the specific exemption activity concentration of radioisotope i,
$\acute{A}MEAK_i$ is the general exemption activity concentration of radioisotope i.

The regulations on exemption and clearance of radioactive materials also apply to radioactive waste. Exemption levels *(general and specific exemption activity concentrations)* are regulated by Govt. decree [II.36] in accordance with the regulations of the EU. The procedure of clearance from regulatory control is also regulated by this Govt. decree [II.36]. The referenced government decree distinguishes the following cases.

1. *Radioactive material may be released from radiation protection regulatory control with a notification if:*

   – *the activity concentration of the radioactive material decreased below the general exemption activity concentration value, or*

- *the activity of the sealed radioactive source that has a half-life shorter than 100 days does not exceed the relevant exemption activity, and the activity of the sealed radioactive source that has a half-life longer than 100 days does not exceed the one tenth of the relevant exemption activity. If the radioactive material includes more than one radionuclide, then the criterion shall fulfil for the sum of the ratio of the activity and relevant exemption activity of each radionuclide.*

2. *The radioactive material can be released from radiation protection regulatory control in the frame of a licensing procedure established in Paragraph 17 of Subsection (1) of Section 53 of Govt. decree [II.36], if*

   - *the reprocessing, reuse or disposal as non-hazardous waste (including incineration) of artificial radionuclides does not induce an individual annual dose to any member of the public exceeding 30 µSv effective dose, and the effective dose remains below 1 mSv/year in the occurrence of low probability events, or*
   - *the surplus effective dose from the practice with naturally occurring radionuclides to one person is 1mSv/year at most,*

   and the analyses made considered the effects of materials previously released from the radiation hazardous workplace.

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 *2019*, approximately 1*03.7 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 *extended service life (50 years)* of the nuclear power plant can be stored in the existing storage space.

D.2.3 Inventory and rate of generation of low and intermediate level non-nuclear power plant origin (institutional) radioactive waste

The small-scale, non-*nuclear*-fuel-cycle producers such as hospitals, laboratories and industrial companies generate about 5-15 m^3 low and intermediate level waste, about 300 used radioactive sources and typically *2,000* radioactive sources from dismantled smoke detectors per year. *As of 31 December, 2019*, *3,832* shipments were carried out from *648* 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 *175 m^3* wastes were stored at the end of *2019*. In order to further increase the capacity of temporary storage, the classification of Type-A storage pools 65 and 66 was requalified to temporary storage, where at the end of *2019*, *76 m^3* waste was stored. At the end of *2019* the total activity of the radioactive wastes in the repository was *262 TBq* based on the available data.

Most of the *received* radioactive wastes, including spent sealed sources, are generated in 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 low and intermediate level wastes 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.

Gaseous wastes:

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

Liquid radioactive wastes:

Chemical waste waters containing radioactive isotopes are generated from various sources within the controlled zone of the 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 *2019* was *7,823 m^3*, of which *230 m^3* was generated in 2019. There are *6,709 m^3* of evaporation residue at the site of the Paks Nuclear Power Plant, as the processing of *1,114 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 *2,444 m3* evaporation residues – containing alpha emitters – produced until 31 December *2019* in consequence of the serious incident at Unit 2 in April 2003, the temporary storage of which takes place in separate from the other concentrates. The expected annual volume of evaporation residue based on the current generation rate will be *200 m^3/year*. Considering the 20 year service life extension, *altogether 11,350 m^3* evaporation residue can be expected.

A special tank was provided for the storage of evaporator acid solution. Evaporator acidation solution was not generated in *2019*; thus as of 31 December *2019* 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 *436 m^3*.

The total quantity of resins used up to 31 December *2019* was *266 m^3*, of which *12.5 m^3* was generated in 2019. At present, there is no necessity for immediate processing of the ion exchange resins. Considering the present 5 m^3/year generation rate for ion exchange resin, the total volume till the end of the 50 year service life, taking into account the final blowdown of the ion exchange resins, will be *484 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 (placed into 200 l drums),
- ultra filter membrane modules,
- caesium selective sorbent columns (placed into reinforced concrete containers),
- borax (hazardous waste that can be exempted).

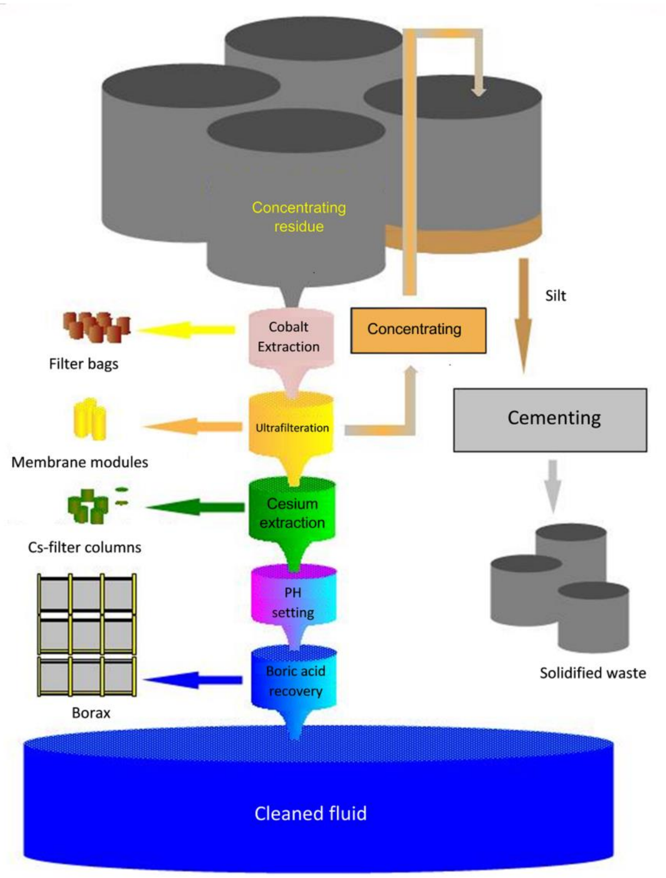


Figure D.2.4 - 1. Steps of the LWP technology

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, 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

Until 31 December *2019*, a total of 6,536 drums were transported from Paks Nuclear Power Plant to the NRWR. Out of these, *4833* were put into chamber I-K1 for final disposal. As of 31 December *2019*, *9,424* 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 *750* drums of 200 l capacity.

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

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

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

Only relatively small amounts of waste are planned to be produced by the early stages of decommissioning, e.g. from the removal of fuel and the flushing out of the reactor coolant circuits. The accepted decommissioning strategy includes a 20 year safe enclosure period of the primary circuit; thus it entails postponed dismantling. The total estimated volume of low and intermediate level 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* m3 size containers	Number of *3.6* m3 size containers
20 year long safe enclosure 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.

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 OECD NEA) were also considered.

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

- declares the priority of nuclear 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 the licensing procedures;
- defines and allocates the competences and tasks of other public administration bodies involved in the application of atomic energy;
- declares the organisational and financial independence of the 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 the Act on Atomic Energy or a law issued for the implementation of the Act on Atomic Energy*, or *failing to comply with a provision set forth in its regulatory resolution* issued based on the above;
- requires that the *organisation appointed by the Government provides a proposal on the National Policy and National Programme on the management of radioactive waste and spent fuel, and performs the tasks related to the final disposal of radioactive waste, the interim storage of spent fuel, the back-end of the nuclear fuel cycle, and to the decommissioning of nuclear facilities;*
- requires the establishment of a Central Nuclear Financial Fund (hereinafter CNFF) intended for financing the disposal of radioactive waste, the interim storage and final disposal of spent fuel, back-end of the fuel cycle, and for the decommissioning of nuclear facilities;
- requires 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 between 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 *or ceased to be in force*, 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 public health departments of the capital city and country government offices (hereinafter 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 Govt. decree [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 *and refer* to 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 expansion 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 new* 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 (2013 December 5) 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 (hereinafter 2013/59/Euratom directive).

According to the provisions of 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 requirements, 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 requires an environmental licensing procedure based on an environmental impact assessment. *As a part of certain licensing proceedings (as set forth in Paragraphs a) and c) of Subsection (1) of Section 11/A) the Act on Atomic Energy also calls for public hearings, where anyone can participate. During the public hearing, the HAEA shall provide the participants with the possibility to ask questions.*

Hungary is a state party to the international agreements concerning *environmental impact assessment* too. As a member of the European Union, Hungary introduced provisions in compliance with the Council Directive 2001/42/EC of the European Parliament and of the Council in Govt. decree 2/2005. (I.11.) on the environmental assessment of certain plans and programmes.

Service life extension of the Paks NPP

In Hungary proceeding for the 20 year service life extension of the units of the Paks Nuclear Power Plant has been *completed*.

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 Govt. decree [II.24] the Paks NPP 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 procedure the HAEA assessed the compliance with the requirements in force [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 expired on 31 December 2017. The licensee applied for the 20 year service life extension in November 2016. The environmental protection authority participated as co-authority in the proceedings. The HAEA also held a public hearing as part of the procedure. The proceeding was completed in December 2017, and Unit 4 has also received the license for service life extension.

The licensee also holds a producer license for Units 1-*4* valid for an additional 20 years, issued by the Hungarian Energy and Public Utility Regulatory Authority.

E.1.1 Spent fuel management

The volume of Nuclear Safety Code titled as "Interim storage of spent fuel of a nuclear facility" on the nuclear facilities providing dry interim storage of spent fuel was issued as an annex to Govt. decree [II.24] which entered into force in 2011. *In addition, the main body of the Govt. decree and the general volumes of the Nuclear Safety Code (contained in the Annexes of the Govt. decree) (hereinafter NSC) provides further provisions for the interim storage of spent fuel. The application of the NSC* is supported by guidelines. *There are 10 guidelines in force that relate to the spent fuel interim storage*; additional guidelines are to be elaborated as needed.

E.1.2 Radioactive waste management

Interim and final storage of radioactive waste is regulated by the Govt. decree [II.35], which entered into force in 2014. There are *10* guidelines available to support the application of the decree and additional guidelines will be elaborated as needed.

E.2 Regulatory body

E.2.1 The Hungarian Atomic Energy Authority

According to the Act on Atomic Energy [I.6], the competent authority regarding nuclear facilities and thus regarding, among others, the spent fuel management facilities is the HAEA (see Govt. decree [II.21]).

The HAEA is a *supreme government office* dealing with peaceful usage of atomic energy, acting under the control of the government with independent task and regulatory competence; *almost half of its budget is ensured from the central budget*. The HAEA is supervised by a minister designated by the Government (*currently, the minister for innovation and technology*). The HAEA cannot be instructed in its scope of authority defined by law.

The independence of the HAEA is guaranteed by the provisions of the Act on Atomic Energy [I.6], which states that the decisions made in its oversight competence cannot be altered or annulled. Taking into account the recommendations of the 2015 Integrated Regulatory Review Service mission (hereinafter IRRS mission), the Parliament strengthened the independence of the HAEA through the following measures in the Act of Atomic Energy [I.6] upon the request of the Government:

- 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 officials working at the HAEA was made more competitive.
- Authorized the Director-General of the HAEA to define the fringe benefits of the government officials of the organization.
- *The Act on Atomic Energy also sets forth that the competent authorities are independent of any other bodies or organisations that have interest in the use or development of atomic energy (including electric power generation, application of radioisotopes and management of spent fuel and radioactive waste).*

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, accountancy 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 *Government* and the Parliament, the compilation of which is the task of the HAEA. The HAEA informs 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 informing the general public about issues of nuclear safety of public interest. *To this end, the HAEA publishes, in addition to reports and evaluations attracting public interest, the results of the regulatory assessment of incidents registered as Level 1 or above on the International Nuclear and Radiological Event Scale (hereinafter INES) and of other reportable events relevant to the press and the newly published guidelines. Furthermore, the HAEA provides information on substantial decrease of power on the nuclear power plant units, and makes the drafts of new guidelines accessible on its website open for comments.* The HAEA keeps regular contact with media representatives; about 50 journalists 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] obligates the organization of 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 HAEA continued its long-standing tradition of organizing, the semi-annual conference entitled "About nuclear energy to everybody" together with the Scientific Information Association Studio Association to students. Starting in 2017 the conference has been held on the basis of a new concept *putting more emphasis on interactivity and experience. Based on the lessons learned during recent years, the new format is well accepted, several hundreds of people attended the events, the interest of students in the nuclear field was successfully raised and direct relation was established towards them. This is strengthened by the positive feedback received from teachers.*

The HAEA strives to provide more comprehensive information about its activities, *regularly* publishing a colourful, illustrated information booklets, and *every six months it also prepares a bulletin in Hungarian and English about recent news on its regulatory activities, Hungarian facilities and their nuclear safety, as well as on security, nuclear and radiological emergency response and radiation protection.*

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 HAEA 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 HAEA is also supported by a Scientific Council (hereinafter HAEA SC) that is composed of members having a national reputation. The HAEA SC, 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.

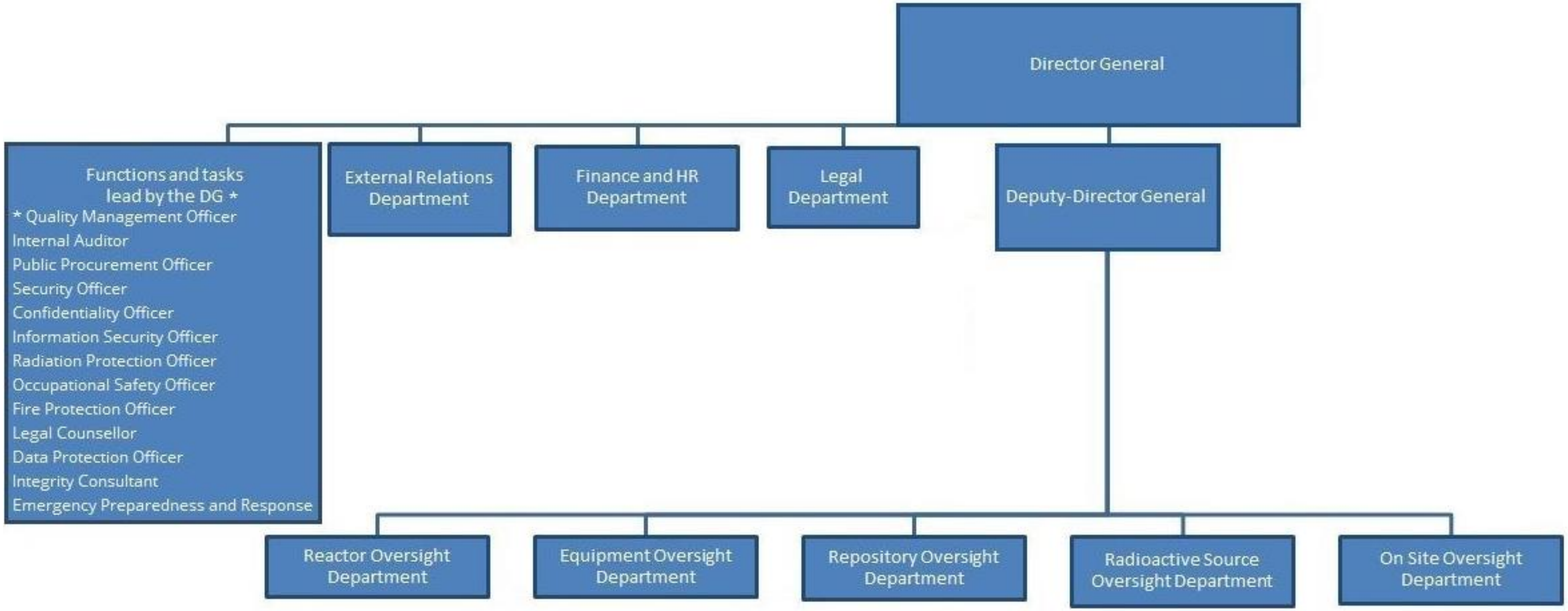


Figure E.2.1-1 Organisational structure of the Hungarian Atomic Energy Authority

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 OCMO NPHMOS) according to the relevant Govt. decree [II.30] and ministerial decrees [III.3 and III.9].

