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**THE SIXTH MID AND LONG TERM
PLAN OF PUBLIC UTILITY FOR RADIOACTIVE WASTE
MANAGEMENT**

**FOR THE ACTIVITIES TO BE FINANCED FROM THE
CENTRAL NUCLEAR FUND**

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1. INTRODUCTION

According to Article 40 of the Act No. CXVI. on Nuclear Power from 1996 (hereinafter referred to Nuclear Act) a body appointed by the Government will be responsible for dealing with tasks related to the final disposal of the radioactive wastes, interim storage and final disposal of spent nuclear fuel, furthermore with the issues related to the decommissioning of the nuclear facility, since the solution of the said tasks are of national interest.

The Government has entrusted the HAEA to establish, for executing the said tasks, the Public Utility for Radioactive Waste Management (hereinafter PURAM). In addition in Article 2 (1) c of Governmental Order No. 240/1997. (XII. 18.) it is required within the scope of the planning and reporting activities to prepare mid and long term plans for the activities to be financed from the Fund and of the income sources of the Fund as well as the annual review of them.

According to Article 62 (1) of the Nuclear Act the performance of the tasks will be financed from the Central Nuclear Financial Fund (hereinafter: CNFF or fund) existing as separated state financial fund. The minister supervising the Hungarian Atomic Energy Agency (hereinafter HAEA) has the responsibility for the fund; the HAEA is the manager of the fund.

The systematic review of the mid and long term plans and of the cost estimations is justified by the need of having realistic coverage from the CNFF for the potential costs that will arise in the distance future. Thus it is possible to enforce the basic principle of having the generation using the nuclear power to pay for the costs arising in the future and related to this utilization without leaving unjustified burdens to the next generations.

The sixth mid and long term plan of PURAM is functionally linked to the cost estimations prepared earlier, which were first made by Paks Nuclear Power Plant Ltd. (hereinafter Paks NPP,) while later on by PURAM.

The present plan is not taking into account the effects connected to the potential extension of operational life-time and increase of power output, because their Authority licensing has not yet been completed.

The most important target of the mid and long-term plan of the activities to be financed from the CNFF is actually the justified, transparent, but unambiguous determination of the level of the contributions to be paid to the Fund.

In the next coming years we are anticipating such changes which will have significant influence on the amount to be paid to the CNFF. Among the factors causing the changes one can list the prolongation of the operational life-time of the power plant, the consideration of the country specific cost factors in relation to disposal of the high level radwastes and of the spent nuclear fuel, the anticipated decrease of the value added tax, the re-consideration of the system of promotions provided to the public, as well as the updating of the discount rate taken into account for the calculations.

The above mentioned changes will take place at different moments of time and thus they would also affect the payments to the Fund in several steps, in a shock-like form. The significantly changing (increasing or decreasing) payments could soundly modify the consumption price for

electricity. In order to avoid this, the above mentioned influences will be taken into account by our Company at the time of introduction of the European Union currency in Hungary, and at the time of completion of the licensing procedure related to the operational life-time extension. The effects of the different changes are continuously analyzed by PURAM. When the analysis will achieve their final form, they will be step by step incorporated into the mid and long term plans, in such a manner that the effect of the changes on the payments would first appear in 2010. As a consequence of this the payments on behalf of the power plant will remain nearly constant until 2009. Based on the preliminary estimations taking into account the listed factors in a joined manner will probably grant and even transition from the point of view of the amount to be paid by the power plant beginning from 2010, and thus the consumption price of the electricity will not change significantly either.

The mid and long term plan deals separately with the issues related to the spent fuel management generated in the nuclear facilities operated by institutions financed by State Budget (training reactor of the Budapest University of Technical and Economical Sciences, Institute of Nuclear Technology [BME NTI] and the research reactor in the Atomic Energy Research Institute of the Central Physical Research Institute [KFKI AEKI]) and the decommissioning of the said facilities, since in relations to those institutions the source is granted by payments into the Fund by the central budget in the year of the arise of the costs.

2. Analysis of the source side and storage possibilities of radioactive wastes and of spent nuclear fuels

2.1. Definitions

Radioactive waste: according to article 2. § m) of the Nuclear Act it is such a radioactive material not intended for further utilization, which cannot be handled as ordinary waste due to its health physics characteristics.

Spent nuclear fuel: according to article 2. § 1) of the Nuclear Act it is nuclear fuel used in the nuclear reactor, which, due to its potential reuse out of nuclear reactor, cannot be deemed as waste.

The classification of the radioactive wastes is carried out in accordance with Appendix 2 to the Order No. 47/2003 (VIII. 8.) ESzCsM (Ministry of Health, Social Policy and Family Care).

Those radioactive wastes are qualified as low and interim level radioactive wastes in which the heat generation during disposal (and storage) is negligible.*

Those low and interim level radioactive wastes are qualified as short-living ones, in which the half-life of the radio-nuclides is 30 years, or shorter, and includes long-living alpha-radiating

* Within the Hungarian regulation the standard MSZ14344-1 re-issued in 2004 provides guidelines, by determination of those levels of the heat generation which shall be taken into account in course of storage (disposal). According to this in the case if the heat generation of the waste is less than 2 kW/m^3 , then it might be disposed as low and interim level radioactive waste.

** Within the Hungarian regulation the standard MSZ14344-1 re-issued in 2004 provides guidelines, by determination of those levels of the heat generation which shall be taken into account in course of storage (disposal). According to this in the case if the heat generation of the waste is more than 2 kW/m^3 , then it might be disposed as high level radioactive waste.

radio-nuclides only in small concentrations (this concentration might be 4000 Bq/g in case of one collective package, and 400 Bq/g in average for the total amount of wastes).

Those low and interim level radioactive wastes are qualified as long-living ones, in which the half-life of the radio-nuclides and/or the concentration of the alpha-radiating radio-nuclides exceed the limit values set forth for the short-living radioactive wastes.

Those radioactive wastes are qualified as high level wastes, the heat generation of which shall be taken into consideration during planning of the storage and disposal and the operation.*

The Authority might prescribe more detailed, than above described classification for the low, interim and high level radioactive wastes.

For the classification of the low and interim level radioactive wastes the following aspects are taken into account:

The classification of the radioactive wastes into low and interim level classes shall be performed on the basis of the activity concentration of the included radio-isotopes, and on the basis of the exemption activity concentration (Table 2.1.1.). The values of the exemption activity concentrations for the different isotopes are given in order No. 23/1997. (VII. 18.) NM (Ministry of Public Health).

In the case if the radioactive waste contains several types of radioactive isotopes, then the classification shall be performed in accordance with Table 2.1.2.

In the present document the high level and/or long life-time radioactive wastes – since in long term they require similar treatment – are hereinafter simply referred to as high level radioactive wastes.

2.2. The stored material quantities and the storage capacities

Within Hungary, radioactive waste is finally disposed only in Radioactive Waste Processing and Storage Facility (hereinafter RWPS) operating in Püspökszilágy.

On site of Paks Nuclear Power Plant low, interim and high level radioactive wastes as well as spent fuel assemblies are temporarily stored. The fuel assemblies burnt in the reactor during the process of power generation are loaded for minimum 3 years to the cooling ponds, from where they are transferred to the Interim Spent Fuel Store (hereinafter ISFS) for 50-year-long interim storage. By 1998 there were 2331 spent fuel assemblies shipped back to the Soviet Union, and later to Russia, respectively.

Beyond that in Hungary there are such facilities of users of isotope and radiation sources, where exhausted radiation sources are temporarily stored, however – since later or sooner they will be transported to the RWPS – they are not treated in the present document.

Table 2.2.1 indicates the quantities of the radioactive wastes disposed of temporarily and finally on RWPS and Paks Nuclear Power Plant sites, together with spent fuel assemblies; as well as the utilization of capacities of the storage facilities as of January 1, 2006.

Comments to Table 2.2.1:

- A) The storage capacity of the Püspökszilágy RWPS is provided in its gross volume. In this repository packages of different forms were disposed (e.g. 200 liters drums, 400 liters drums, special containers, bagged packages, etc.). Due to the non-perfect volume filling the disposed waste occupies more place, than the actual volume of the waste. It is not indicated separately in the Table, that in case of the RWPS there is available the reconstructed operational building suitable for temporary storage of the arriving wastes, where 800 drums of 200 liters might be located.
- B) Concerning the intermediate storage created on site of Paks Nuclear Power Plant for disposal of low and interim level radwastes in solid form the value of the storage capacity is expressed in 200 liters drums, since this form of packing is the most common in the practice of the power plant. Within that the followings shall be mentioned:
- The slight change in the solid waste storage capacity of Paks NPP in comparison to the value given in the previous year can be explained by technological changes.
 - The Table provides no information about the below listed storage capacities, since they are not intended by the operators of the power plant for location there of 200 liters drums:
 - that pool of room VK 302/I, in which storage of cemented liquid waste is planned, the capacity of this would provide possibility for storage of 336 pieces of 400 liters drums. (The modification of this room might be on the agenda in the future. The capacity to be created so would be suitable for placement of approximately 730 pieces of 200 liters drums, however thus the storage capacity for the cemented wastes, which will be needed in the future, would be lost.)
 - that part of room VK 302/I, where 20 storage containers of cesium-filter columns could be placed.
 - The pool of room VK 302/I with dimension of 5 x 8 x 11 m, which is maintained for storage of waste packages including large dimension wastes.
- C) Concerning the data relevant to tanks created for storage of liquid low and interim level radwastes on site of Paks NPP the following remarks are applicable:
- The indicated storage capacity (9950 m³) is relevant to the storage volume, which might be utilized in normal operational manner.
 - In addition to that the volume of the emergency tanks constitutes further (550 + 400 + 550) 1530 m³. (The nominal storage capacity of the emergency tanks is lower, than this value, i.e.: 550 + 380 + 550 = 1480 m³.)
 - This tank storage capacity has been created as a consequence of the extension performed in 2005 after the accident in 2003.
 - The total stored quantity does not include the volumes of the transport waters used for transportation of the resins. The quantity of the transport waters is approximately 500 m³, however, in the future it will not be necessary to treat the whole volume as waste, since due to the future evaporation only a few m³ of waste will be generated. (Earlier the total quantity of the transport waters was kept in records as waste.)
- D) In relation to storage capacity created for storage of high-level radwaste on site of Paks NPP the following remarks shall be made:
- The indicated capacity is related to the so called tube-wells created for storage of high-level radwaste.
 - The waste volumes indicated in the Table are given in gross volumes (i.e. indicating the volumes they occupy within the storage volume).
 - Those high-level radwastes, which, due to their dimensions cannot be placed into the tube-wells are stored in lead collection containers located in other rooms. At the present

time 11 exhausted filter cartridges with dimensions of \varnothing 500 x 700 mm (with volume of 0.137 m³ each) are stored here.

- There changes (decrease) among the data of the Table in comparison with the earlier provided data. The decrease appeared at the time of modification of the record-keeping system. The performed controls reinforce the reliability of the new data.

E) In relation to the quantity of the spent fuel assemblies it shall be mentioned that this figure does not include in quantitative manner the 30 irradiated fuel assemblies which suffered damage during the accident in 2003, since they require special treatment.

The fuel assemblies utilized in non-power-generation aimed reactors differ in all their parameters from the fuel assemblies used in Paks Nuclear Power Plant. Table 2.2.2 provides data on the fuel assemblies ever used, presently used and planned to be used in research and training reactors. It shall be noted that a certain part of the VVR type fuel assemblies are used in batches of three, joined mechanically, while other part of them as single fuel assemblies. For sake of simplicity in relation to all VVR type fuel assemblies for estimation of the heavy metal mass the fuel assemblies coupled in three are recalculated for individual single fuel assemblies.

On site of KFKI AEKI (Atomic Energy Research Institute of the Central Physical Research Institute) the spent fuel assemblies are stored in pools filled with water. There are two such pools available for the Institute, the at-reactor internal spent fuel storage pool and the erected outside of the building external spent fuel storage fuel pool.

The characteristics of the interim storages situated on site of KFKI AEKI, the quantities of the heavy metal stored there for the as-loaded status valid for January 1, 2006 are presented in Table 2.2.3.

With the aim of enhancement of the safety of the interim storage in 2002 the hermetic encapsulation of the spent fuel assemblies was started. The capsules are filled with nitrogen, assuring thus the corrosion protection of the spent fuel assemblies. In a single capsule either one fuel assembly of EK-10 type, or three fuel assemblies of VVR type were placed. The three VVR type fuel assemblies were placed either as one coupled batch of three fuel assemblies or three single ones. In 2004 the encapsulation activities were completed and thus the encapsulation of the fuel assemblies used prior 1986 was performed. The decision about encapsulation of the further spent fuel assemblies will be made by KFKI AEKI later on.

In the external storage pool the spent fuel assemblies earlier were placed without capsulation, while nowadays they are stored partly in encapsulated form, partly without them. This facility is suitable for location of either 752 capsules, or 3 x 752 pieces of VVR type fuel assemblies. From the total capacity $1179 : 3 + 82 = 475$ capsule positions were used as per January 1, 2006. This constitutes approximately 63.2 % utilization rate.

The internal storage is suitable for location there of 260 capsules or 260 x 3 pieces of db VVR type fuel assemblies. In accordance with the authority requirements 76 positions or locations for 228 pieces of VVR type fuel assemblies shall be left vacant, ensuring thus the possibility of emergency core removal at any time. Thus, the free capacity of the storage is available for 184 capsules. As per January 1, 2006 there were 323 VVR type fuel assemblies stored in the internal storage, which – rounded up figure – equals to location of 108 capsules, and so the rate of utilization of the storage is roughly 41.5 %.

The bulk incorporating the training reactor of BME NTI (Budapest University of Technical and Economical Sciences, Institute of Nuclear Technology) includes 25 tubes, equipped with appropriate biological shielding, which were designed for location in them spent fuel assemblies, however these tubes never were used for location there and interim storage of irradiated fuel assemblies. There are no spent (or irradiated) fuel assemblies stored on site BME.

2.3. Rate of generation of the radioactive wastes and spent fuel and the anticipated development in the storage

2.3.1. Generation and storage of low and interim level radioactive wastes of nuclear power plant origin, the anticipated changes in the storage capacities and the estimation of the capacity of the new final repository

There are solid and liquid radioactive wastes generated during normal operation of the nuclear power plant. These wastes are temporarily stored in the nuclear power plant – until the final repository will not be completed.

The major part of the solid wastes is stored in 200 liters steel drums, in compacted form. The liquid wastes are collected in tanks. The wastes might be finally disposed only in solid form, and thus the solidification of the liquid wastes takes also place in the nuclear power plant prior their disposal in the final repository. There will be such types of wastes generated during decommissioning of the nuclear power plant as well, which also will have to be ultimately disposed in processed, solid form, together with the operational wastes.