The Govt. decree [II.44] lists the government offices performing radiation health tasks and sets forth their jurisdictions. The provisions of this legislation entered into force on 1 April 2017.

In accordance with the provisions introduced by Govt. decree 162/2018. (IX.10.) on the modification of certain government decrees in relation to the establishment of the National Public Health Centre and entered into force on 1 October 2018 , the National Public Health Centre (hereinafter NPHC) performs all those tasks, which fell under the competence of the National Public Health Institute (hereinafter NPHI) and the organisational units led by the deputy state secretary of the Ministry of Human Resources responsible for the tasks of the national chief medical officer by 30 September 2018. Accordingly, the NPHC also has radiation health tasks and competences. The NPHC performs its tasks established in its foundation document and the relevant laws in the field of radiation health.

E.3 Licensing proceeding

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 several year long sentence of imprisonment.

E.3.2 Radioactive waste management

On the basis of the amendments to 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 is the HAEA.

A nuclear safety license must be obtained for the site investigation and evaluation, siting, 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 the *Act on Atomic Energy [I.6]*.

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 *Govt. decree [II.33]* since 2011. In these procedures the National Police Headquarters (hereinafter 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 requirements, and the safety of the applications of nuclear energy.

The HAEA is entitled to perform inspections at the facilities supervised by it, either with or without advance notice.

In addition to the HAEA's inspection activities, the special authorities taking part in the licensing procedure or giving their separate licenses may also carry out inspections.

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

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

The 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 PSR 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 PSR process, which is mandated by Act on Atomic Energy. Decisions on keeping the operation license further in force or its withdrawal, and – if necessary – on the possible requirement of further safety enhancement measures to be performed by the licensee 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 safety area 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. *Review and extension of the safety area of RWTDF became necessary*[4]*, which was approved by the HAEA in 2018.* According to the regulation the designation of a safety area is required for nuclear facilities with a reactor having higher than 150 kW nominal thermal power, for radioactive waste disposal facilities designed for a total activity greater than 10^{14} Bq and for spent fuel interim storage facilities.

[4] As an outcome of the review made after the Govt. decree [II.35] entered into force, the licensee of the facility identified a deviation from the provision set forth in Para 2.2.2.1200 of Annex 2 of the new decree. Consequently, the HAEA required by its resolution HA6178 the revision of the safety area of the facility.

In the field of radioactive waste management, the HAEA performs regular inspections and reviews at the licensee. Checks if the licensed modifications and any extraordinary events are carried out. The objectives of inspections and reviews are to:

- check compliance with nuclear safety;
- check compliance with the required 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 NERMS) set up by Govt. decree [II.20]. (These annual reports are accessible on the internet, on the websites of the National Public Health Centre, Radiobiology and Radiation Health Department (hereinafter NPHC RBRHD) and HAEA.)

Legislation [II.20] governing the operation of the NERMS was amended on 1 January 2016, according to the new Govt. 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 *[I.6]* 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 an *IT* 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], *then in the Act on general public administration procedures [I.18] from 1 January 2018*, 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.

F. OTHER GENERAL SAFETY PROVISIONS

F.1 Responsibility of the licence holder

In general, 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 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 storage and final disposal of radioactive wastes and their establishment;
- construction (extension) and operation of the storage facility for interim storage of spent nuclear fuel, ie. the SFISF;
- 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;
- provision of information and maintaining 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 factor;
- to keep the exposures of the personnel and the public as low as reasonably achievable (taking into account the social and economic factors);
- to take into account, from the aspect of safety, the limits of human performance;
- to establish and operate a radiation protection (health physics) service which plans and controls all actions and measurements necessary to adhere to the basic principles of radiation protection;
- to maintain (regulatory and/or its own) dosimetry control;

- to derive the estimated annual discharge limits from the dose constraint specified by the radio-hygiene authority and to submit them for approval to the environmental protection authority and to the HAEA;
- to determine the planned (airborne and liquid) discharges for normal operation;
- to ensure compliance with the annual discharge limits;
- to monitor/control radiation levels and concentrations of the radionuclides in the environment continuously and provide the general public with relevant information;
- to maintain an appropriate organisation which is capable of accomplishing each and every required periodic and event reporting obligation in due time (including categorisation of all events according to INES;
- to ensure that the qualifications, professional education, and health of the employees are in line with the requirements;
- to carry out continuous activities in order to maintain the highest possible level of safety through continuous improvements, including evaluation of all relevant operation experience available, and to finance the costs of related research and development activities;
- to regularly revise and upgrade the licensee’s own management system in order to fulfil the safety-related requirements;
- to qualify subcontractors and suppliers for the task, taking into account that their quality management system required by 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 required for the inventories of nuclear and radioactive materials, and the operational data necessary for the evaluation of safety and the planning of decommissioning;
- to participate in the fulfilment of obligations of Hungary arising from international treaties, conventions, and multilateral and bilateral agreements.

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

According to the Govt. 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 airborne and liquid discharges in the case of a severe, rapidly developing event; estimate the consequences and give advice for the introduction of countermeasures.

F.2 Human and financial resources

F.2.1 Human and financial resources of the authorities

F.2.1.1 The Hungarian Atomic Energy Authority

The number of employees of the HAEA *increased by 5% in 2019 in comparison with the previous year, reaching 181 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 *84%* 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 and radioactive waste repositories are obliged to pay a supervision fee to the Authority in the way and to the extent defined in the Act on Atomic Energy [I.6].
- administration fee shall be paid for the service carried out by the HAEA.

Furthermore, the central budget provides additional financial resources in the form of central budgetary support.

For the year 2019 it can be stated that the HAEA received a substantial amount of budgetary support to cover the additional cost of the staff increase. In 2019, the ratio between central budgetary support and revenue generated almost equalled (49%-51%).

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 Public health state administration bodies

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 (formerly 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 National Public Health Centre (hereinafter NPHC) and the NPHC National Radiobiology and Radiation Health Department (hereinafter NPHC RBRHD).

The regulatory tasks were supported by the National Research *Directorate* for Radiobiology and Radio-hygiene (with about 65 highly qualified employees). The National Radiation Hygiene Preparedness Service with its appropriately equipped vehicle provided and *still provides* a 24-hour service every day.

As of 2017 April 1, as a legal successor, the National Public Health Institute (hereinafter NPHI) performed the tasks of NPHC, while the NPHI Public Health Directorate Radiation Health Department (hereinafter NPHI PHD RHD) performed the tasks of the NPHC RBRHD.

As of 1 October 2018, as a legal successor, National Public Health Centre (NPHC) performs the tasks of NPHI, while the NPHC RBRHD preforms the tasks of NPHI PHD RHD.

F.2.2 Human and financial resources of the licensee

F.2.2.1 Human resources

The Act on Atomic Energy [I.6] requires that the organization designated by the Government shall prepare a proposal for the National Policy and the National Programme on radioactive waste and spent fuel management 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 to 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 [I.6] as to be performed by the organization designated by the Government, performs other activities of public use according to the act on public utilities [I.14] and performs the permanent tasks determined by the Govt. 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. *Altogether 234 employees worked for PURAM on 31 December 2019*, including 86 security guards. The operation and maintenance of the SFISF is performed by the staff of Paks Nuclear Power Plant on a contractual basis under the direction of PURAM.

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

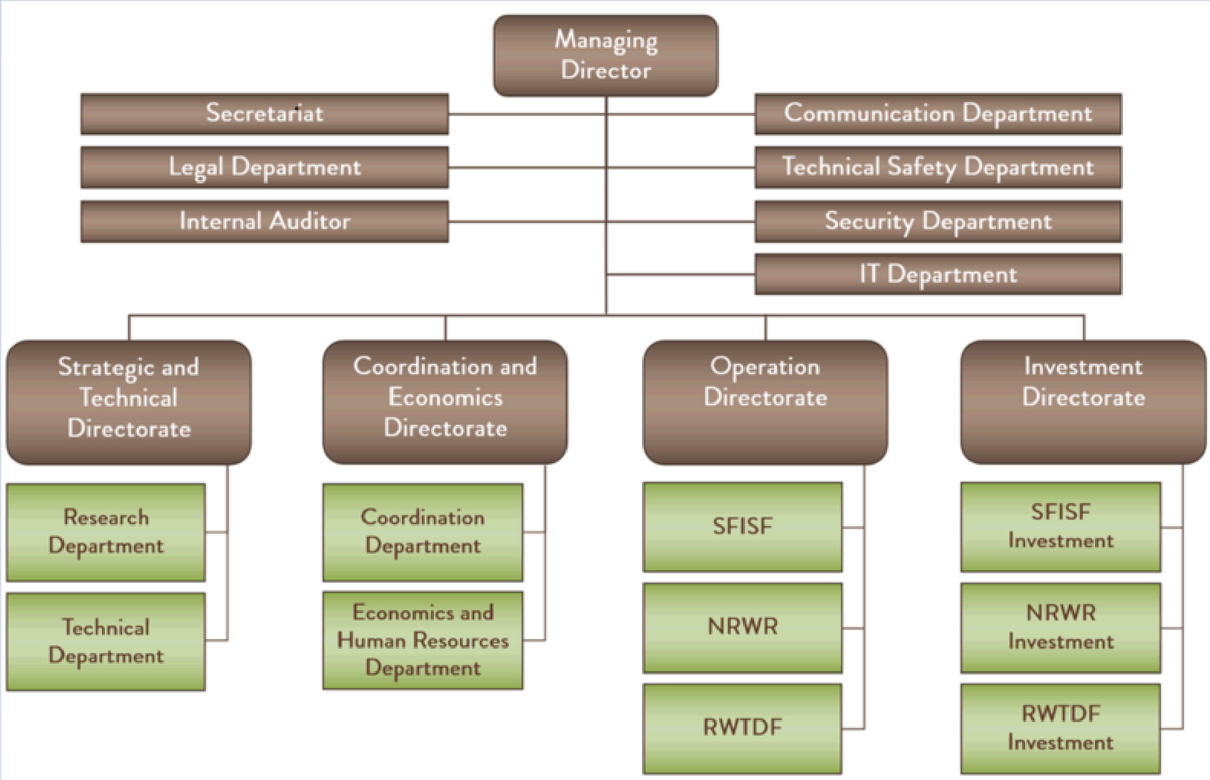


Figure F.2.2.1-1 Organizational chart of PURAM

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 CNFF operating as of 1 January 1998. From 1 January 2014 the ministry lead by this Minister is responsible for the management of the Fund. 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 the closure of the radioactive waste repositories*) 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 Paks Nuclear Power Plant to the Fund are proposed by the minister supervising the HAEA. Due payments are based upon submittals prepared by PURAM, to which the Central Nuclear Financial Fund Special Committee, supporting the work of the Minister shall develop a preliminary opinion.

The institutes delivering radioactive waste to the RWTDF are also liable to contribute to the Fund in accordance with the Annex of the Act on Atomic Energy [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.

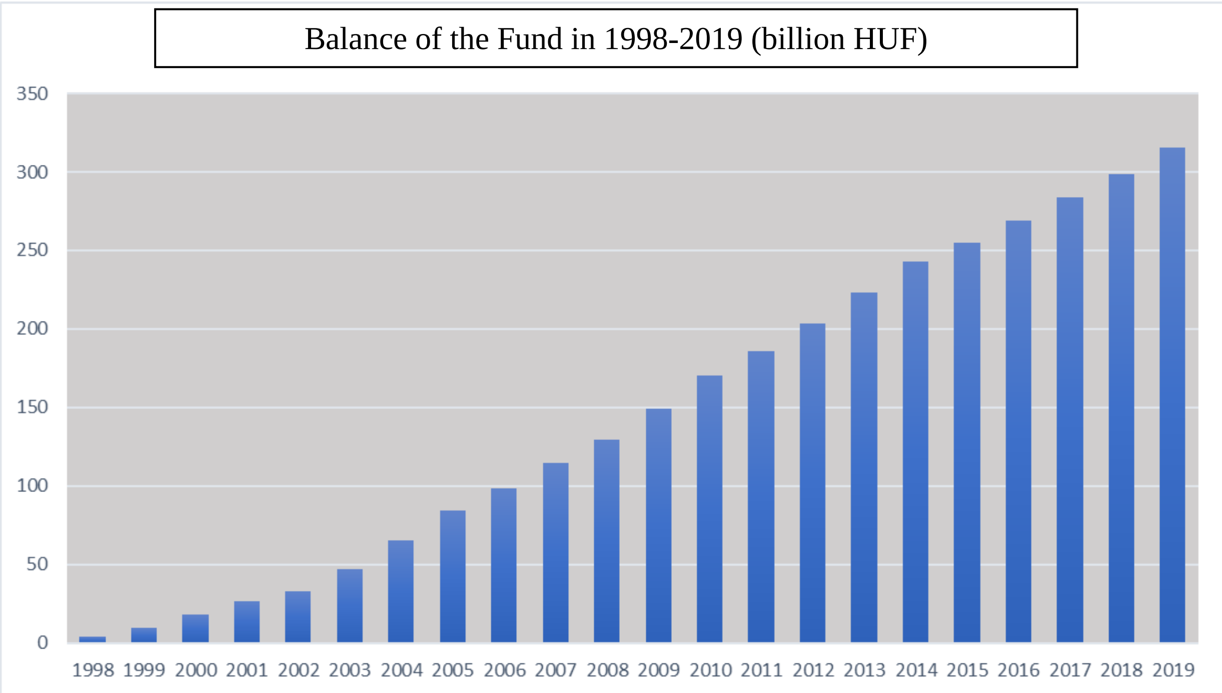
The rate of payments into the Fund shall be specified in such a way as to provide appropriate sources for all costs of management of radioactive wastes and spent fuels and of the decommissioning of nuclear facilities. These sources also provide coverage for supporting the municipal associations aimed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

In order to ensure that the Fund maintains its value, the Government annually contributes to the Fund with *a sum that is calculated* on the average assets of the Fund in the previous year using the average base interest rate of the central bank of the same period.

The money paid into 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 2019 ***(M HUF)***

	Income	***Expenditure***	***Increase of assets***
1998	7 777.4	3 941.1	3 836.3
1999	9 399.0	3 634.6	5 764.4
2000	10 449.0	2 094.1	8 354.9
2001	14 886.9	6 084.0	8 802.9
2002	17 205.8	11 239.4	5 966.4
2003	23 703.2	9 183.5	14 519.7
2004	27 577.0	9 705.9	17 871.1
2005	30 497.1	11 026.9	19 470.2
2006	28 445.9	14 680.4	13 765.5
2007	29 184.9	13 068.6	16 116.3
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
2017	*27 516.2*	*13 044.5*	*14 471.6*
2018	*27 510.8*	*12 153.6*	*15 357.2*
2019	*30 974.0*	*14 709.0*	*16 264.9*



Balance of the Fund

The assets of the Fund amounted to 315.1 billion HUF as of 31 December 2019 (please note the exchange rate on 31 December 2019: 1 Euro ~ 331 HUF).