Table 2.3.1.1 provides an overview of the low and interim level radioactive wastes generated in connection with the operation and decommissioning of the nuclear power plant.

The first column of the Table shows the amount of the wastes existing on January 1, 2006, separating from each other the solid and the liquid radioactive wastes. The quantitative data of the first column are also presented in Table 2.2.1 in summarized form. The great size wastes stored on-site of the power plant yet did not place in room VK 302/1, thus the cumulated by January 1, 2006 amount of the great size wastes are not indicated in the Table.

The second column of the Table describes the annual generation rate of the waste quantities originating from normal operation of the nuclear power plant. It can be seen from this that annually 190 m³ of compacted, solid waste (approx. 950 pieces of 200 liters drums) is generated. The great size solid wastes are also mentioned among the solid wastes. These wastes cannot be (or not reasonable) placed into 200 liters drums. The annual generation rate of this type of waste cannot be realistically predicted. The cesium-filter cartridges belong to the scope of the solid wastes, which are loaded into special, circle-cross-section storage containers, and the dimensions of these cylindrical concrete containers is approximately 0.7 m³ (diameter and height 1300 mm). A low amount of this type of waste is generated during the overall operational life-time, and thus the annual generation rate is not determined. On annual basis generation of 280 m³ of liquid waste shall be anticipated, a major part of which (250 m³/year) is evaporation remains (concentrates), but also among the liquid wastes are recorded the evaporator acid-solutions, the ion-exchanging resins (without transport water), the sludges and the decontamination solutions as well.

The third column of the Table summarizes the extra waste quantities generated as a consequence of the incident in 2003 up to 2007. The wastes generated earlier (before January 1, 2006) as

consequence of the incident – since they stored together with the normal operational wastes – are not indicated separately.

The fourth column of the Table summarizes the quantities of the solid and liquid wastes, assuming 30-year-long operation of the nuclear power plant. In this column are separately summarized the volumes of the compacted, the great size and non-compactable wastes and of the storage containers containing the cesium-filter cartridges, assuming 30 years of operational life-time. The remaining life-time, calculated from the average of the operational life of the individual reactor units can be estimated for 9 years. Accordingly by the end of the 30-year operational life-time of the nuclear power plant there will be 3251.4m³ of compacted waste, suitable for placing into 200 liters drums, approximately 600 m³ of great size waste, and cesium-filter cartridges requiring only 2.1 m³ of storage volume. These amounts of solid wastes include as well the wastes generated as a consequence of the incident in 2003. This column provides an overview about the quantities of the liquid wastes as well, generated during the total operational life-time. Within this scope the biggest share is devoted to the concentrates (7381 m³), however all the other liquid wastes are indicated here extrapolated to the total operational life-time. The volumes of the resins here as well are indicated without the transport waters.

The fifth column of the Table indicates the treatment procedures applied in case of different type low and interim level radwastes. The Table shows, that in case of solid form wastes our Company does not plan any further treatments. In relation to liquid wastes the commissioning of the liquid waste processing (LWP) technology is not anticipated in Paks Nuclear Power Plant. The successful application of this technology would result in less quantity of solid waste to be disposed, however, since the commissioning of the LWP technology did not take place yet, in relation to construction of the now waste repository facility PURAM is using a more conservative approach (generation of greater volumes of waste) of more waste quantities. Since the use of the LWP technology shall not be taken into consideration, in course of the 30 years operational life-time only 3 cesium-filtration cartridges will be generated. It is indicated in this column, what kind of treatment (evaporation and/or cementing) shall be taken into consideration in case of different waste types, and what are the characteristic parameters of the different procedures (VR: is the volume reduction factor of evaporation, while in case of cementing – what volume of the given liquid waste will result the given volume of the final product following solidification).

The sixth column of the Table shows only the solid and the solidified waste quantities. In this column are for the first time the decommissioning wastes indicated. The quantities of the wastes which will be generated during decommissioning of the power plant are given in the study indicated in Chapter 6.4. According to the summary related to this column the total amount of the operational and decommissioning wastes of the power plant will be 33751.8 m³.

The last two columns of the Table shows in what type of waste packages will be disposed the cumulative low and interim level radwaste generated during operation and decommissioning of the nuclear power plant, and what quantities of the different waste packages shall be anticipated. These columns provide a possibility for estimation of the total mining volume of the waste repository.

The data summarized in Table 2.3.1.1 might be used for investigation of possibility of temporary location of the wastes on site of Paks Nuclear Power Plant by the time of construction of the new repository, as well as for estimation of the necessary dimensions of the new storage facility to be constructed.

The tank park extension, performed in Paks Nuclear Power Plant, as well as the commissioning of the LWP technology (see article 2.2) will provide possibility for collection and storage of the liquid wastes by the end of the planned operational life-time of the power plant.

Without commissioning of the LWP technology the capacity of the presently available tank-park will be sufficient until 2012. At the same time this provides also a possibility to perform the solidification, which has a volume increasing effect after commissioning of the final repository.

Concerning solid wastes at the present time the capacity available for the power plant provides possibility for storage of 949 barrels (see Article 2.2). The construction of a new temporary storage capacity – on the site of the nuclear power plant – can only be avoided if in 3rd quarter of 2007 it will be possible to commission in Bataapati at least one facility suitable for disposing there minimum 3000 barrels of 200 liters. The power plant will be capable to store the barreled waste on its site by this moment, provided that it will use as well the roof level capacity of the VK302/I storage room as well (see Article 2.2). The schedule related to construction of the Bataapati storage facility is given in Article 3.3.2.

The dimensions of the new repository to be constructed are provided in exact manner in investment proposal titled “Final deposition of low and interim level radwastes of nuclear power plant origin in the sub-surface repository planned in region of Bataapati” which is in good correlation with the figures provided in Table 2.3.1.1. According to this the operational wastes might be disposed in altogether 2275 m long, 72 m² free cross-section chambers, the total volume of which is 163800 m³. On the other hand the disposal of the decommissioning waste will require construction of a chamber system with length of 2067 m and also of free cross-section of 72 m². The total volume of this chamber system will be 148824 m³.

2.3.2. *Generation and interim storage of the nuclear power plant originated high activity level radioactive wastes, , the anticipated changes of the storage capacity, estimation of the necessary storage capacity of the new, final repository to be constructed*

During operation of Paks Nuclear Power Plant, according to data provided by the power plant on annual level high level radioactive wastes are generated in relatively small quantities (net 5 m³/year), which are temporary stored on site of the nuclear power plant in tube pits designed for this purpose. The estimated annual generation quantity data seem to be adequately conservative. (In 2005 there was altogether approximately net 0.7 m³ of high level radioactive waste generated.) According to Table 2.2.1. on January 1, 2006 there was 63.3 m³ of waste stored in the storage capacity of 222.8 m³. By the end of the operational life-time generation (what is taken by our Company at this time as well for 9 years) of further 45 m³ of waste is anticipated. With the aim of final reposition this waste is collected in containers and filled with concrete. Having on mind that the volume filling of the wastes placed into the tube-wells is extremely poor, the volume of the wastes placed into the containers and prepared for storage is deemed to be equal to the volume occupied by this waste in the tube wells in its present condition.

The dimensions of the wastes, that can be stored here are limited by the geometry of the tube pits. The characteristic dimensions of the storage tube are: diameter 183 mm. height 6880 mm. The wastes, which cannot be placed in the storage pits – due to their great sizes – are collected in lead containers. At the present time there are 11 exhausted filter cartridges are presently stored in such manner, the net volume of each of one is 0.137 m³. Each single filter cartridge, together with the biological shielding, occupies a space of approximately 0.2 m³ (net). For the final deposition of

one of such filter cartridge, taking into account the 1.75 volume filling factor storage area with volume of 0.35 m³ shall be created. Thus, the total estimated volume capacity need of all the high level and great-sized radioactive wastes of big dimensions is 3.85 m³.