F.3 Quality management

All organizations dealing with spent fuel management and the interim or final storage of radioactive waste are obliged by the Act on Atomic Energy [I.6] and the relevant Govt. 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 NSC, published as an annex to Govt. 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 an annex to Govt. decree [II.35]. As part of the safety reports required, among others, by Section 31 of Govt. Decree [II.24] and Section 98 of Govt. Decree [II.35], the licensee shall explain the bases 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:*2015* and an Environmental Management System based on ISO 14001:*2015* standards, into which it already integrated the relevant requirements of Volume 2 of the NSC and the relevant requirements of Govt. 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 HS EN ISO 9001:2001 (HS EN 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 *certificate renewal audit* in *2018*, the certificate is valid for another three years, until March *2021. It justifies that the integrated management system of the HAEA operates in compliance with the requirements HS EN ISO 9001:2015 standard.*

The radiation health related 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 *Authority* according to the requirements of the relevant legal regulations and the ISO/IEC 17025:*2015* 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 Govt. decree [III.36] (effective as of 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 on Atomic Energy [I.6], a 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 NPHMOS 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.5.1 *National emergency response organization*

The *structure and operation* of the National Nuclear Emergency Response System (hereinafter: NERS) is governed by the Govt. decree [II.29] that was promulgated in 2010. The legislation, which was accepted with consensus among professionals, takes into consideration the international recommendations. It reflects the concept of continuous operation, and the criterion based concept of operating states 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 Interministerial Disaster Management Coordination Committee (hereinafter IDMCC), the chairperson of which is the minister responsible for the defence against emergencies, and its members are the state level leaders designated by the competent ministers. The managers of the central state administration bodies participate as advisors in the meetings of the IDMCC.

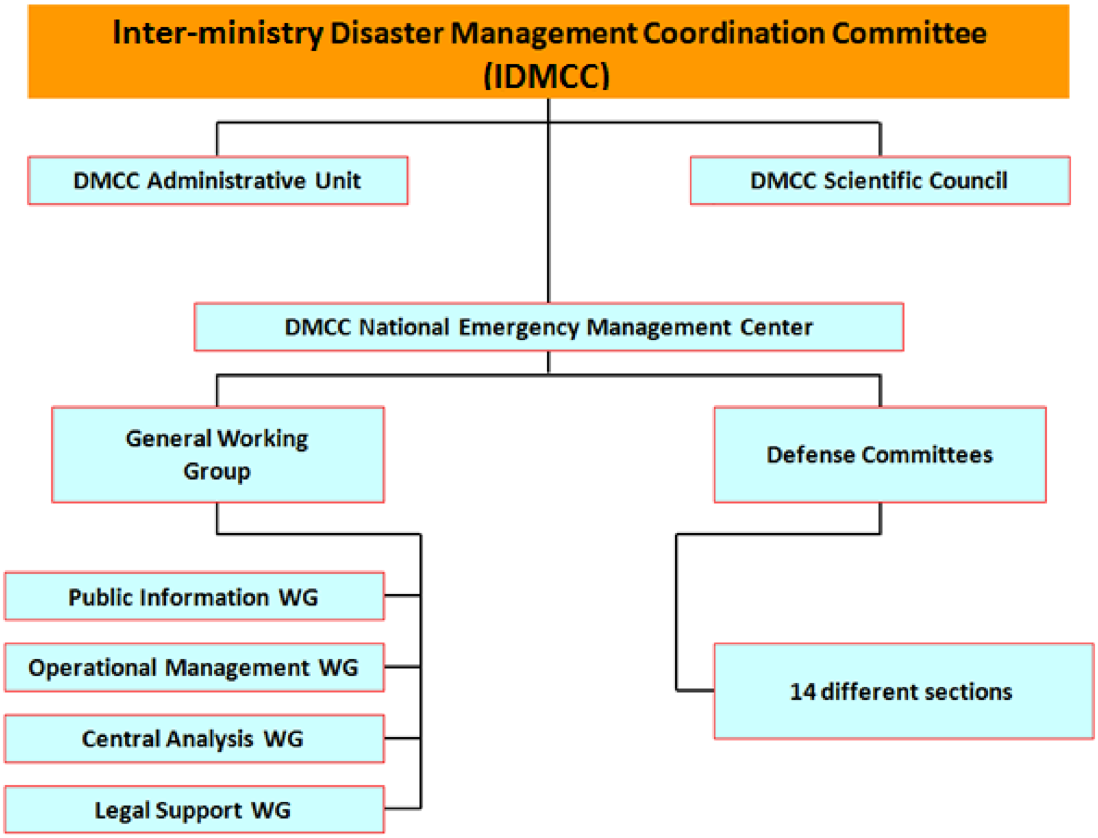


Figure F.5.1 – 1. Organizations participating in emergency management

The scientific task force of the IDMCC is the IDMCC Scientific Council (hereinafter IDMCC SC); the operative task force is the IDMCC National Emergency Management Centre (hereinafter IDMCC NEMC). The IDMCC NEMC consists of its chairperson, a general working group and emergency-specific defence working groups tasked with professional issues. The IDMCC NEM operates a Public Information Group. *As of 1 May 2019, pursuant to* *the modification of the relevant Govt. Resolution [V.5]*, the Nuclear Defence Working Group is operated by the HAEA.

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 in order to improve the operability and effectiveness conduct preparatory work and exercises in order to improve the operability and effectiveness. Certain organizations perform, apart from preparation, continuous data gathering, planning, and information or cooperation tasks.

F.5.2 Sectoral and local nuclear emergency response organisations

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

Sectoral coordination and management of emergencies affecting more than one county and causing unplanned radiation exposure of the population is the responsibility of sectoral organizations taking part in the operation of the 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 NERP). As a result of the work of the High Level Working Group, *NERP version 3.0 was developed in 2018, and then approved by the IDMCC.* The High Level Working Group, *with the authorization of the IDMCC*, develops technical-scientific documents (guidelines) to harmonize the nation-wide planning and to provide guidance in expert questions that are not regulated in sufficient detail by the NERP.

The previous version of the NERP (version 2.3) was issued in 2015. Based on the review, the High Level Working Group elaborated version 3.0 of the plan. The new plan was submitted to the chairperson of the IDMCC (the minister of the interior) in February 2018, who approved it.
The review was performed along with the recommendations and suggestions provided by the Emergency Preparedness and Review (EPREV) mission conducted in 2016. The most important aspect of the review of the NERP was the adherence to the relevant IAEA standard (i.e. Preparedness and Response for a Nuclear or Radiological Emergency, GSR Part 7).
The modification of the NERP occurs in two steps. In the first step, the modifications induced by the transposition of the Council Directive 2013/59/Euratom to the domestic legal framework were made. Accordingly, the new version of the NERP specifies the radiation protection reference levels, the generic criteria and the operational intervention levels, as well as the strategy of protection. With these changes, the plan partially adheres to the IAEA GSR Part 7 standard.
The second step aims at the total compliance with the IAEA GSR Part 7 standard to be carried out by the High Level Working Group; NERP version 3.1 is expected to be issued in 2020.[5]

The High Level Working Group continuously develops and reviews guidelines related to the NERP. Guide and technical aids issued so far:
- Legal basis of the NERP,
- Accidents of nuclear and radiological facilities domestically and abroad,
- Critical tasks of the NERS,
- Evaluation of the critical tasks of the NERS,
- Organized assistance in response,
- Structure and operation of the National Radiation Monitoring, Alert and Control System,
- Emergency monitoring strategy,
- Planning work of the NERS organizations related to preparedness,
- Communication between NERS organizations,
- Development and continuous maintenance of organizational nuclear emergency plans,
- Preparation, conduct and evaluation of nuclear emergency response exercises,
- Decision on, introduction and implementation of urgent protective actions,
- Local management of a radiological emergency,
- Organization of treatment of radiation injured people.

[5] *NERP version 3.1 was approved by the IDMCC on 31 March 2020.*

F.5.4 Emergency preparedness in the facilities

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 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 if revised, *it shall be submitted for approval to the HAEA. The current emergency response plan entered into force in 2019.*

F.5.4.2 Radioactive Waste Treatment and Disposal Facility

In *2019* the RWTDF introduced a new nuclear emergency response plan in line with the new Hungarian legal background *[II.35.]* and the international requirements.

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 the international expectations. *The next review of the nuclear emergency response plan of the NRWR is due in 2020.*

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 the law, the plans shall define the qualification requirements for the personnel of the emergency response organization and their preparation, regular training and exercises. The legislation requires the organization of comprehensive emergency exercises at regular intervals. In such exercises the potential participation and contribution of off-site emergency organizations shall be assured and their conduction is regularly observed by the Hungarian authorities within the framework of field inspections.

The preparation and exercising of the off-site emergency response organizations is performed according to annual plans that are developed on the basis of the 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 EU.

In compliance with Article 36 of the EURATOM treaty and the EURDEP agreement (memorandum of understanding between the European Commission and the IAEA regarding the European radiological data exchange platform), the Nuclear Emergency Information and Evaluation Centre (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 Nuclear Emergency Information and Evaluation Centre with Austria, Croatia, Slovenia and Slovakia among the neighbouring countries.

Apart from that Hungary concluded bilateral agreements with the following countries in the areas of early notification, mutual provision of information, and co-operation in nuclear emergency matters: Austria (1987), the Czech Republic and the Slovak Republic (1991), the Federal Republic of Germany (1991), Republic of Slovenia (1995), Ukraine (1997), Romania (1997), Croatia (2000) and Serbia (2014).

F.5.7 Radiological Emergency Support Project for the European Commission (RESPEC)

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. *In 2016, Hungary played the role of the host in the IAEA CONVEX-3 international nuclear emergency response exercise.* Since 2003, as a full member of the EU ECURIE nuclear emergency information exchange agreement, Hungary also takes part in the ECURIE exercises.

The HAEA first signed the Radiological Emergency Support Project for the European Commission (so called RESPEC) contract at the end of 2006, in the framework of which HAEA provided the European Commission with professional support for three years in the case of nuclear and radiological emergencies which have an effect on the EU. Based on the contract the Nuclear Emergency Response Organisation of the HAEA provided 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 period (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 contract, between 2016 and 2019, the HAEA organized 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 regulations 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 the decommissioning reference levels established by the Western European Nuclear Regulators' Association (WENRA).

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 NSC, published as annex to Govt. decree [II.24]. The HAEA is mandated to periodically review the Govt. decree and the NSC.

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 around it, and the monitoring of personal doses as well as discharges and the radiation in the environment. Emergency plans have to be updated regularly according to the current life cycle phase, and shall be supplemented as necessary with new or likely scenarios. Any necessary organisational changes required must be adjusted accordingly.

For all nuclear facilities, i.e. 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 1990s and since then it has been updated regularly. 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 Paks Nuclear Power Plant submitted the updated version of its decommissioning plan in 2016 to the HAEA. Review of the decommissioning plan *was* carried out by the HAEA during 2017. *The next updating cycle of the plan starts in 2020, the submission of the documentation will be due in the end of 2021.*

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. *The professionals of the BRR has been participating in workshops, technical meetings and training organised in the frame of IAEA RER 3/009 TC project since 2004.* In 2010 *an IAEA decommissioning expert 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 *2015* for the Training Reactor and in *2016* for the BRR).

The final goal of the decommissioning of the BRR is to hand over the site and the buildings back to the owner of the site in a radiation clean condition.

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 Paks Nuclear Power Plant, and was submitted to the authority. Review of the updated decommissioning plan *was* carried out by the HAEA during 2017. *The next updating cycle of the plan starts in 2020, the submission of the documentation will be due in the end of 2021.*

G. SAFETY OF SPENT FUEL MANAGEMENT

The safety of spent fuel in 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 500 m south of the geometric centre of 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 had occurred in 10 000 years. 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 Paks Nuclear Power Plant, which also covers the SFISF.

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 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 *vault* interim *dry* storage *(MVDS)* and the first three storage vaults were completed in 1996. The facility was commissioned in 1997. *Since then the SFISF has been operating continuously and its expansion is taking place in parallel with its operation by the construction of new vaults. The SFISF can be expanded module by module; its expansion is planned in line with the storage needs of Paks Nuclear Power Plant considering the 20-years' service life extension and favourable effects of fuel assembly design development. By the modular expansion the SFISF has been consisting of altogether 24 vaults since 2017. The new vaults 21-24. were commissioned in 2018. The already constructed and operating 24 vaults have a capacity to store 11 416 spent fuel assemblies. Starting from vault 17 till vault 24 a square arrangement of the storage tubes is used instead of the triangle arrangement of the previously constructed vaults 1-16., which means that 527 storage tubes can be placed in one vault instead of 450 storage tubes. A solution for further increase of number of storage tubes per vaults from vault 25 during the expansion of the SFISF is already in the implementation phase. According to the new concept accepted in the construction licence amended in 2017, starting from vault 25 a vault will be able to accommodate 703 spent fuel assemblies. The increased capacity vaults will be the result of loading only very low thermal power (< 100 W) assemblies in these vaults, which will be re-loaded from vault 1-15. originally loaded a long* *time ago. In parallel to that, the assemblies of higher thermal power transferred from the spent fuel pools of Paks Nuclear Power Plant will be stored in the place of the re-loaded fuel assemblies, i.e. in the sparse grid vaults.*

The HAEA issued the construction licence for the expansion of the SFISF with vaults 25-28. in 2017, currently preparation for the construction of the module incorporating these vaults is in progress. Expansion of the storage capacity *has always been* determined by the demands of Paks Nuclear Power Plant, accordingly, considering the *50 years* of operation of the plant and the annually expected quantity of spent fuel *formerly* construction of 36 vaults were planned. *The construction licence amended in 2017 makes it possible that by means of the new development construction of 33 vaults can ensure sufficient storage capacity. After full completion of the SFISF,* maximum 17 743 spent fuel assemblies could be placed into the *33* vaults *(see Section K.1).*

Figure G.1 – 1. Spent Fuel Interim Storage Facility

A description of the layout of the *SFISF* is given in Annex 1.

According to the Operational Limits and Conditions of the SFISF, currently there are 5 different fuel assembly types that can be stored in the facility. The main limitations for these are:

- min. 3 years – *3 years and 10 months* cooling in the nuclear power plant *before placing in the SFISF depending on the type,*
- maximum initial enrichment *(depending on type): 3.6*-4.7%,
- average burnup level *(depending on type): 42*-50.7 GWday/tU,
- *maximum* burnup level *(depending on type): 49*-58 GWday/tU,
- *minimum burnup level: 2 GWday/tU.*

According to the operation licence in force of the SFISF, only geometrically intact, leaktight assemblies or assemblies with unrecognized leakage can be stored in the facility.

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 corresponding to the given operational phase. Among the underlying safety assessments, the most important ones are the subcritical, thermal PSA based accident analyses as well as radiation protection analyses which include the dose rates for the operator and the general population under normal and in emergency situations. The analyses demonstrate that in case of safety-related events, the facility remains safe and under control; chain reaction cannot occur in the SFISF, efficient cooling of the spent fuel assemblies is achieved, releases remain under the legal limits set for the installation and neither workers nor the general population in the surrounding areas are exposed to doses higher than the limit.