In addition, it is anticipated that during the future decommissioning of the nuclear power plant further 247 m³ of high level radwaste will be generated. This quantity of waste shall be treated in accordance with literature referred to in article 6.4 as gross volume, i.e. the construction of repository with such volume capacity will be necessary for deposition of the high level radwastes originating from decommissioning.

Thus, the necessary capacity of the high level radwaste repository to be constructed in the future for receipt of the high level radwaste of nuclear power plant origin will be 63.3 + 45 + 3.85 + 247 ≈ 359 m³.

Taking into account the rate of generation of the high level radioactive wastes, the issue of the final disposal will have to be solved in accordance with the technical design only during the decommissioning phase, since the available storage capacity can be used as a temporary one until the decommissioning, its capacity meets the needs.

The above mentioned considerations in relation to quantities do not include the amount of the high level radioactive wastes, which will be generated in the future, in quantities, much higher than the usual, due to the liquidation of the consequences of the accident on Unit 2, since in this respect the actual data will be available for our Company only after removal of the damaged fuel assemblies.

2.3.3. *Generation and interim storage of the spent nuclear fuel in the nuclear power plant*

The interim storage of the spent nuclear fuel is carried out in the ISFS erected in the vicinity of the nuclear power plant, for a period of 50 years. The quantity of the spent fuel assemblies generated during the normal operation of the nuclear power plant is well predictable.

According to our present knowledge the number of the spent nuclear fuel assemblies that will be generated by the end of the designed 30-year-long life-time of the nuclear power plant and which will remain in Hungary will be 11122. The average annual quantity generated during normal operation is 372 fuel assemblies. The total amount, not taking into account the possibility of back-shipment to Russia, includes the following portions:

2117 assemblies	in the cooling ponds (January 1, 2006), see Table 2.2.1
4267 assemblies	in the ISFS (January 1, 2006), see Table 2.2.1
4738 assemblies	spent fuel assemblies to be generated between 2006 and 2017 including the full core removal due to the final shut-down of the units.

This total of 11 122 fuel assemblies can be disposed and temporarily stored by means of appropriate expansion of the ISFS.

According to the data provided by Paks NPP Ltd., the total amount of the spent fuel assemblies – from the point of view of the procurement source – is of Russian origin. The average mass of

heavy metal in the individual assemblies - calculated on the basis of the whole amount of spent fuel is 116 kgU per assembly, and thus the amount of the spent fuel to be generated by the end of the life-time will amount altogether 1 290 152 kgU (i.e. 1290.152 tU) heavy metal or uranium content.

2.3.4. *Rate of generation and disposal of the low and interim activity level as of the long life-time radioactive wastes of non nuclear power plant origin*

Besides the operating nuclear power plant radioactive wastes are generated in research institutes, in medical, industrial, agricultural institutions and laboratories. The generation rate of the non - nuclear power plant origin low and interim level radioactive wastes has increased to 20-30 m³/year during the past years. This waste is disposed in the RWPS in Püspökszilágy. As it is given in Table 2.2.1., the presently available free capacity in the RWPS has exhausted. By the time of completion of the capacity relief to be carried out on the final repository area a solution might be granted by the interim storage area to be created by means of modification of the processing building, where there is a possibility for temporary storage of 800 pieces of 200 liters drums. (The details are given in Chapters 3.1. and 3.2.)

In Hungary the performance of the industrial, agricultural and medical activities, on annual level, leads to generation of extremely small amount of long-life radioactive wastes. Presently these wastes are stored on site of RWPS, or they can be found at the location of their generation. Today it is not possible to provide correct annual data relevant to the generation of these material types, however we deem – based on conservative upper estimation – that the overall quantity of the long-life radioactive waste in summary will not exceed the amount of 100 m³. These types of materials will have to be disposed together with the nuclear power plant origin high level and long-life radioactive wastes, and thus the total amount of the wastes to be disposed shall be increased by this 100 m³.

2.3.5. *Generation and interim storage of the spent fuel of non nuclear power plant origin*

The research reactor of KFKI AEKI – the Budapest Research Reactor (hereinafter BRR) – is operating since 1959. Following the reconstruction started in 1986 the reactor is again in operation since 1992. The operating license issued in 1993 for undetermined period of time shall be renewed in every tenth year within the framework of periodical safety review. The first review took place in 2003.

According to data provision of KFKI the planned operational life-time of the reactor is 30 years from the date of the reconstruction, thus, according to the plans the reactor will be finally shut down in 2023. According to data provision of KFKI annually – depending on the utilized operational time – in average 70 (VVR type) fuel assemblies are replaced.

On January 1, 2006 KFKI AEKI was in possession of 441 pieces of fresh VVR type fuel assemblies (415 pieces of VVR-M2 type and 26 pieces of VVR-SzM type). The enrichment level of these fuel assemblies is 36 %. Following the worldwide valid tendencies the KFKI AEKI is also planning introduction of new fuel types. The new VVR-M2 type fuel assemblies with enrichment level of 20% latest might be introduced when the available today fresh fuel assemblies will be utilized (this is anticipated in 2010). In principle it is possible to introduce the new fuel assembly type earlier as well.

Based on the data provision of KFKI the amount of the generated by now and to be generated in the future spent fuel assemblies in BRR by the end of the operational life-time is shown in Table 2.3.5.1. Within the Table the quantities of the spent fuel assemblies to be generated in the future are presented in two phases. The first period (supposing that the change of the fuel assembly type will take place after utilization of the presently available fresh fuel assemblies) lasts from 2005 until 2010. While the second period covers the remaining after 2010 operational life-time.

It can be seen from the Table that the introduction of the fuel assembly type with lower enrichment level will significantly increase the amount of the heavy metal, which will be generated. The Institute has no such storage capacity, which would allow the location there of the spent fuel assemblies to be generated by the end of the planned operational life-time, since the total storage capacity is 936 places, while the required amount would be 1072 places.

In the training reactor of BME NTI there are 24 pieces of partially modified EK-10 type fuel assemblies are operated since 1971. The nominal heavy metal mass of these fuel assemblies was 30 kg, from which by now approximately 0.02 kg of U-235 was utilized. Due to technological reasons it is possible that during the operation of the training reactor, planned until 2027 the active core will be partly or fully reloaded. According to data provision of BME NTI this reload should have taken place latest by 2008, and this is justified primarily by the decreasing reactivity margin. Thus, in total spent fuel with heavy metal mass of 59.96 kg shall be anticipated for the total period of operation. These data are summarized in Table 2.3.5.2.

By the end of the planned operational life-time of the two institutes there will be spent fuel with $490.3 + 59.96 \approx 550.3$ kg U quantity generated. The accumulated storage need – providing that the fuel of BME NTI will be also encapsulated - will require deposition of $1072 + 48 = 1120$ capsules.

3. Final disposal of the low and interim level radioactive wastes

3.1. Precedents

Radioactive wastes appeared simultaneously with the introduction of use of the isotope technology in Hungary. These wastes were initially stored on site of the Central Research Institute of Physics, leading organization in utilization of the said technologies. By 1960, an experimental isotope repository was constructed in Solymár. The complete facility was taken over from the Hungarian Atomic Energy Committee by the Budapest branch of the State Public Health and Epidemiology Office in 1960. Accordingly, the national collection of the radioactive wastes was started in 1960. At the same time the rules regulating this activity were made (Governmental order no. 10/1964 (V.7.), and its execution order the EÜM order No. 1/1964 (V.7.)).

The site selection of the first, experimental radioactive waste repository facility was not adequately founded and the technical solutions of the facility (pits lined with concrete rings) were not perfect either. The capacity of the experimental repository was shortly exhausted as well, and so ten years after the construction in January 1970 the Executive Committee of the Budapest Council and the Budapest branch of the State Public Health and Epidemiology Office were entrusted by the decision of the Hungarian Atomic Energy Committee for the construction of a new radioactive waste repository (RWPS).

The new facility was completed in Püspökszilágy by December 22, 1976, with capacity of 3540 m³. From technical point of view the repository was of a near surface pool and tube pit formation.

The first transport to the RWPS was received in March 1977. The Ministry of Healthcare issued the final operational license for the facility in 1980. Having no contradictory resolution, the RWPS has taken over almost all kind of radioactive waste generated in course of utilization of the nuclear technology. The only exceptions are the sealed radium sources, other exhausted radiation sources including fissile materials as well, and certain parts of products, which were and are stored temporarily in other locations.

The commissioning of the first reactor of Paks Nuclear Power Plant has multiplied on annual level the quantity of the generated low and interim level radioactive wastes. According to the concept described in the Technical design of Paks Nuclear Power Plant the storage, in the auxiliary buildings of the nuclear power plant, of the low and interim level radioactive wastes generated during the operation of the power plant was foreseen. However the temporary character of the storage shall be emphasized, since the final disposal of the wastes on the site of the nuclear power plant is excluded taking into account technical and safety aspects.

It was an obvious idea that it would be adequate to dispose finally the wastes generated as a result of the operation and decommissioning of Paks Nuclear Power Plant in Püspökszilágy, since the only facility of Hungary designated for disposal of low and interim level radioactive wastes operated here.

According to the various investigations carried out earlier and taking into account the near surface solution used on site of RWPS the expansion corresponding to the needs of Paks Nuclear Power Plant was not feasible. An other argument against the disposal of the Paks' waste in Püspökszilágy was the long and consequently hazardous transportation route.

So the low level solid radioactive wastes of Paks Nuclear Power Plant were transported to Püspökszilágy only as temporary solution. During this activity between 1983 and 1989 the nuclear power plant has used 1230 m³ by transporting there 854 m³ of waste of the capacity of RWPS.

Simultaneously the Paks Nuclear Power Plant has made efforts to solve the issue of disposal of the power plant origin low and interim level radioactive wastes in an individual repository. These efforts spectacularly failed in January 1990, when an ultimate negative decision was made in relation to the planned repository nearby Ófalu, because of the reluctance of the inhabitants.

From 1990 to 1991 the transportation of the low and interim level radioactive wastes to the RWPS was suspended due to public resistance. At the same time the storage capacity of the Püspökszilágy RWPS was expanded with the financial support of Paks Nuclear Power Plant. The expanded storage capacity of the facility is in a total of 5040 m³. During the licensing procedure related to the expansion the Hungarian Geological Service has questioned the suitability of the site, and consequently in the future only temporary operational licenses were issued for the expanded part, altogether four times.

After stop of the public protest further low and interim level radioactive wastes were transferred to Püspökszilágy in period between 1992 and 1996, so altogether there is some 1580 m³ nuclear power plant origin waste was disposed in approximately 2500 m³ of storage capacity.

The efforts made during the past years in relation to the RWPS were oriented on prolongation of the operational license of the facility by the authorities. With this aim in mind the reconstruction of the facilities of the RWPS was started. The work has started with the full scope evaluation of the safety of the waste repository. Following the necessary data collection in 2001 and 2002 two safety analysis were prepared. The analyses seek the response, whether by means of what kind of corrective actions would guarantee the long-term safety. The updated safety analysis prepared in 2002 has reinforced the former evaluations, and based on this it can be stated that the operation of the RWPS and the safety of the environment are appropriately guaranteed till the end of the institutional supervision period. The actions necessary for assurance of the long-term safety were determined on the basis of the updated safety analysis, and this served also as a basis for the document, titled "Safety upgrading program of the Püspökszilágy RWPS 2002 – 2005" approved by the minister disposing over the Fund on August 29, 2002. Within the framework of these activities were oriented to preparation and starting of the safety enhancement measures. The successful completion of the safety enhancement measures will contribute to the assurance of further waste disposal capacities as well.

In order to obtain the operational license the radiation protection conditions and the physical condition of the site shall be improved. The waste take-over criteria were developed and implemented. Based of the above written and of the here non listed reconstruction works the competent authority has issued the operational license, the new license is valid until February 28, 2015. As a preparation for the safety upgrading measures were prepared the above mentioned safety analysis as well as the feasibility study outlining the plans of the activities. Based on them, in order to start the activities it was necessary to purchase a compacting press and a hot-chamber. Here can be mentioned the reconstruction of the operational building and its licensing as a temporary (for 5 years) repository, the recovery of the vicinity of the pool-lines No. III and IV renewal of the precipitation drainage system. The investigation of the origin of the increased tritium activity, which was noticed in the monitoring pits during the past few years and the execution of the additional geological investigations also might be deemed as preparation of the safety upgrading measures.

In 2005 was prepared a document titled "Safety upgrading program of the Püspökszilágy RWPS, 2nd phase (2006-2010)" which was approved by the Minister disposing over the Fund on December 21, 2005, determining thus the further reconstruction tasks for the site. For supervision of the reconstruction tasks, as well as for promotion of the operation of the site with multiple technical systems it will be necessary to contract a general-designer office beginning from 2007.

Since such an expansion of the Püspökszilágy facility that would satisfy the total need of the nuclear power plant is impossible, beginning from 1993 an Interdepartmental Target Project (later on National Project) has been launched. The main purpose of it was the solution of the issue of final disposal of the nuclear power plant origin low and interim level radioactive wastes. Within the framework of the said project the preparation of the site selection was started. On the basis of the professional literature data the whole country has been screened, and later on in the promising areas, where the public supported it as well, preliminary site explorations were carried out in order to identify the geological objects suitable for surface and near surface repository.

In 1996 the final document of the geological, safety technical and economical investigations proposed to carry out further explorations in the vicinity of Üveghuta for near surface disposal in granite, keeping in reserve the sites that seemed to be suitable for construction of surface repositories. This area is deemed to be favorable from that point of view as well that it is located not far away from the nuclear power plant on the same side of Danube river. Consequently a

decision was made in agreement of HAEC to start the more detailed explorations in 1997 in the Üveghuta region.

At the end of 1998, in its final report on the geological investigations carried out in 1997-1998 the Hungarian State Geological Institute (MÁFI) made a recommendation to start the detailed geological and site characterizing works founding the licensing procedure and the construction in the Üveghuta research area. The experts supervising the program suggested the acceptance of the final investigation report.

At this point the program got into the focus of the professional and political debates. Due to it the experts of the International Atomic Energy Agency, upon request of HAEC have reviewed the activities carried out within the framework of the program, and agreeing with the results gained by that time they have suggested the continuation the explorations.

The Hungarian Geological Service has also evaluated the explorations performed, and agreed with them. Safety assessments relying on the results of explorations verified that the repository could be operated in a safe way at the given site.