Ageing management

In 2002 the licensee launched a programme on ageing management. The programme has been operating since and includes the regular inspection and testing of all safety-related structures, systems and components, beyond the normal maintenance work. A computer database was established for recording the operational safety parameters of the systems of the facility. *The ageing management programme was last extended in 2018 after the commissioning of the SFISF vaults 21-24.*

No problems were discovered by the analyses carried out till now that would affect the safety indicators of the SFISF.

Figure G.1 – 2. Refuelling 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 *activities* and the maintenance work 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 facility currently operates under the operation licence issued on 27 November 2018 by the HAEA *for the expansion of the facility with vaults 21-24., related to the* SFISF *design with vaults 1-24. The licence is valid until 2 March 2030.* The licence permits the *storage of spent fuel assemblies* of defined parameters unloaded from Paks Nuclear Power Plant *in the SFISF*. The loading rate shall not *exceed* 500 spent *fuel assemblies per* calendar year. The conditions for extending the licence are discussed in Section K.1.

In addition to the operation *licence and the related supporting documentation* for safety related matters*, among others, especially according to* Volume 6 of the NSC "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 *summarizes* 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 prescribed in the national regulations were derived from these principles.

During the long term dry storage of spent fuel *assemblies* 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 long term policy and practices followed by Hungary are described in Section B. As mentioned there, it is a strategic goal to establish a waste repository *within the territory of the country* for the disposal of high level radioactive wastes in a deep, geological formation to provide long-term *containment and isolation*. In accordance with internationally agreed 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 *potentially* applicable to host a deep geological repository. Several research phases have already been completed to survey this area. Based on the results obtained during the survey of the BCF and on the *multi-aspect assessment* 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.

The investigation and evaluation of the site of the disposal facility *continued in several shorter phases with longer interruptions. In 1990-1991 two boreholes of 1200 m depth, then between 2004 and 2017 four more boreholes of 500-1000 m depth were executed. Detailed field measurements and water samplings were performed. Six seismic sections were used to examine the geological structure of the research area. Surface geological and geomorphological maps were prepared, and the identified fault zones were studied by two research trenches. In 2005, a hydrogeological model of the site and a preliminary safety assessment of the disposal facility were developed. Within the research area, a complex geological-hydrogeological monitoring system was established, which has been operating continuously.* In 20*18*, the PURAM prepared *the site* investigation *frame programme for the* BCF, *which was approved by the HAEA in 2019. According to the frame programme, within the approximately 87 km^2 of research area, based on three surface research phases, a graded narrowing should be applied to determine that area of a few km^2, where first an underground research laboratory, then the disposal facility itself can be constructed. Furthermore, the potential site of the surface facilities of the disposal facility should be designated. The frame programme, after obtaining the necessary licences and approvals, schedules the construction of the underground research laboratory after 2032 and* *by 2055 the beginning of construction of the disposal facility itself, while by 2064 the commissioning of the facility.*

Spent fuel of non-nuclear power plant origin

Transportation to the Russian Federation or final domestic disposal of the low-enriched spent fuel assemblies 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.

H. SAFETY OF RADIOACTIVE WASTE MANAGEMENT

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

H.1 Past practice

In Hungary, the significant use of open and sealed radioactive sources began during the second half of the 1950s. Simultaneously with the domestic use of artificial radionuclides, the disposal of the produced radioactive waste 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 1980s. 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 enhancement

In the course of the construction 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 Service 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 disposed of earlier unfavourably influence long term safety. The results of safety assessments show when *the active institutional control is over,* by *unintentionally* disturbing the waste layer, the raising of certain sealed radioactive sources and long lived wastes to the surface 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 was launched in 2006, the objectives of which are as follows:

- to make the repository safe for the period after institutional control;
- to carry out the refurbishments that are necessary to maintain safety;

- to make the repository suitable for the disposal of additional institutional waste.

The second stage of the safety improvement programme started with a demonstration period, 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 Govt. decree [II.35], which entered into force in 2014 required the licensees of storage and disposal facilities including the operator of the RWTDF to review compliance of the facility with the relevant requirements of the Govt. 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, *which were implemented by the licensee in 2018. After the amendment of the Govt. decree in 2018, the HAEA in a new resolution required the implementation of further actions, part of which has already been carried out by the operator of the RWTDF, and other actions are in progress with a deadline expiring in 2023.*

Application for a single operating licence

At the time of entering into force of the Govt. decree [II.35], activities carried out in the facilities *were subject* to individual licences, which *were* valid until 2019 and 2024. In accordance with the new requirements, the operator *intended* 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 analysis report encompassing all activities, documentation on all operating limits and conditions and emergency operating procedures to the HAEA in June 2016 as part of the unified operating license application. *In 2016, the HAEA granted the unified operating licence for the RWTDF based on the licence application. During the modifications that has taken place since and during the preparation of the safety enhancement programme the unified structure safety analysis report and the document containing the operational limits and conditions of the RWTDF were modified and a new operation licence was issued by the HAEA in 2019.*

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. *The HAEA assessed the report and terminated the PSR process in December 2017 by ordering for implementation of corrective actions. The implementation of the ordered corrective actions was accomplished by a deadline of 31 December 2019.*

Refurbishment

From the beginning of the 2000s' 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 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 USA Department of Energy (Ministry of Energy of the USA, hereinafter DoE) about joint counter-terrorism efforts, in which the DoE financed some parts of the equipment to be installed. Refurbishment of the physical protection system began in 2013 and finished in 2015.

- improvements to the work instructions and waste inventory systems;
- reconstruction of the ventilation network, including the construction of a new ventilation stack, a new ventilation system and a new electric power supply;
- *construction of a hall and containment building above the pool row of 24 pools necessary for the implementation of the safety improvement program, and installation of equipment to extract the radioactive waste.*

Incident event

On 2 December 2013 three employees were processing four pieces of 200 l drums of radioactive waste containing ^{241}Am. Their intention to open 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 following indirect causes of the incident were:

- 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 *two of the workers* could already return to their previous jobs, *while the third worker was not placed into the same radioactive waste handling position, but in a maintenance job position.*

Based on the experiences of the investigation of the incident on 2 December 2013, significant organizational, personnel changes and technical improvements was 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.

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 several years, but for low and intermediate level waste coming from the operation and decommissioning of 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 given to just a few dozen out of the potential areas.

Finally, 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 geological point of view; it is suitable for the final 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. Concluding from the summarising safety assessment, the dose to the public caused by the planned repository will be by two or three orders of magnitude less than the dose constraint (100µSv/year) for the public.

Preparing for the Environmental Impact Assessment Study, the environmental monitoring of the site was continued.

By October 2004, the special authorities had issued every important license necessary for the excavation of inclined shafts 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 performed from two inclined 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 consent in principle, to initiate activities to prepare for constructing a radioactive waste repository.

Parallel to 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 Radiation Health De-centre as the competent authority of the NPHMOS in the region granted a commissioning license for the *surface facilities* of the NRWR, which was renewed on 5 October 2010. In possession of the license, the first 16 drums containing low and medium level radioactive waste were transported on 2 December 2008.

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

In parallel with the *buffer storage of the waste* in the surface facility and in accordance with the construction license, the construction works of the sub-surface repository were continuing.

In the second phase of the construction on the eastern part of the storage joint cut (see figure H.3-3) the first two chambers 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 chamber I-K1 of the NRWR came into force on 10 September 2012. The inauguration ceremony of the chamber I-K1 and the final disposal of the first reinforced concrete container took place on 5 December 2012. (see figure H.3-2)

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

The reinforced concrete containers contain 9 waste drums, while the empty space among them is filled with inactive cement pulp.

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 placement concept, construction of chambers I-K3 and I-K4 were completed, as well as test vault No. 3 required for the selection of the final closure concept of the Western exploration cut and the facility (see figure H.3-5).

In parallel with the construction of vaults I-K3 and I-K4, the final disposal of waste packages in chamber I-K1 were being carried out in such a way that there was always at least one empty vault (i.e. chamber I-K2) between the vault being filled and the vault being mined to ensure seismic safety. *Disposal of reinforced containers in chamber I-K1 was accomplished in May 2017 by disposing of the container No. 537.*

Figure H.3 – 3. The full I-K1 vault in the National Radioactive Waste Repository

In addition to the spatial development works, in line with the new waste disposal concept, construction of a reinforced concrete vault in chamber I-K2 began in 2016. *The reinforced concrete vault has been completed and the operation licence extended for the new disposal chamber (I-K2) was granted by the HAEA on 5 September 2017.*

Figure H.3 – 4. Reinforced concrete vault in disposal chamber I-K2 of the National Radioactive Waste Repository

In 2018, the PURAM launched the preparatory works for the construction of the reinforced concrete vault in disposal chamber I-K3 and for the extension of the process systems. This was continuing in 2019, while in summer of 2019, the construction itself began.

In the first quarter of 2018, the PURAM deepened two exploration holes to better specify the expansion concept of the NRWD.

Repository concept and safety aspects

Construction and operation of the underground facility (including the transport of the radioactive waste to the disposal area) 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 utilises a chamber-type solution. The excavation of the one-exit chambers is executed from the connecting tunnel in a systematic arrangement, parallel to each other, and arranged in vault-fields. For safety reasons the shafts are constructed in a single-level arrangement: this means that neither the shafts nor the chamber-fields integrating them into a unified system can cover each other.

In the design of the disposal system, the concept of multiple barriers was applied, so to guarantee safety in the post-closure phase the following play roles

- *the host rock environment (natural barrier);*
- *technical solutions (engineered barriers) as the reinforced container (in disposal chamber I-K1) and the reinforced concrete vault (in disposal vault IK-2), filler materials, closures, plugs;*
- *and the waste packages (waste matrix and packaging) satisfying the waste acceptance criteria determined on the basis of safety assessments.*

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

Optimization of the arrangement concept

In parallel with commissioning of the first shaft of the facility, 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 reinforced containers a new compact waste package is 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 Paks Nuclear Power Plant. The placement of the compact waste package is planned in the reinforced concrete vault constructed within the disposal chamber. The I-K2 chamber*, after the necessary modification licensing, was constructed in compliance with these plans*. In order to use the available space most effectively the arrangement of vaults I-K3 and I-K4 was planned with a section dimension according to the new layout concept. Chamber I-K2 protects the operating chamber I-K1 against the unfavourable effects occurring while drilling the chambers.

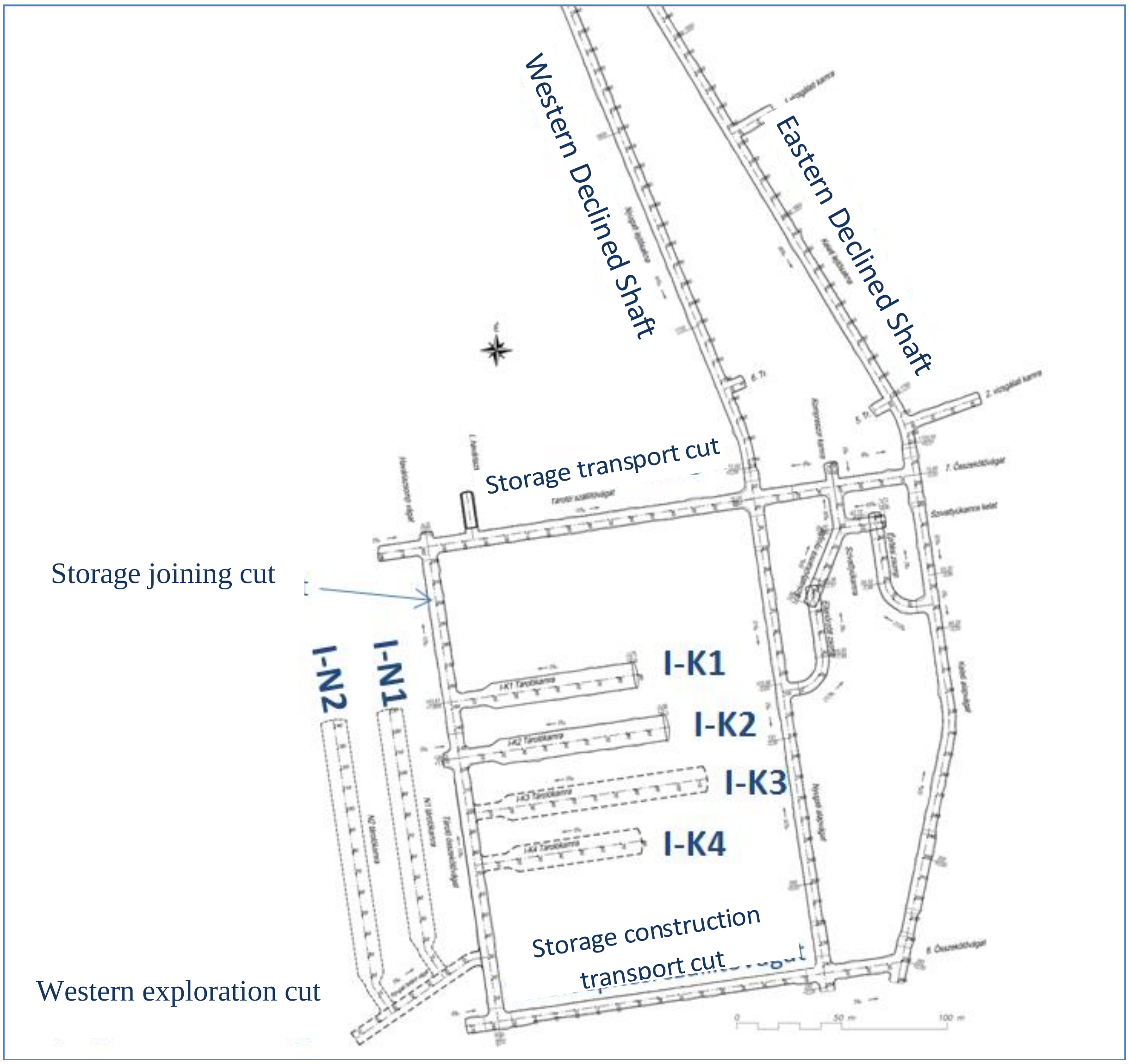


Figure H.3 – 5 Arrangement of the vaults of the National Radioactive Waste Repository

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 as a co-authority.

Govt. decree [II.28] prohibits shipments from Hungary to any destination south of latitude 60° south and to any *such destinations that are either members of the African, Caribbean, Pacific country-group, or to such Parties of the ACP-EU Partnership Agreement (Cotonou Agreement) established between the EC and it member states that are not member states.* No shipment shall be licensed if the country of destination does not have the technical, legal, *regulatory* 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.

J. DISUSED SEALED SOURCES

All practices involving radioactive materials, including sealed radioactive sources, are subject to licensing as required by the Govt. decree [II.36] in order to ensure safety. All sealed radioactive sources *belonging under the scope of legislation* [II.36] *and [III.13]* are recorded in a central registry, operated by the HAEA. The central registry system has been in operation since the end of the 1960s and it provides for the regulatory control of radioactive sources throughout their full life-time. This registration system was upgraded on the basis of a 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 be disposed of in a disposal facility. The reporting system defined 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 in the RWTDF at Püspökszilágy. The facility has sufficient space and infrastructure to handle the disused radiation 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 already nearly 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 Govt. decree [II.38] promulgated at the end of 2015, among others regulates the tasks of the licensee in case of missing sources (preliminary preparation, performing searches, notification of authorities).