Based on the facts above, the Minister supervising the CNFF in May, 2001 signed the four – year exploration program. Preparations of the contracts referring to the explorations were conducted within the framework of a public procurement process. In December 2001, the BÁTATOM Ltd. was established aiming to implement the program, by holding together the most excellent institutions in Hungary (ETV – Erőterv Ltd., Mecsekérc Environment Protection Ltd., Golder Associates Hungary Ltd.) and with the support of the Hungarian State Geological Institute, as subcontractor. During year 2002 the BÁTATOM Ltd. along with preparatory works necessary for the investigations has prepared the geological research plan. On the basis of the licensed plan there was a final report prepared on the performed geological investigations at the end of 2003, the main statements of which were the followings: „The Bábaapáti (Üveghuta) site complies with all the requirements set forth in the order, and thus, from geological point of view it is suitable for final disposal of low and interim level radioactive wastes.” This document was evaluated by the competent geological authority, the South-Transdanubian Regional Office of the Hungarian Geological Service, and has accepted it by means of a resolution. Since within the appealing time-period there were no objections raised against the resolution, it became legally valid at the end of 2003.

In 2004 was prepared the valid until 2007 underground research plan, which was opinionated, and afterwards approved by the South-Transdanubian Regional Office of the Hungarian Geological Service. In case of execution of this research plan it will be possible to determine in second half of 2007 that rock-volume, which will host the repository. The minister managing the Fund has approved this research program in late 2004, while the executor of the program will be selected on the basis of public procurement procedure.

The underground researches were started in February 2005 by deepening of the inclining shafts. By the end of the year length of both shafts exceeded 330 m and the first connection corridor was also prepared.

In parallel with the underground researches was prepared the Preliminary Environmental Impact Study of the repository, which was submitted to the competent authority, to the Mid-Transdanubian Environmental Protection, Nature Protection and Water Authority.

Two further important events took place in 2005. Upon initiative of municipality of Bábaapáti an opinion expressing public poll was held in the town. Along with high (75%) participation nearly 90.7% of the people voting agreed with construction of a low and interim level radwaste repository in Bábaapáti. On November 21, 2005 the Hungarian Parliament, based on Paragraph (2) of Article 7 of the Nuclear Act granted a preliminary, principal approval for beginning of preparatory activities for low and interim level radwaste repository on the territory which has been already earlier qualified as suitable from geological point of view. The resolution of the Parliament was supported by overwhelming majority of the MPs present (339 persons, 96,6%).

On the basis of the above described precedents the development of the strategy concerning the final disposal of the low and interim level radioactive wastes, the tasks and their scheduling shall be divided to the Püspökszilágy RWPS and to the new facility that will host the nuclear power plant origin wastes.

3.2. Disposal of the low and interim activity level radioactive wastes in the RWPS

3.2.1. The strategic target

Having in mind that the Püspökszilágy RWPS is operating only on the basis of temporary operating licenses, the upgrading of this facility that goes on since 1998 and the state-of-art safety analysis that will serve as basis for the prolongation and finalization of the operational license are of outstanding importance.

The possibilities for freeing storage locations within the storage pools shall be investigated, taking into account the legal, technical economical and public acceptance aspects. Every such possibility shall be analyzed that might result in such a free storage capacity which could solve in long term the receipt of the radioactive wastes of the Hungarian isotope users on the said site.

In relation to PURAM the target is the continuous operation. In the future the RWPS will serve exclusively for final disposal of non-nuclear power plant origin low and interim level radioactive wastes. The storage of the long-life wastes will be solved in the RWPS only temporarily. The performance of the tasks in relation to disposal of the low and interim level radwastes will be possible by occurring free storage capacities in the future, thus this is deemed to be a priority target.

3.2.2. Scheduling of the tasks

- | | |
|------|--|
| 2007 | <ul style="list-style-type: none">- Testing of the waste packages, certification of the appropriateness of the waste forms.- Renewal of the asphalted roads and illumination system.- Upgrading of the dispatching center, erection of a check-point, creation of negotiation and storage rooms.- Beginning of reconstruction of the sewage water purification system and demolishing of the old system, procurement of an environmental sampling vehicle.- Execution of the first (demonstration) phase of the capacity-release (safety enhancement) in four pools (A11, 12, 13, 14), summary of the experiences of the 1st phase, preparation of the 2nd phase.- Operation and maintenance of the facility. |
|------|--|

- | | |
|-----------|---|
| 2008-2010 | <ul style="list-style-type: none"> - Reconstruction of the outer fence, landscape correction between the two fences. - Completion of the reconstruction of the sewage water purification system. - Licensing and execution of the 2nd phase of the capacity-release (safety enhancement) (in pools 20-24). - Recovery of the vicinity of pool rows I-II. - Operation and maintenance of the facility. |
| 2011–2047 | <ul style="list-style-type: none"> - Operation and maintenance of the facility. |
| 2048–2050 | <ul style="list-style-type: none"> - Termination of the facility operations, delivery of the long life radioactive wastes stored in the facility to the storage of the long life radioactive wastes. |
| 2051–2101 | <ul style="list-style-type: none"> - Guarded supervision of the facility and radiation protection surveillance of the vicinity (active institutional supervision). |
| from 2101 | <ul style="list-style-type: none"> - Continuation of the active institutional supervision (if the regulatory authority requires so) - Long term, passive institutional supervision. |

3.2.3. Source data and information for the execution of the economical calculations

Financial implications of the tasks as due between 2007 – 2010 are determined in document titled *”Safety upgrading program of the Püspökszilágyi RWPS 2nd Phase (2006-2010)”* .

Concerning the guarded supervision of the facility and the health physics surveillance of the environment, as well as of the closure of the facility, the guiding document is *the study of ETV-ERŐTERV, 1995, Paks Nuclear Power Plant, Units 1-4, “Final disposal of the low and interim level radioactive wastes – Site independent cost estimation comparison”*.

A periodically repetitive data is the operational cost of the facility what is described in details under chapter 7. This component includes for period from 2048 to 2050, divided for three years, the cost of conditioning of the long-living wastes stored in the facility, based on technical estimation.

The institutional surveillance following the closure of the waste repository includes the active and the passive supervision of the facility and the preservation of the facility related data. The related to these costs are indicated in connection with the year of closure of the facility based on technical estimation.

The operation of the Püspökszilágy repository is depending on the project of the high level and long life-time radioactive waste repository, since the earliest date of closure of the facility is determined by the fact when the other facility will be commissioned where the long life-time radioactive waste temporarily stored in Püspökszilágy could be transferred there. By means of capacity relief in the Püspökszilágy repository there is a realistic chance for such prolongation of the operational life-time.

3.3. Disposal of the nuclear power plant origin low and interim activity level radioactive wastes

3.3.1. The strategic target

The final disposal of low and interim level radioactive wastes of nuclear power plant origin – including as well the wastes originating from the decommissioning of the nuclear power plant – shall take place in a new facility satisfying all the technical and safety aspects. With this aim in mind the investigations shall be continued for determination of the exact location of the repository.

The design, rating and time schedule of the construction and operation shall be adjusted to the requirements of Paks Nuclear Power Plant, however on design level the possibility of expansion shall be taken into account as well.

3.3.2. Scheduling of the tasks

In case of scheduling of the tasks it shall be mentioned, that the licensing procedures will be completed earlier (in 2006) than it was stated in the former plans. Our Company assumes that the construction license for the repository will be issued at the end of 2006. These modifications are necessary in order to be able to construct the surface facilities in 4th quarter of 2007 (see Chapter 2.3.1).