K. PLANNED ACTIVITIES TO IMPROVE SAFETY

K.1 Spent Fuel Interim Storage Facility

The design work of the SFISF was performed in the 1990s, thus the facility is considered to be a modern one. 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 of the discharges and the environment must be mentioned. The container service reception building *for the containers used to transport fuel assemblies from Paks Nuclear Power Plant to the SFISF*, the seismic support components of the refuelling machine and the radiation protection control system have also been improved. The modifications typically enhanced the serviceability of the facility, so they improved operational safety.

Safety reassessment of nuclear facilities shall take place every 10 years *within a PSR*. 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 prescribed the modernization of the instrumentation and control systems fulfilling safety functions 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 in the first phase, and by the end of 2016 modernization of the process systems of the reception building was completed as well.

In 2013, the HAEA issued a resolution to PURAM, requiring the review and utilization of the experiences gained from the Fukushima accident and to produce an assessment report thereof. Similarly to the Targeted Safety Reassessment (TSR) carried out at Paks Nuclear Power Plant, PURAM also concluded the safety reassessment of the SFISF. *Between 2014-2017, 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 hazards has been performed. *The HAEA accepted the submitted documentation in 2017.* The results of the tests carried out satisfactorily *demonstrated* that the *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 2016, the PURAM commenced the preparation for the upcoming PSR, and in the following year it completed the review. The licensee submitted the Periodic Safety Review Report in November 2017 to the HAEA, which contained the results of the review, the deviations affecting the safety of the facility and the program of safety improvement actions. In 2018, based on the report, the authority terminated the review by a resolution in which it required the implementation of the actions. The obligations (the latest deadline of which is March 2022) are first of all aimed at developing or reviewing supporting analyses and administrative actions.

In the course of the procedure initiated by the licensee, on 26 June 2015, the HAEA granted a construction license for the construction of vaults 21-33. of the SFISF, valid until 31 December

2033. In February 2016, PURAM submitted an application *with the subject* “modification of the construction license concerning vaults 25-33 of the SFISF”. 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 assemblies* that have 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 *storage capacity* increase inside the vaults, i.e. storing 703 storage tubes in the same geometry. *Spent fuel assemblies* that have been cooled for over 20 years in vaults 1-15. *operated already for a longer period* will be moved to vaults 25-33. with increased storage capacity. The architectural parameters of these vaults 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 sufficient storage capacity in just 33 vaults to ensure the interim storage of spent fuel assemblies of Paks Nuclear Power Plant until the end of its service life, including the 20 year service life extension. *The amended modification license for vaults 25-33. of the SFISF were issued on 31 May 2017.*

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 performed which set out the opening of four vaults. 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 for two years. About one-third of the waste is long lived and therefore 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 within 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 on the mid-term.

Figure K.2 - 1. Retrieval of special packages

Figure K.2 - 2. Placement of repacked wastes

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

In mid-2014, the Govt. decree [II.35] assigned the construction and modification activities carried out at the RWTDF into the competence of the HAEA. Constructions and modifications licensing procedure in connection with *preparation for* the safety improvement *measures* were successfully completed, the HAEA authorized these activities. *In 2019, the corresponding process systems (electrical system, ventilation system, crane) were commissioned, and the light structure hall and the containment were prepared for use.*

Figure K.3 – 3. Light structure hall over the vault row 1 in the RWTDF

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

2020-2025 Construction of a light-structure hall and infrastructure to be able to carry out the safety improvement measures and free up capacity, implementation of the safety improvement measures (free up capacity) on vault row I. vaults A01-A24 (waste retrieval, processing, qualification).

2026-2031 Continuation of safety improvement (free up capacity), retrieval of the contents of vault row II. (vaults A25-A48), processing, deposition of the waste and restoration of the environment surrounding the vaults I-II.

2032-2039 Continuation of safety improvements (free up capacity), conditioning the contents of vault rows III and IV and space filling.

K.3 National Radioactive Waste Repository

The NRWR was designed in the early 2000s, in line with international recommendations, thus it can be regarded as a modern facility. Operation of the surface part of the facility began at the end of 2008, while operation of the underground part of the facility began in 2012 therefore no safety improvement measures affecting the operation of the basic systems have so far been required.

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

ANNEX 1: THE SPENT FUEL INTERIM STORAGE FACILITY

An1 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 storage hall, and the storage modules.

An1.1.1 Reception building

The first unit is the reception building in which the reception, preparation, and unloading of the spent fuel transfer containers 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 container 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 Storage hall

The fuel handling machine performs the fuel transfer operations in the storage 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 cladding on the other side. The basic function of the cladding is to protect the fuel handling machine and the fuel charging board against climatic effects.

An1.1.3 Storage vaults

The storage modules serve for the storage of the spent fuel. These modules are enclosed by thick reinforced concrete walls and shell structures filled with concrete; the basic function of these structures is to provide radiation shielding and mechanic protection. The cooling air inlet channel, 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 vaults 1-16. is suitable for receiving 450 spent fuel assemblies. Thanks to the modification of the construction supported by safety analyses each of the further 17-*24.* vaults accommodates the placement of 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 mixture is used in the tubes to create an inert atmosphere. The upper level of the chambers forms the charging board, which is covered by the closed storage hall.

In the case of vaults 1-11. the lifetime of the storing tube O-rings (while the 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. If gas from the nitrogen supply system of any of the modules would 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 vaults 1-11., every 5th year the sealing of 8 randomly selected closure plugs are removed and investigated by destructive material testing. As far as vaults 12-*24.* 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 inspection of the applied surface protection (i.e. anticorrosion metal spraying).

An1.2 Handling of fuel assemblies

The fuel handling machine moves the fuel assembly from a water-filled transfer container to the fuel storage tube via a drying tube. The fuel handling machine operates in the storage 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 assemblies as the driving force and the pressure 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 a separate security organization independent from Paks Nuclear Power Plant and by using state-of–the-art security systems meeting today’s requirements, *and security is further reinforced by the presence of the armed security guards*.

The site can be accessed by persons and transports only with due authorization, under strict control of the security staff. The system assures the identification and registration of those accessing the facility. Transport of the spent fuel assemblies of Paks Nuclear Power Plant is carried out under strict control from one facility to the other via the transport gate.

The installation method of the components and the presence of the armed security guards ensure the adequate environmental resistance and protection against sabotage and unauthorized removal, and the efficient cooperation of the physical protection functions (deterrence, detection, response) that comply with the requirements of the related Govt. decree [II.33]. There has not been attack against or crime committed within the area of the facility.

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 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 *SFISF* are drained into the waste water system of Paks Nuclear Power Plant, after assessing the samples taken from the tanks located in the basement of the facility. The discharges from the *SFISF* are very *low*: *in 2019* the amount of actual value of airborne releases was only *0.012%*, while the actual value of liquid discharges was also only *0.012%* of the derived limits. Accordingly, only *0.024%* of the derived airborne and liquid discharge limit values were utilized in *2019*.

Since the site of the SFISF and that of 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 detected any increment of the dose to the population living in the vicinity of the site. The impact can be estimated only based on calculations using discharge data. Up to now, the excess dose calculated for the critical group of the population from emission data has been less than *5 nSv/year* in every year; in other words, orders of magnitude less than the authorized dose constraint which is 10 μSv/year.

ANNEX 2: RADIOACTIVE WASTE MANAGEMENT FACILITIES

An2.1 Radioactive Waste Treatment and Disposal Facility

The RWTDF is located near to 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 are 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 facility 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. Storage vaults designated as 'C'-type' and the storage wells designated as 'B'-type and 'D'-type and the interim storages (barrel storage, tube wells, nuclear material storage) are used for interim 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 process building. This temporary solution, by which the continuity of reception of institutional radioactive wastes from all over the country can be possible, 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 tube wells with a diameter of 40 mm, and 16 wells with diameters of 100 mm. The wells are made of 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 tube 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 Analyses Report Substantiating the Operation created for the unified operating license of the RWTDF, *which entered into force after granting the unified operation licence in 2016.*

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” tube wells or tubes of the 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 the waste generator to the site and on-site is organised by PURAM under its own responsibility, *and by other authorized companies in full compliance with the legal requirements,* using first of all their 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 (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 *2014* 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 also 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.

The installation method of the components and the presence of the armed security guards ensure the adequate environmental resistance and protection against sabotage and unauthorized removal, and the efficient cooperation of the physical protection functions (deterrence, detection, response) that comply with the requirements of the related Govt. decree [II.33]. There has not been attack against or crime committed within the area of the facility.

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 less than 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.

The RWTDF operates a radiation protection monitoring system within the site and release and environmental monitoring systems within and around the site.

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 Analysis Report Substantiating Operation and from 2017 surveys are carried out according to the revised program. Since *November 2019, review and licensing process of the monitoring program has been in progress.*

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

In line with the Govt. 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 *and radiocarbon* 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 examined continuously and periodically*. 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 *and radiocarbon* accumulated in the body of ground water under the facility during the years of operation (within the controlled zone) is measurable.

Based on the measurement results of the monitoring system the releases from *the facility remained under the annual investigation criteria*.

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.*72* 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 area, 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 later 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 the armed security guard service.

The process 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 process building hosts the reception of waste packages, as well as the storage, inspection and treatment of wastes.

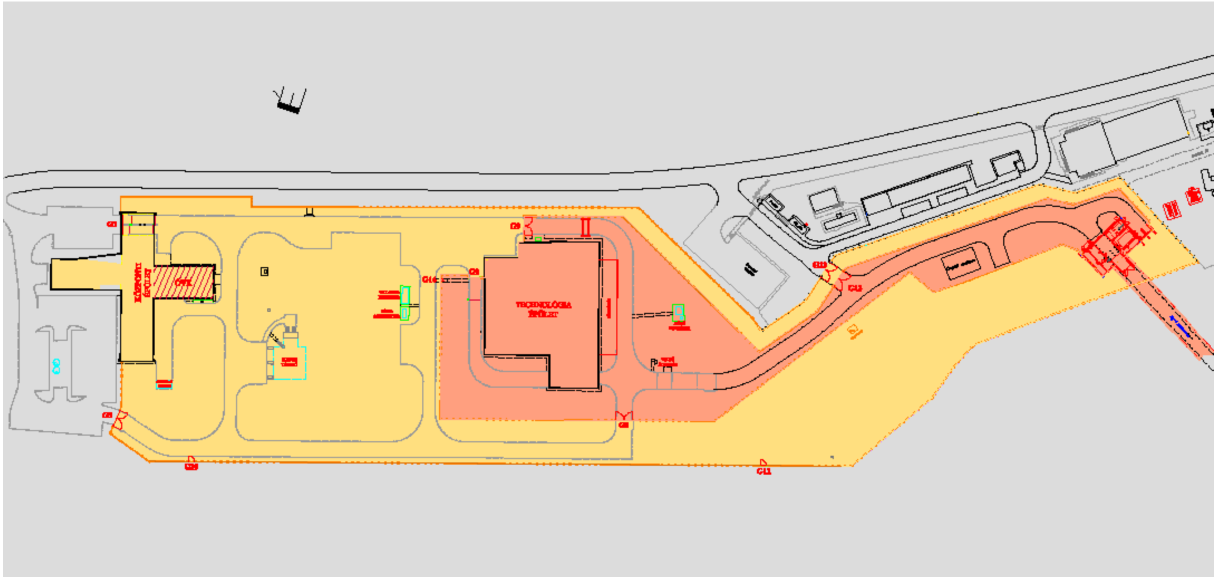


Figure An.2.2.1 – 1: Division of the site of the National Radioactive Waste Repository into zones (the controlled zone of the site is indicated by the dark colour)

The subsurface shaft system is divided to a construction zone based on process and functional needs (i.e. the eastern inclined 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 inclined 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 includes the operation of the receiving and processing site on the ground level, and the underground I-K1 *and I-K2* disposal chambers and the cuts leading to them (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 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. *Transport of liquid waste cemented into metal containers to the NRWR is expected to begin from 2021. The metal container will accommodate 4 drums containing 200 l of solid waste, while the space between the drums will be filled with cement pulp generated from liquid waste (this is the so-called compact waste package). The applicable transport vehicle can take 4 of such waste packages at the same time.*

The maximum allowed amounts of compact waste packages and drums in the NRWR process building *are 255 compact waste packages and 406 transport frames with 4 pieces of 200 l drums per frame (altogether 1624 drums). The place of a compact waste package can be occupied by a transport frame.* The operating license *authorizes to conduct the following process activities:*

- receipt of waste packages, unloading of transport frames *and compact waste packages* from the transport vehicle;

- loading of drums into reinforced concrete containers (one container hosted 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 Paks Nuclear Power Plant to the NRWR with vehicles 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 in their final form are disposed in the subsurface disposal vaults, in the predetermined and registered positions.

During the operation period of the facility the wastes shall be retrievable, if it the retrieval is justified by future operating experience or a regulatory requirement.

An2.2.4 Physical protection

The entire area of the site is surrounded by a double security fence, *with patrolling routes and protected and controlled access points.*

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 and environmental conditions, and their energy supply is ensured from different electric networks. 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 *and the presence of security guards ensure the adequate environmental resistance and protection against sabotage and unauthorized removal*, as well as the effective cooperation of the physical protection functions (i.e. deterrence, detection, delay and response) that comply with the requirements of the relevant Govt. decree [II.33]. Attack against the facility or any offense on the site of the facility 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 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 results of *continuous* measurements at the environment of the facility, 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 remained lower than ten-thousandth of the regulatory limit. Consequently, the operation of the facility has not caused any exposure above the natural background.

The continuous 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 the regulatory dosimeters and the dosimetry records no employee has received exposure above the investigation level. 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 process building, and the *two* sub-surface disposal chambers serve for 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 there, until their final disposal is solved in a Hungarian deep geological repository.

The quantity of waste temporarily stored at small-scale, not nuclear power plant 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 *2019*.