- | | |
|-----------|---|
| 2007 | <ul style="list-style-type: none">- Completion of preparation of the tendering documentation related to the surface facilities, execution of the public procurement procedure, entering into contracts.- Construction of the surface facilities in such a scope, that provides possibility for receipt of solid waste packed into 3000 pieces of 200 liters barrels in 4th quarter of 2007; commissioning of the technological building.- Beginning of preparation of the tendering documentation related to the underground facilities and launching of the tendering process.- Construction of the underground facilities by completion of the transportation tunnel of the storage area and beginning of construction of storage chambers 1-4.- Completion of the underground exploration.- Geological final report.- Safety evaluation.- Construction of public works.- Monitoring operation.- Preparation of construction designs. |
| 2008 | <ul style="list-style-type: none">- Completion of the public procurement procedure related to the underground facilities.- Completion of the construction of storage chambers 1-4.- Operational tests and beginning of the commissioning.- Obtaining of the operational licenses.- Beginning of the construction of storage chambers 5-18.- Operation of the facility (transfer of the operational wastes).- Monitoring operation. |
| 2009-2013 | <ul style="list-style-type: none">- International peer-review.- Completion of the construction of storage chambers 5-18.- Commissioning of storage chambers 5-18.- Operation of the facility (transfer of the operational wastes).- Monitoring operation. |
| 2014-2019 | <ul style="list-style-type: none">- Operation of the facility (transfer of the operational wastes).- Monitoring operation. |

2020–2094	-	Decay period, condition maintenance.
2093–2094	-	Expansion of the facility.
2095–2104	-	Operation of the facility (transfer of the operational wastes).
2105–2107	-	Closure of the facility.
from 2108	-	Long term supervision.

A precondition of the strategic target and of completion of the listed activities by the set deadline is as well the availability of the necessary financial resources.

3.3.3. Source data and information for the execution of the economical calculations

The estimation of the costs related to tasks of construction of a facility suitable for disposal of low and interim level radioactive wastes is based on the costs provided in document titled: „*Final deposition of low and interim level nuclear power plant origin wastes in the underground repository planned to be constructed in vicinity of Bataapáti; INVESTMENT PROPOSAL*”

The quantity of the waste to be disposed is constituted from the low and interim level conditioned radioactive wastes generated during operation and decommissioning of the nuclear power plant. The inland enterprising transportation cost in relation to low and intermediate level radioactive wastes has been determined as 30 000 HUF/m³.

A certain part of the quantitative data is refreshed annually. This data reflect the waste generation facts resulting from the operation of the Paks Nuclear Power Plant and the results of the developments of the radioactive waste management technology. The quantitative data is deterministically influenced by the low and interim level radioactive waste amount resulting from the decommissioning of the power plant. The review of this data will be carried out in accordance with processes described under chapter 6.

The review of the transportation cost data might take place if the estimations published in the international literature would significantly change or if there will be Hungarian data available.

The institutional surveillance following the closure of the waste repository includes the active and the passive supervision of the facility and the preservation of the facility related data. The related to these costs are indicated in connection with the year of closure of the facility based on technical estimation.

The technology and scheduling of decommissioning of the nuclear power plant will deterministically influence the expansion, operation and closure of the low and interim level radioactive waste repository.

4. Final disposal of the high activity radioactive wastes and management of the spent nuclear fuel

4.1. Precedents

Such types of waste were generated in Hungary beginning from the 60-s, however they were due to lack of other (prohibiting) regulations stored in Püspökszilágy, while the spent fuel assemblies of the research reactor in the Central Research Institute of Physics.

The issue of the high level radioactive wastes is treated in the same chapter as the plans of the spent fuel management, since the realistically feasible scenarios of the fuel cycle will lead to disposal of the high level radioactive wastes.

4.1.1. Final disposal of the high activity radioactive wastes

The commissioning of Paks Nuclear Power Plant has created a new situation since it became evident that the operation and decommissioning of the nuclear power plant will significantly contribute to the source term of the Hungarian high level radioactive wastes. It has been obvious from the very beginning that all the problems in the management of that type of waste will have to be solved by Hungary on its own, independently of the fact how will be solved the issue of the spent fuel management, which, from professional point of view, can be enrolled to the same category.

The National Project launched in 1993 (see chapter 3) beyond dealing with solution of the safe disposal of the low and interim level radioactive wastes, in relation to high level radioactive wastes has been expanded upon initiative of IKIM (Ministry of Industry, Trade and Tourism) with the task of continuation of the earlier started investigations of the Boda Aleurolit Formation (BAF). This activity has been completed in March 1995, and so an independent program has been launched for solution of disposal of the Hungarian high level and long life-time radioactive wastes, which has been approved by HAEC on its meeting in November 1995. This program has already outlined long term ideas, however it was focusing on the in-situ investigations due in 1996-98, which was carried out by the Canadian AECL and the Mecsek Ore Mining Company in the area of BAF at 1100 m depth, with the purpose of detailed investigation of the formation. A time limitation for the three-year-program was that the closure of the mine was forecasted for 1998 that time, so it was the time period during which the existing infrastructure could be economically utilized.

On this basis the explorations were completed in the end of 1998 in a documented form. According to the final report there were no such circumstances revealed that could prevent the construction of a facility serving as repository for long life-time and high level radioactive wastes in the BAF. Upon effect of the results of the final report a recommendation was made for construction of an underground research base, for qualification of BAF and for further researches. This recommendation was discussed on April 1999 meeting of HAEC. The minister of economy made the relevant decision in summer 1999, rejecting the proposal. At the same time decision was made on closure of the uranium mine in accordance with the original plan.

The PURAM has prepared a research program for investigation of a site suitable for disposal of the Hungarian high level and long-life radioactive wastes. The Minister, managing the Fund, has accepted the program in 2003. In accordance with that a vendor has been selected on the basis of a public procurement tender, with whom a frame-contract was signed for the execution of the research program. The works were started in 2003. Since that time the content of the contract is annually updated. The works are aimed on selection of the location for a new underground research laboratory.

Within the framework of this program in 2004 geological and geophysical mapping, shallow and deep boring researches took place as well as theoretical-methodological developments. The boring Ib-4 was deepened up to 710 meters in 2005 as a basic boring of the research plan. Due to significantly decreased financial resources in 2005 the works, except the activities related to Ib-4 boring were limited to surface geological investigation, documentation of the sites data-base

filling and area-informatics, as well to environmental monitoring. The environmental monitoring was also continuously operated.

4.1.2. Management of the spent nuclear fuel

Following commissioning of Paks Nuclear Power Plant the burning of the nuclear fuel has started. Afterwards the spent fuel assemblies were discharged from the reactors to the next to the reactors cooling pools.

In accordance with a concept in force at the time of acceptance of the Technical Design of the Paks Nuclear Power Plant the spent fuel assemblies cooled in the cooling pools of the power plant for 3 years should have been taken back by the Soviet Union free of charge. According to this concept the spent fuel was to be reprocessed in the Soviet Union, however all the end products of reprocessing would have remain in the Soviet Union. In other words the Soviet partner has offered a world unique service to the constructor of the nuclear power plant, since the commercial reprocessing procedures already operating at that time have foreseen the back-shipment of the end products (uranium, plutonium, low, interim and high level conditioned radioactive wastes) to the country of origin of the spent fuel. At the same time, making use of the Soviet back-shipment service meant, that Hungary adopted the closed fuel cycle option with a special background service, in relation to closure (back-end) of the nuclear fuel cycle.

After the commissioning of the first unit of the power plant the back-shipment conditions were unilaterally modified by the Soviet Union. According to this modification the necessary cooling time was increased to five years, and a more and more increasing compensation was requested for the receipt of the back-shipments, considered as a service.