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	*251**	*1,53E+14*
Disposal	4900**	*1,09E+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 *2019*. The data of the wastes being stored in the surface process building and those disposed in the I-K1 disposal chamber 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)
Process building	*340,2*	*2,18E+10*
Disposal vault (I-K1)	*966,6*	*1,67E+11*

Table An3.2-2 presents the volume and total activity of radioactive wastes originated from the operation of Units 1-4 of 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 from Paks Nuclear Power Plant planned to be disposed in the National Radioactive Waste Repository

Type of disposal	Hulladék mennyisége (m^3)
Reinforced concrete container	*967*
200 l drum	*1417*
Compact waste package	*10308*
Large size waste	200
Cemented ion exchanger resin	*1877*
Cs-column storing container	*61*
Total:	***14830***

ANNEX 4: LIST OF LEGISLATIONS RELEVANT TO THE CONVENTION

I. Acts and law-decrees

I.1	Law-decree 12 of 1970	on the promulgation of the treaty on non-proliferation of nuclear weapons resolved by Session No. XXII. of the General Assembly of the United Nations Organisation on the 12th of June in 1968
I.2	Act C of 2012	concerning the Penal Code
I.3	Law-decree 8 of 1987	on the promulgation of the convention on physical protection of nuclear materials
I.4	Act CXCV of 2011	concerning the state budget
I.5	Act LIII of 1995	on the general rules for the protection of the environment
I.6	Act CXVI of 1996	on atomic energy
I.7	Act I of 1997	on the promulgation of the Convention on Nuclear Safety concluded in Vienna on the 20th of September in 1994 under the umbrella of the International Atomic Energy Authority
I.8	Act L of 1999	on the confirmation by the Republic of Hungary and on the promulgation of the Comprehensive Test-ban Treaty resolved by the General Assembly of the United Nations Organisation on the 10th of September in 1996
I.9	Act CXXVIII of 2011	on disaster management, and the amendment to certain acts associated therewith
I.10	Act LXXVI of 2001	on the promulgation of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management concluded under the International Atomic Energy Agency
I.11	Act CXL of 2004	on the general rules of regulatory procedures and services in the public administration[6]
I.12	Act LXXXII of 2006	on the promulgation of the safeguards agreement and protocol in the implementation of Article III(1) and (4) of the Treaty on the Non-Proliferation of Nuclear weapons, and on the promulgation of the Additional Protocol, enclosed with the agreement
I.13	Act CI of 2013	on the amendment to the act on atomic energy, to certain acts associated with energetics, and to the Act CLIX of 1997 on armed security guards, nature protection and field guard service
I.14	Act CLXXV of 2011	on right of association, non-profit status and the operation and funding of civil society organisations
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

[6] *This act ceased to be in force by [I. 18] as of 01.01.2018.*

I.16	*Act VII of 2015*	*concerning the investment in relation to the maintenance of the capacity of the Nuclear Power Plant of Paks and modifying certain related acts*
I.17	*Act CXLIII of 2016*	*on the amendment of energy related acts*
I.18	*Act CL of 2016*	*on general public administration procedures*
I.19	*Act L of 2017*	*the amendment of certain acts associated with the coming into force of the general public administration procedure and public administration judicial procedure*
I.20	*Act LXXV of 2017*	*on the amendment of energy related acts*
I.21	*Act CXXV of 2017*	*on the sanctions for breaching public rules*
I.22	*Act XLV of 2018*	*on the amendment to the Act CXVI of 1996 on Atomic Energy*
I.23	*Act CXXV of 2018*	*on governmental administration*

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.)	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.)	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.)	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.)	on the actions in connection with the found or confiscated radioactive or nuclear materials[7]

[7] *This Govt. Decree ceased to be in force by [II.38] as of 1 January 2016*

II.10	Govt. Decree 124/1997. (VII. 18.)	on radioactive materials as well as equipment generating ionising radiation, exempted from the scope of the Atomic Energy Act CXVI of 1996.[8]
II.11	Govt. Decree 185/1997. (X. 31.)	on the promulgation of the agreement on the early notification in the case of radiological emergency concluded between the Government of the Republic of Hungary and the Government of the Republic of Slovenia, signed in Budapest on the 11th of July in 1995
II.12	Govt. Decree 246/2011. (XI. 24.)	on the safety area of the nuclear facility and the radioactive waste repository
II.13	Govt. Decree 227/1997. (XII. 10.)	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.)	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[9]
II.15	Govt. Decree 61/1998. (III. 31.)	on the promulgation of the agreement on the early notification in the case of nuclear accidents concluded between the Government of the Republic of Hungary and the Government of Romania, signed in Bucharest on the 26th of May in 1997
II.16	Govt. Decree 108/1999. (VII. 7.)	on the promulgation of the agreement on the early notification in the case of nuclear accidents, and on the mutual information and co-operation in the field of nuclear safety and radiation protection, concluded between the Government of the Republic of Hungary and the Government of Ukraine, signed in Budapest on the 12th of November in 1997
II.17	Govt. Decree 13/2000. (II. 11.)	on the promulgation of the agreement on the early notification in the case of radiological accidents concluded between the Government of the Republic of Hungary and the Government of the Republic of Croatia, signed in Zagreb on the 11th of June in 1999
II.18	Govt. Decree 72/2000. (V. 19.)	on the special conditions of acquiring the possession rights of certain materials, equipment and facilities belonging in the scope of application of atomic energy, as well as on the procedure for reporting their possession and operation[10]
II.19	Govt. Decree 136/2002. (VI. 24.)	on the promulgation of the agreement on cooperation in the field of the peaceful use of atomic energy between the Government of the Republic of Hungary and the Government of Australia

[8] *This Govt. Decree ceased to be in force by [II.36] as of 1 January 2016*
[9] *This Govt. Decree ceased to be in force by [II.31] as of 1 January 2016*
[10] *This Govt. Decree ceased to be in force by [II.36] as of 1 January 2016*

II.20	Govt. Decree 275/2002. (XII. 21.)	on the monitoring of radiation levels and radioactivity concentrations in Hungary[11]
II.21	Govt. Decree 112/2011. (VII. 29.)	on the scope of tasks of the Hungarian Atomic Energy Authority in association with nuclear energy related European Union and international obligations, the designation of co-authorities contributing to the regulatory procedures of the Hungarian Atomic Energy Authority, the amount of imposed penalties, and on the scientific council assisting the work of the Hungarian Atomic Energy Authority
II.22	Govt. Decree 165/2003. (X. 18.)	on the information to be provided to the public in nuclear and radiological emergencies
II.23	Govt. Decree 244/2004. (VIII. 25.)	on the promulgation of the protocol signed by the Government of the Republic of Hungary and the Government of the Russian Federation on conditions concerning the reshipment to the Russian Federation of Russian-made (irradiated) spent fuel assemblies
II.24	Govt. Decree 118/2011. (V. 5.)	on the nuclear safety requirements of nuclear facilities and the related regulatory activities
	Annex No. 1 Nuclear Safety Code Volume 1	Regulatory procedures for nuclear facilities
	Annex No. 2 Nuclear Safety Code Volume 2	Quality management of nuclear power plants
	Annex No. 3 Nuclear Safety Code Volume 3	Design requirements for operating nuclear power plants
	Annex No 3/A *Nuclear Safety Code* *Volume 3/a.*	*Design requirements for new nuclear power plant units*
	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	Requirements for the design and construction period of a new nuclear facility

[11] *This Govt. Decree ceased to be in force by [II.37] as of 1 January 2016*

	Volume 9	
	Annex No. 10 Nuclear Safety Code Volume 10	Nuclear Safety Code definitions
II.25	Govt. Decree 314/2005. (XII. 25.)	on environmental impact assessment and on the integrated environmental usage permitting process
II.26	Govt. Decree 257/2006. (XII. 15.)	on declaring the outstanding importance of certain administrative regulatory matters in connection with the project of a repository of low and intermediate activity, to be established in Bátaapáti[12]
II.27	Govt. Decree 267/2006. (XII. 20.)	on the Hungarian Office for Mining and Geology
II.28	Govt. Decree 34/2009. (II. 20.)	on licensing of transboundary movement of radioactive waste and spent fuel
II.29	Govt. Decree 167/2010. (V. 11.)	on the National Nuclear Emergency Response System
II.30	Govt. Decree 323/2010. (XII. 27.) [13]	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.)	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.)	on the rules of financial supports provided to monitoring and information aimed local government associations from the Central Nuclear Financial Fund
II.33	Govt. Decree 190/2011. (IX. 19.)	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.)	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.)	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.)	on the protection against ionizing radiation and the corresponding licensing, reporting (notification) and inspection system
II.37	Govt. Decree 489/2015. (XII.30.)	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.)	on reports and interventions regarding missing, found or seized nuclear and other radioactive materials and other actions pertaining to radioactive materials following their report

[12] *This Govt. Decree ceased to be in force by [II.42] as of 1 January 2015*
[13] *This Govt. Decree ceased to be in force by [II.44] as of 1 April 2017*

II. 39	Govt. Decree 2/2005. (I.11.)	on the environmental assessment of specific plans and programmes
II.40.	Govt. Decree 132/2010. (IV.21)	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 26 February 1991
II.41	Govt. Decree 204/2008. (VIII.19.)	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.)	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
II.43	*Govt. Decree 184/2016. (VII. 13.)*	*on the detailed rules of verification of skills and registration of civil engineering-technical experts, civil engineering designers, technical building inspectors and responsible construction supervisors of buildings and structures belonging under the effect of the act on atomic energy, and on the rules for data content of the registration*
II.44.	*Govt. Decree 385/2016. (XII.2.)*	*on fulfilment of public health tasks of the capital and county government offices and settlement (capital district) offices, and on the designation of health state administration body*
II.45.	*Govt. Decree 161/2017. (VI.28.)*	*on the Mining and Geological Survey of Hungary*
II.46	*Govt. Decree 457/2017. (XII. 28.)*	*on the amendment to certain government decrees corresponding to the entering into force of the general public administration procedure*
II.47	*Govt. Decree 27/2018. (II. 28.)*	*on the amendment to certain government decrees associated with atomic energy*
II.48	*Govt. Decree 28/2018. (II. 28.)*	*on the amendment of Govt. Decree 118/2011. (VII. 11.) on the nuclear safety requirements of nuclear facilities and the related regulatory activities and of the Govt. Decree 155/2014. (VI. 30.) on the safety requirements for facilities ensuring interim storage or final disposal of radioactive wastes and the corresponding authority activities*

II.49	*Govt. Decree 70/2018. (IV. 9.)*	*on the amendment to certain government decrees associated with atomic energy*
II.50	*Govt. Decree 147/2018. (VIII. 13.)*	*on the amendment of the Govt. Decree 247/2011. (XI. 25.) on the independent technical expert proceeding in the scope of the application of atomic energy*

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 Goods14
III.2	Decree of the Minister of Public Welfare 23/1997. (VII. 18.)	on the exemption levels (activity-concentrations and activities) of radionuclides[15]
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 associated with radiation protection
III.4	Decree of the Minister of Health 30/2001. (X. 3.)	on the operational radiation protection of the outside workers[16]
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 medical services [17]
III.6	Decree of the Minister of Environment 15/2001. (VI. 6.)	on the radioactive releases into the air and into the water in connection with the application of atomic energy, and on their control
III.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[18]
III.10	Decree of the Minister of Justice 14/2005. (VII.25)	on the operation and administration of the Central Nuclear Financial Fund[19]
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

[14] The promulgating legislation *ceased to be in force on 1 July 2013, incorporated into the new promulgating legislation, see I.15*
[15] *This Govt. Decree ceased to be in force by [II.36] as of 1 January 2016*
[16] *It ceased to be in force by [III.18] as of 16 January 2016*
[17] *This Govt. Decree was replaced by [III. 21] as of 10 July 2018*
[18] *It ceased to be in force by Govt. Decree [II. 47] as of 1 March 2018.*
[19] This Govt. *Decree ceased to be in force* by [II.31] on 1 January 2014

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 inspection of radioactive materials and related data supply
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[20]
III.15	Decree of the Minister of National Development 51/2013. (IX. 6.)	on the transport, carriage 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
III.18	*Decree of the minister of human resources 2/2016. (I. 15.)*	*on the amendment to certain ministerial decrees corresponding to the entering into force of the government decree on the protection against ionizing radiation and the corresponding licensing, reporting (notification) and inspection system*
III.19	*Decree of the minister of national development 4/2016. (III. 5.)*	*on the fees to be paid for certain public administration procedures and administration services of the Hungarian Atomic Energy Authority*
III.20	*Decree of the minister of national development 52/2017. (XII. 22.)*	*on the promulgation, amendment and setting aside certain ministerial decrees associated with energy corresponding to the entering into force of act on general public administration procedure and for other purpose*
III.21	*Decree of the minister of human resources 21/2018. (VII. 9.)*	*on the rules for the protection of the health of persons exposed to ionising radiation during the provision of health services outside their work duties*

[20] *Not in force since 31 June 2014. This Govt. Decree ceased to be in force by [II.35] at 11pm on 30 June 2014*

V. Parliamentary Resolutions

IV.1	Parliamentary Resolution 21/2015. (V.4.)	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

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

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

In preparing the report, the HAEA is supported by other regulatory authorities competent in nuclear applications. First the report is subject to intergovernmental discussions and the Government then decides on its submission to the Parliament.

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

In 2018 the Hungarian Parliament accepted the annual report on the safety in the application of nuclear energy 2016, and in 2020 it discusses the annual reports 2017 and 2018. The reports concluded that the application of nuclear energy in Hungary fulfils the relevant safety requirements.

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

Hungary is a Party to the Convention on Nuclear Safety [1.7] and prepared a National Report on the fulfilment of the obligations contained in this Convention in 1998, 2001, 2004, 2007, 2010, 2012 (Extraordinary Conference following the Fukushima accident), 2013, 2016 *and in 2019*. The Reports are available on the website of the HAEA (www.haea.gov.hu).

All of the reports until 2017 were received favourably in the review meetings. *Review of the eighth National Report prepared in 2019 would have been taken place in March 2020, but due to the Covid-19 pandemic the review meeting was postponed to a date to be determined later.*

An5.3 Participation in the reporting schemes 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 is extended to the SFISF, but in this facility, corresponding to the favourable operational experience, no events have taken place to be reported in the framework of IRS or INES.

Since 2017 this obligation is 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 follow-up mission at the Hungarian Atomic Energy Authority

In 2010 the international peer review to be organized by the IAEA started in the framework of 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 National 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 National 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 participation of the HAEA, the radiation health and the environmental protection co-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 National Action Plan, *which was implemented then. An IAEA follow-up mission to review the implementation of the National Action Plan returned to Hungary between 24 September and 1 October 2018. As the result of the review the IRRS mission concluded that Hungary had taken important steps since 2015 to improve its regulatory systems and had closed 21 of the 32 recommendations and 9 of the 10 suggestions, because Hungary had implemented them successfully. The follow-up mission has supplemented the still open 11 recommendations and 1 suggestion with 1 new recommendation and 2 new suggestions.*

In relation to the open issues, the HAEA developed a long term action plan for addressing the 5 recommendations (1 is common with the co-authorities) and 1 suggestion that concerns the HAEA. On the basis of the action plan, during 2019, two of the recommendations were completed by the HAEA, while accomplishment of the remaining recommendations and the suggestion is planned in 2020, since these are such long term tasks, which need more time to solve. The next IRRS mission to Hungary is planned to be invited in 2025 in line with the Council Directive 2014/87/Euratom of 8 July 2014 amending Directive 2009/71/Euratom establishing a Community framework for the nuclear safety of nuclear installations.

An6.2 IPPAS follow-up mission to Hungary

Between 26 June and 7 July 2017, the delegation of the IAEA held again a nuclear security review in Hungary: implementation of issues raised in 2013 by the experts invited by the IAEA was reviewed.

The International Physical Protection Advisory Service (IPPAS) hold the first comprehensive review in Hungary in 2013. It reviewed the national regulatory system for physical protection of nuclear and other radioactive materials and the related facilities and activities, the corresponding legal background how it complies with the international recommendations and good practices. The review was successful, in the closing report the international experts took 9 recommendations and 57 suggestions to improve the efficiency of the system and also identified several good practices.

The HAEA, after the review in 2013, developed a National Action Plan in co-operation with the organizations participating in the review and had been co-ordinating its implementation during the following years. In 2015, the HAEA notified the IAEA that Hungary is ready to receive the IPPAS follow-up mission and started the organization accordingly.

During the two-weeks follow-up mission between June 26 and July 7 2017, the IAEA experts, in addition to reviewing the implementation of the recommendations and suggestions in the 2013 report, first in the world, also reviewed and commented the physical protection implications of the national accountancy system for nuclear materials and the physical protection preparations of the new Paks Nuclear Power Plant units.

The expert group concluded that Hungary has made a commendable progress in the implementation of the recommendations and suggestions of the former review mission. They identified several good practices and gave new recommendations and suggestions to support further developments.

An6.3 International missions to Paks Nuclear Power Plant

An6.3.1 WANO follow-up review in 2018 at Paks Nuclear Power Plant

The latest WANO peer review was conducted at Paks Nuclear Power Plant in spring of 2016. The result of the review was positive as compared to the former reviews at the plant and international level as well, since it concluded less deficiency in the operation. The reviewers identified 14 areas for improvement and two good practices. The follow-up peer review to check the elimination of the deficiencies took place between 9 and 13 April 2018 at Paks Nuclear Power Plant. During the follow-up the review group evaluated the efficiency of the actions taken for the elimination of the 14 areas for improvement and the progress on a four grade scale („A"-„D"). They did not identify any new safety related deviation. The reviewers concluded that after the original review in 2016 the plant correctly determined the causes of the issues and the directions of corrective actions to eliminate them. During the two years available, the professional staff of the plant implemented most of the decided tasks. The effect of these particularly appears in the performance of the areas identified for improvement. In the case of some of the areas for improvement needing a comprehensive approach, the deadline for implementation of the decided long term actions was after the date of the follow-up review, but their implementation progressed as anticipated. 4 areas out of the 14 received an „A" grade (resolved), while the evaluation of 10 areas closed with „B" grade (satisfactory progress). The result of the follow-up at Paks is extraordinary in international comparison. Based on the

WANO peer group's evaluation it can be stated that in the case of all non-closed areas of improvement a significant performance development was achieved.

An6.3.2 Preparation for the next[21], WANO peer review in 2020 at Paks Nuclear Power Plant

In accordance with the long term plan of the WANO, each nuclear power plant should subject itself to an international peer review every four years. In Paks Nuclear Power Plant, the last WANO peer review was conducted in 2016, so the upcoming, fifth, WANO peer review should have taken place in 2020. [22]

The 2020 WANO review is to take place according to the new version of "Performance Objectives and Criteria (PO&C)". Two new other novelties are that this WANO review is to be a so-called „design-informed" (DiPR) that is nuclear safety of the plant will be evaluated with consideration to the main design features of the plant, while the review programme is supplemented with the observation of the main control room staff during simulator activities (Crew Performance Observation – CPO).
In order to successfully implement the CPO reviews, training was conducted between 5 and 7 November 2019 on the WANO review methodology for the review counterparts of Paks Nuclear Power Plant and the developers of the advance information package. The training programme covered a detailed introduction of the changes of the new PO&C document, the design-informed peer review and the CPO observations. In the frame of the training a test CPO observation was performed on the simulator.

[21] *Due to the COVID-19 pandemic situation the review did not take place in the originally planned dates in the first quarter of 2020, the review is expected to take place in the last quarter of 2020 or the first quarter of 2021.*

[22] *Due to the pandemic situation the review did not take place in the originally planned dates. The MVM Paks Nuclear Power Plant requested the WANO Moscow Centre to conduct the review in the first quarter of 2021. No response from WANO was received so far.*

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

An7.1 Preliminaries

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 terminated. 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 Govt. resolutions [V.1- V.4].

Remediation tasks were carried out practically according to the plans 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 Govt. resolution [V.4]. The Govt. resolution set a new deadline for the completion of the remediation activities, this was 31 December 2008. Also, the budget of the remediation project was 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 laws as well as international requirements, 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 limit values for the radiological parameters in the following tables 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 competent Radiation Protection Decentre *(its legal successor today is the HAEA).*

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

Radon (Rn) exhalation	0.74 $Bq/m^2/s$
Gamma-dose rate – workplace average – at specific points	 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[23]	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 limit***
Natural uranium content	0.4 mg/dm3
Radium-226 content	0.63 Bq/dm3

[23] *Note: from 2016 it changed to 300 Bq/m^3 reference level.*

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 limit*
Ra-226	*3.1 E+10 Bq/year*
*For *U isotope group*	*2.7 E+11 Bq/year*
Po-210	*3.8 E+09 Bq/year*

*Note: groups of isotopes U-234, U-235 and U-238

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

Isotope	*Discharge limit*
*For *U isotope group*	*2.0 E+08 Bq/year*

*Note: groups of isotopes U-234, U-235 and U-238

An7.2.4 Features of the remediation programme

The determination of the spatial dimensions 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 An7.2.5-1.

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.

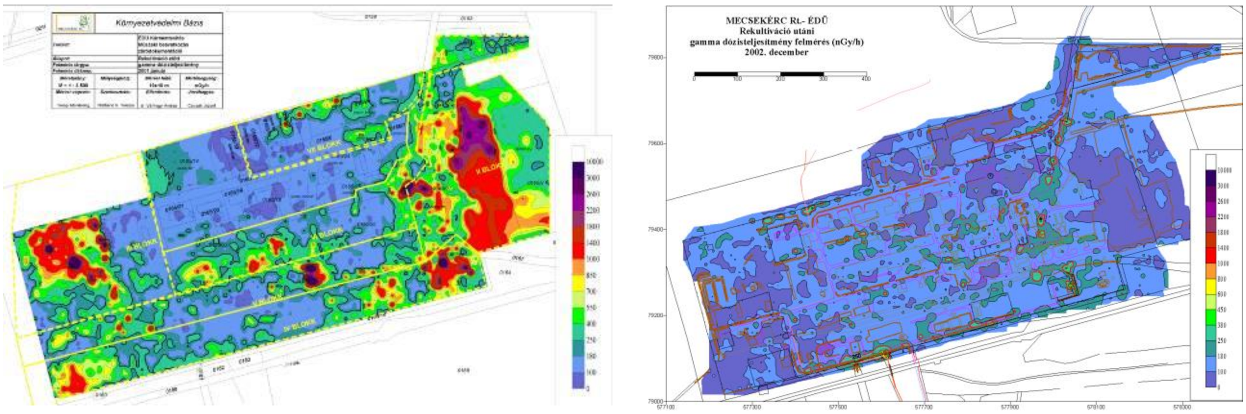


Figure An7.2.5-1: ***Gamma dose measurement rates results in the Ore Enrichment Plant site before and after the remediation***

An7.3 Post-remediation tasks

The "Investment Programme of the remediation tasks of the abandonment of the uranium mining in Hungary" approved by a Govt. 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 responsible for mining. The sources for the long term activity at the old uranium industry site can be found in the budget chapter of the Ministry of Innovation and Technology.

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 from

2023. Due to an investment in 2014, the annual maximum capacity of the uranium removal facility increased to 1.8 million m^3);

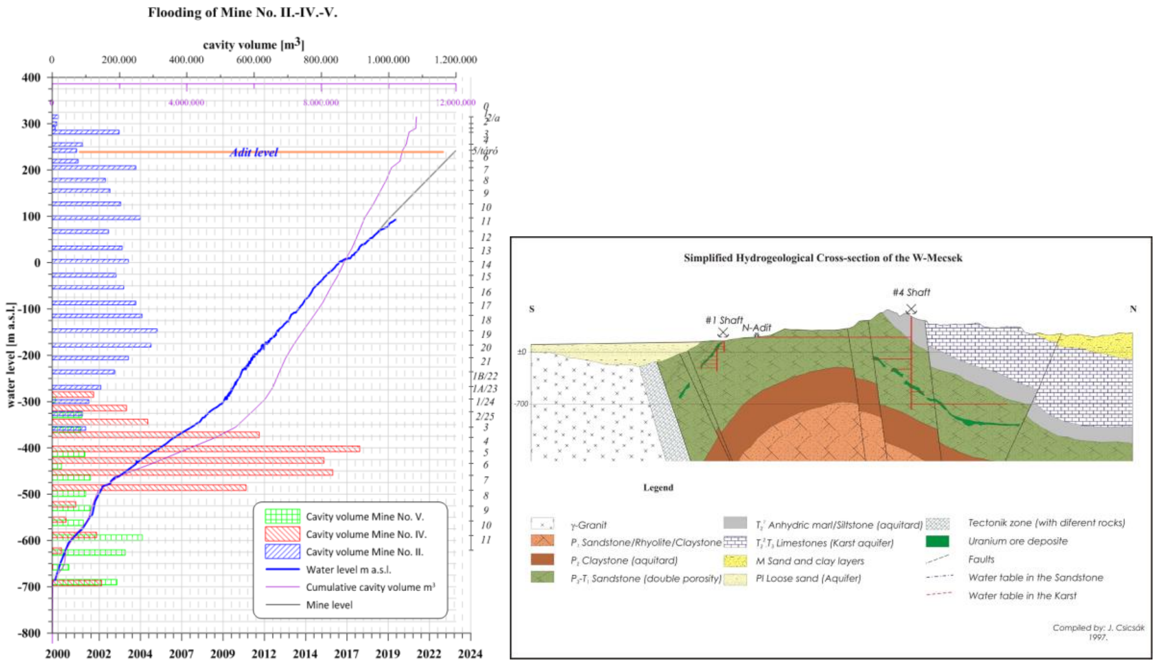


Figure An7.3 – 1: Filling up of the cavity system of the northern mines and geological section of impact areas of uranium ore mining

Figure An7.3 – 2: Expansion of the water treatment system in pictures

Figure An7.3 – 3: Expansion of the sorption column system


Figure An7.3 – 4: Uranium concentrate drier


Figure An7.3 – 5: Construction of the drain leakages system of the dumps

Figure An7.3 – 6*: *Construction of emergency mine water reservoir

- desalination of groundwater and aquifers (treatment of an average water volume of 2000 m^3/day). *Necessary expansion of the active damage elimination system serving this purpose, operating in the environment of the uranium industry tailings ponds took also place, in line with which the amount of water to treat also increased in this area;*
- 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 post-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.

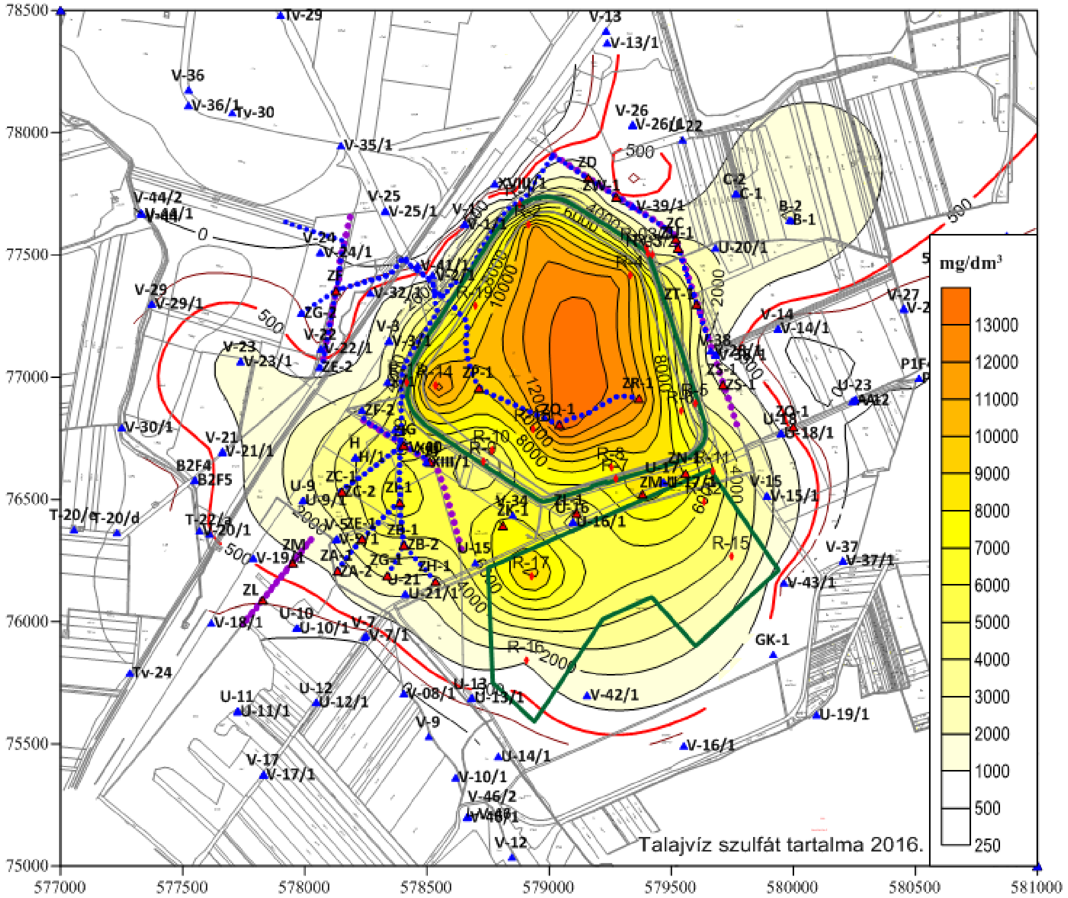


Figure An7.3 - 7: Sulphate content of ground water in the vicinity of tailings ponds in 2019 (areas in green boundaries show the location of the two tailings ponds)

Figure An7.3 - 8: Remedied uranium industry tailings pond

The current environmental and mining authority permits for the activity are valid until 2023. In recent years, environmental reviews of mining reclamation activities have been identified on a regular basis, that the reclamation work was practically carried out in accordance with the program originally approved, as a result of which the isolation of radioactive mining and ore processing waste released into the environment by previous uranium industry activities has taken place. The activity significantly reduced the radiological load on the population, however, open radon concentrations in the region remain above the national average and this situation is expected to persist in the long term.

By the end of 2019, as the results of the fully completed investment, the system became applicable to manage, in accordance with the regulatory requirements, the leaking excess water originating from mining spaces filled up and expected to be filled up in the near future, and from under the dumps. The most important components of the modifications were:

- *The number of uranium removal sorption columns increased from 12 to 15,*
- *The number of elution columns increased from 3 to 5.*
- *The uranium concentrate production works, including the concentrate drier-packer system was also expanded, and a new drier cauldron was installed in addition to the existing one,*
- *The water transport capacity of the piping system of the unified water direction system was increased as it was needed,*
- *The leaking water of the dumps I and II are collected by the newly constructed drain leakage systems and the shafts connected to the drain leakage systems,*
- *Integration of the expanded system components to the industrial control systems,*
- *As part of the water treatment activity, a volume of 495 644 m^3 of water contaminated with uranium was decontaminated, from which 3 755 kg of uranium concentrate was produced. During the remediation works of the tailings spaces, a volume of 487 580 m^3 waster was treated, from which 64 355 m^3 was treated chemically.*

ANNEX 8: SPENT FUEL OF NUCLEAR FACILITIES

An8.1 Paks Nuclear Power Plant

An8.1.1 Management of 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 Paks Nuclear Power Plant. Legal requirements and technological changes taking place in the meantime made it necessary to renew the Nuclear Power Plant Safety Technique Code. The Government, based on the authorization given in the Act on Atomic Energy [I.6], issued the Govt. decree on the proceedings of the HAEA [II.24]. The new NSC was published as annex to this government decree.

Systems managing spent fuel elements

Storage of spent fuel assemblies

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

In the spent fuel pool belonging to the individual unit the spent fuel assemblies 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 assemblies, control assemblies, followers (absorbers). 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 pools in case of a need to expand storage capacity.

Handling and transport equipment of spent fuel assemblies

The handling equipment of spent fuel assemblies is used to move the fuel assemblies burnt up in the reactors during refuelling and, if necessary, to check them as well to prepare for their transport from the plant after the decay period in the spent fuel pools.

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

Decay heat removal

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

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 using the C–30 containers, the following limiting conditions shall be met:

a) highest average enrichment of the spent fuel assemblies: 4.7%;
b) maximum fuel assembly burn-up: 58 GWday/tU;
c) maximum operation time of fuel assemblies is five years;
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 is between 3.82% and 4.2%) or 46 months decay period (if the average enrichment 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 the storage filled with radially profiled fresh fuel assemblies of 3.82% average enrichment, containing 120.2 kg uranium each. *Verification calculations with the parameters of the new fuel assemblies containing 126.3 kg uranium and gadolinium as burnable poison was performed before their introduction, and it was repeated for the optimized geometry fuel assemblies with an average enrichment of 4.2% and 4.7%, containing 129 kg uranium, introduced in the coming years.* 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 according to the regulations keep the sub-critical state even if they are flooded with clean, i.e. boron-free, water.

Other risks taken into account

- Dropping or any other kind of damage to the fuel assemblies, and the development of unacceptable mechanical stresses are minimized by the transport and lifting process equipment (with bayonet joint grip, retainers and cranes with a prescribed safety factor) and storage technologies.
- The seismic safety revision and the necessary strengthening of Paks Nuclear Power Plant have been accomplished. Ensuing from the low frequency of fuel handling manipulations, no seismic event of safety level was assumed simultaneously with re-fuelling and transport manipulations (in case of Paks Nuclear Power Plant this is defined by 0.25g peak ground acceleration and a site-specific response spectrum).
- Evaluations of resistance against external hazards were accomplished generally for facility level; thus, the extent of the hazard could not be determined specifically for the nuclear

fuel handling tools and equipment. 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 hazards within the design basis, and appropriate margin is available for such hazards beyond the design basis. As a whole, the facility and the handling of stored nuclear fuel could be seen as protected against external hazard.

- Fire risk assessments carried out for 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, within its own competence, in the spent fuel pools. Maximum storage capacity of the spent fuel pools amounts to 1025 assemblies (679 on the operating racks and 346 on the reserve racks) for each unit. Following the minimum 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 in 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 in the website of the HAEA (www.haea.gov.hu).

The fuel fragments damaged in Shaft 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:

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

where:

E_{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 discharge monitoring, as well as features of their capability and effectiveness shall be specified in a Discharge Monitoring Procedure 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 Procedure.

Systems for discharge monitoring

In 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 detection of any possible unplanned discharge of radioactive materials into the environment are ensured; furthermore, so that it is possible to track the dispersion of radioactive materials discharged, and, if it is possible, and 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 (telemetry) systems and on sampling laboratory tests. The data gained from the remote discharge and environment monitoring systems, as well as the data of the meteorological mast are collected and archived in a central computer.

Airborne discharges

The monitoring of the airborne discharges is ensure by the continuous operation of the isokinetic sampler installed in the stack before the discharge point. In addition to laboratory sampling, the changes are monitored 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	gross2 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-spectrometry 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 performed 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 uncontrolled way, without laboratory sample analysis.

Environment monitoring

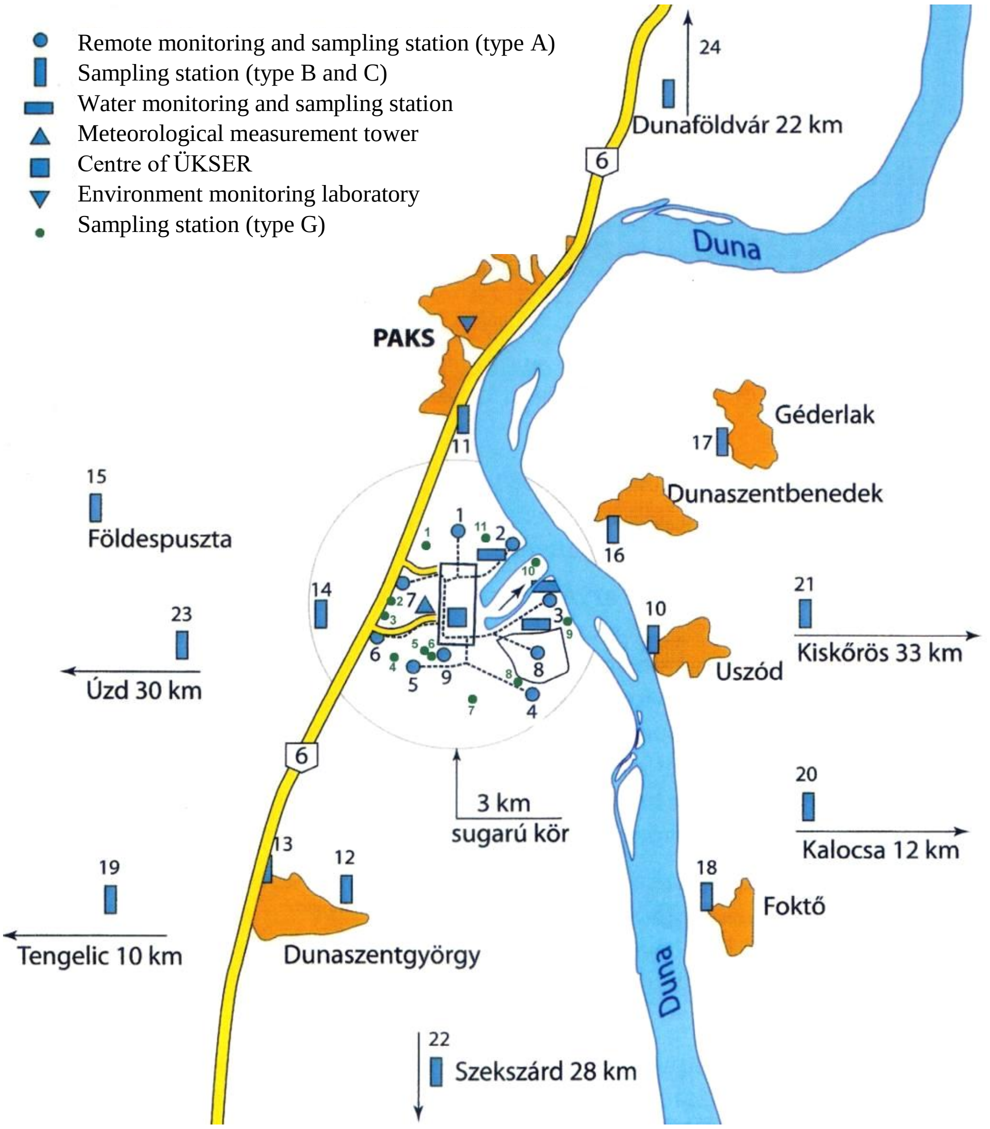
A fixed environmental radiological monitoring system is installed in the surroundings of the nuclear power plant.

Measuring and sampling capabilities of the various stations:

1. Type A station (9 stations within a range of 1.5 km), and Type B (reference) station (1 station, 28 km north of the nuclear power plant):
   - gamma-radiation dose rate (on-line) and TLD dose measurements;
   - aerosol and iodine activity-concentration remote measurement (on-line);
   - aerosol and iodine sampling;
   - air sampling for determining tritium and radio-carbon;
   - fall-out;
   - soil and grass sampling.

2. Type C station (14 stations within a range of 30 km):
   - TLD dose measurements;
   - if needed, collection of soil, grass, and fall-out samples.

3. Type G station (11 stations within a range of 3 km):
   - gamma-radiation dose rate (on-line).



Note: Note: ÜKSER = Operational Environmental Radiation Monitoring System

<u>Figure An.8.1.2 – 1: Environmental Radiation Protection Monitoring System</u>

<u>Optimization of protection</u>

During optimization, dose threshold of the particular protective actions and the sequence of protective actions must be taken into account in the early and late phase of the systems of protective actions.

The table contains the optimized intervention levels for each protective action (in averted dose), the exceedance of which means that an intervention is justified in any circumstances.

Optimized intervention levels assigned to the protective actions (in averted dose)

Protective action	***Exposure pathway***	***Threshold dose for optimized intervention***
Iodine prophylaxis	*Thyroid*	*>= 50 mSv equivalent does in the thyroid*
Sheltering	*External exposure* *Internal exposure from inhalation, or ingestion of aerosol*	*>= 10 mSv effective dose/ 2 days*
Evacuation before the cloud	*External exposure* *Internal exposure*	*>= 50 mSv / 1 week*

Optimized intervention levels assigned to the protective actions (in averted dose)

Evacuation in the cloud	*External exposure* *Internal exposure*	*>= 50 mSv / 1 week*
Resettlement	*External exposure* *Internal exposure from inhalation, ingestion of resuspended radioactive contamination*	*>= 30 mSv / 1 month* *>= 100 mSv / first year* *>= 1000 mSv / lifetime*

Discharge data for the years *between 2017 - 2019*

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 limit for discharge pathway 'j' and radionuclide 'i'.

Table An8.1.2. -1 Discharge data for Paks Nuclear Power Plant between *2017-2019*

Isotope groups	Total discharge in 2017 [Bq]	Discharge limit usage*	Total discharge in 2018 [Bq]	Discharge limit usage*	Total discharge in 2019 [Bq]	Discharge limit usage*
Airborne discharges						
Corrosion and fission products	*$7{,}58 \times 10^{8}$*	*$5{,}00 \times 10^{-5}$*	*$1{,}09 \times 10^{9}$*	*$6{,}40 \times 10^{-5}$*	*$7{,}11 \times 10^{8}$*	*$7{,}46 \times 10^{-5}$*
Radioactive noble gases	*$3{,}80 \times 10^{13}$*	*$5{,}30 \times 10^{-4}$*	*$3{,}50 \times 10^{13}$*	*$4{,}57 \times 10^{-4}$*	*$2{,}58 \times 10^{13}$*	*$3{,}70 \times 10^{-4}$*
Radioiodine	*$4{,}51 \times 10^{7}$*	*$1{,}99 \times 10^{-5}$*	*$1{,}01 \times 10^{8}$*	*$1{,}35 \times 10^{-5}$*	*$7{,}21 \times 10^{7}$*	*$3{,}18 \times 10^{-5}$*
Tritium	*$5{,}36 \times 10^{12}$*	*$3{,}09 \times 10^{-5}$*	*$4{,}93 \times 10^{12}$*	*$2{,}84 \times 10^{-5}$*	*$4{,}16 \times 10^{12}$*	*$2{,}39 \times 10^{-5}$*
Radiocarbon	*$6{,}32 \times 10^{11}$*	*$1{,}98 \times 10^{-4}$*	*$6{,}82 \times 10^{11}$*	*$1{,}83 \times 10^{-4}$*	*$6{,}44 \times 10^{11}$*	*$1{,}79 \times 10^{-4}$*
Total:	-	*$8{,}29 \times 10^{-4}$*	-	*$7{,}46 \times 10^{-4}$*	-	*$6{,}80 \times 10^{-4}$*
Liquid discharges						
Corrosion and fission products	*$1{,}13 \times 10^{9}$*	*$5{,}64 \times 10^{-4}$*	*$1{,}03 \times 10^{9}$*	*$3{,}76 \times 10^{-4}$*	*$9{,}68 \times 10^{8}$*	*$4{,}44 \times 10^{-4}$*
Tritium	*$2{,}78 \times 10^{13}$*	*$9{,}57 \times 10^{-4}$*	*$3{,}38 \times 10^{13}$*	*$1{,}17 \times 10^{-3}$*	*$2{,}96 \times 10^{13}$*	*$1{,}02 \times 10^{-3}$*
Radiocarbon	*$3{,}47 \times 10^{9}$*	*$1{,}12 \times 10^{-3}$*	*$2{,}84 \times 10^{9}$*	*$9{,}15 \times 10^{-4}$*	*$2{,}00 \times 10^{9}$*	*$6{,}45 \times 10^{-4}$*
Alpha emitters	*$1{,}58 \times 10^{5}$*	*$1{,}97 \times 10^{-7}$*	*$1{,}08 \times 10^{5}$*	*$1{,}41 \times 10^{-7}$*	*$1{,}28 \times 10^{5}$*	*$1{,}52 \times 10^{-7}$*
Total:	-	*$2{,}64 \times 10^{-3}$*	-	*$2{,}46 \times 10^{-3}$*	-	*$2{,}11 \times 10^{-3}$*

* The summed up discharge limit usage calculated 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 NSC.

Systems to handle spent fuel elements (removal of decay heat, criticality safety, consideration of other hazards)

The criticality of spent fuel of the BRR similarly to that of nuclear power plant cannot cause any problem, because in line with the 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 assemblies transported together (the device is not able to move more than one fuel assembly at the same time). Heat generation of the BRR fuel assemblies 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 movement 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 process 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.

Introduction of the new VVR-M2 fuel assemblies of less than 20% enrichment was completed. The reactor currently has 6 (calculated in fuel assembly one) fresh VVR-M2 <20% enrichment assemblies, there are 190 in the reactor, and there are 266 spent fuel assemblies. This altogether means 462 fuel assemblies. Due to the former repatriation operations the CER has sufficient storage capacity until the end of its planned lifetime, since the total storage capacity is 2852, as compared to the need of 532 until the end of the planned lifetime.

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

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:

Limits for airborne discharges

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 quarters. 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 chemistry laboratory of the reactor building and the effluents from the water conditioning unit. If radioactive material gets into the acid neutralizing shaft, the radioprotection operator in charge observes the increase in the 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.

Water discharge

Checking of 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 2014 and *2019*, as usual, the following results were obtained in the period:

	2014	***2015***	***2016***	***2017***	***2018***	***2019***
atmospheric discharges*:*						
Noble gas (only ^{41}Ar)		*59,7 TBq*	*36,5 TBq*	*38,6 TBq*	*49,0 TBq*	*46,0 TBq*
Iodine	*below detection limit (<5 Bqh/m³)*	*below detection limit (<5 Bqh/m³)*	*below detection limit (<5 Bqh/m³)*	*below detection limit (<5 Bqh/m³)*	*below detection limit (<5 Bqh/m³)*	*below detection limit (<5 Bqh/m³)*
aerosol	*below detection limit (<3.7 Bq/m³)*	*below detection limit (<3.7 Bq/m³)*	*below detection limit (<3.7 Bq/m³)*	*below detection limit (<3.7 Bq/m³)*	*below detection limit (<3.7 Bq/m³)*	*below detection limit (<3.7 Bq/m³)*
liquid waste discharges*:*						
^{3}H	*did not occur*	*2.15E+11*	*did not occur*	*did not occur*	*1.82E+11*	*9.26E+15*
^{60}Co	*did not occur*	*1.45E+06*	*did not occur*	*did not occur*	*1.12E+06*	1.02E+12
^{65}Zn	*did not occur*	*7.19E+05*	*did not occur*	*did not occur*	0-	9.90E+12
^{137}Cs	*did not occur*	*3.03E+06*	*did not occur*	*did not occur*	*9.46E+06*	9.46E+06

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 spent fuel assemblies

Until now, no spent fuel was generated in the Training Reactor. If the current fuel were to be replaced, the management of the spent fuel would take place in line with Volume 5 of the NSC, 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 prescribed 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.