Paks Nuclear Power Plant Ltd. in order to meet the new requirements has doubled the storage capacity of the cooling pools, by compacting the storage racks, while the back-shipments were carried out on the basis of commercial contracts. During the period between 1989 and 1998, 2331 spent fuel assemblies were shipped back to the Soviet Union (later to Russia).

In the first years of back-shipments, due to the political and economical changes that took place in Europe and in the Soviet Union it became clear that the practice of back-shipment of the spent fuel assemblies cannot be maintained for a long time under the above described conditions. In September 1991 a decision was made in a meeting of HAEC that in parallel with maintaining of the possibility of the back-shipment of the spent fuel assemblies to the Soviet Union a realistic domestic alternative has to be elaborated. In order to promote this it was necessary to obtain license for a facility for interim storage of irradiated fuels (ISFS) to be erected on the site of Paks Nuclear Power Plant, which could be quickly constructed in case of necessity.

A year later, in November 1992, a decision was made in a meeting of HAEC that the concrete preparation related to the construction of ISFS shall be started. The HAEC acknowledged that the MVDS (Modular Vault Dry Storage) system of GEC Alsthom was selected as ISFS by the experts of the nuclear power plant.

In December 1993, the construction, licensing and commissioning of ISFS was treated as a high priority task in the meeting of HAEC. Paks Nuclear Power Plant financed the construction of ISFS. The design, licensing and construction lasted from 1992 to the end of 1996. On February 1997 meeting of HAEC the commissioning of ISFS has been approved. The loading of the ISFS has started already in 1997.

The first three vaults of ISFS were loaded with spent fuel by the end of 1999 and the next four vaults were constructed. The loading to the new vaults was started in February 2000, and PURAM took over the role of licensee in relation to the facility. The third phase, i.e. the 8th - 11th modules were constructed by the end of 2002, and in 2003 the commissioning of the new vaults took place, and afterwards they were taken into operation. The investment program in relation to the further extension as well as the relevant licensing design documentation has been prepared. Since the original licenses were issued for 1st – 11th modules, for further extension the initiation of a new licensing procedure became necessary. Based on the licensing designs the modification of the environmental protection and site licenses of the 2nd phase of ISFS took place. The competent authority has issued the erection and construction licenses related to 2nd phase of the ISFS (modules 12-16). Having the valid licenses and following the successful tendering procedure in 2005 the construction activities of 2nd phase of the ISFS was started.

The HAEC has on its agenda the issue of the nuclear fuel cycle strategy on its meeting in March 1999. The ideas related to the cycle back-end reflected the situation that have developed by that time. In accordance with this the spent fuel assemblies would be loaded to the ISFS for 50 years, and so the decision concerning their ultimate management can be postponed, however it is reasonable to make an overall preparation plan for justification of the decision to be made in relation to back-end.

Under the umbrella of preparation for the closure of the nuclear fuel cycle in 2001 a document entitled “*Determination and evaluation of handling strategies for spent fuel and high level radioactive wastes, establishing a working program and time schedule*” was accomplished, that was evaluated by the ENRESA, a brother-organization of PURAM from Spain. According to the decision of the Hungarian Parliament, in no further expedient works were performed in 2001 – 2002 because of privation of the resources. In 2003 a study-plan was prepared, which determined the activities necessary for the evaluation of the potential strategies. On the basis of this the development of the strategy itself will be the task of the coming years.

In 2003 the representatives of the Hungarian and Russian Governments have re-started the negotiations aimed for back-shipment of the spent nuclear fuel to Russia, which were oriented to the reconsideration of the former inter-governmental protocol, which has existed between the two countries. Finally, such an agreement was concluded on April 29, 2004, which might constitute a legal basis for Hungary for back-shipment of the spent fuel assemblies to Russia even after our joining to the European Union.

4.1.3. Management of the non-nuclear power plant origin spent nuclear fuel

As it was shown in Chapter 2.3.5. the issue of the spent fuel assemblies generated in the research reactor (BRR) operated in KFKI AEKI and in the training reactor of BME NTI is still waiting for solution.

According to the data provision from KFKI the back-shipment of the first part of the spent fuel to Russia will be likely solved between 2007 and 2011. For the interim storage of the further spent fuel assemblies which will be generated by the end of the life-time of the BRR there will be sufficient capacity released and be available taking into account the back-shipment to Russia.

In the case if the back-shipment to Russia still would not take place, then the justification and execution of deposition in Hungary will become necessary.

In the coming years – following the completion of the planned back-shipment activities to Russia – the future back-shipment of the spent fuel assemblies generated in the future in Hungary and remaining here following the first back-shipment, or their final deposition in Hungary will have to be prepared and executed.

In relation to BME NTI the technology of transportation of the spent fuel assemblies from the building shall be elaborated. It would be reasonable to ship back the irradiated fuel assemblies which will be removed from the reactor to Russia together with the spent fuel assemblies of KFKI. If the back-shipment to Russia would not take place it would be reasonable to encapsulate the spent fuel assemblies utilizing the encapsulation technology of KFKI AEKI, and to move them to the interim storage in such a form. In order to be able to store temporarily the irradiated fuel assemblies, which will be removed from the core as a consequence of the reload it will be necessary to design and to license the procedure. Thus, it would be possible to handle in the future the irradiated fuel assemblies of BME NTI together with the spent fuel assemblies of KFKI AEKI. For the time being there is no decision or agreement concerning the storage.

4.2. The strategic target

In order to dispose the high level radioactive wastes it is necessary to get prepared for construction on territory of the country of a stable repository made in the deep geological formation. According to the uniform international standpoint such a repository can be used as well for direct disposal of the spent fuel, or for disposal of the reprocessing wastes of the spent fuel. As a reference scenario the postulation of direct disposal of the spent fuel assemblies is fully acceptable option for the nuclear fuel cycle back-end.

Having a technical solution selected for reference scenario from more conceivable alternatives, it means that the process is feasible, its implementation has a high probability, and therefore it is reasonable to build the economical calculations upon the chosen alternative.

This is confirmed as well by the internationally accepted analyses, which by analyzing the costs of the direct disposal and the reprocessing consider the direct disposal to be a more economical option.

However, it is obvious that the activities related to the elaboration of the final fuel-cycle back-end strategy cannot be avoided. During development of the strategy the finalization of the reference scenario or its potential review can take place.

4.3. Scheduling the tasks

- | | |
|------|---|
| 2007 | <ul style="list-style-type: none">- Surface exploration of the BAF area; aiming to implement a new underground laboratory, 1st phase. Completion of the location qualification investigation program.- Continuous monitoring of the research area.- Preparation of justification for transportation and encapsulation of the irradiated fuel of BME NTI. |
| 2008 | <ul style="list-style-type: none">- Surface exploration of the BAF area; aiming to implement a new underground laboratory, 1st phase. Completion of the surface investigations, final location determination of the research laboratory. Preparation of the geological research final report of the location evaluation research program and its licensing by the |

- regulatory authority.
- Preparation and approval of the quality assurance plans.
- Continuous monitoring of the research area.
- Justification of the temporary storage of the spent fuel assemblies from the research and training reactors in Hungary.
- 2008-2011 - Back-shipment of the spent fuel assemblies of KFKI (potentially of BME) to Russia (1st shipment).
- 2009 - Summarization of the information with the aim of development of the national strategy.
- Surface exploration of the BAF area; aiming to implement a new underground laboratory, 2nd phase. Preparation of the detailed research plan of the potential site, its licensing with the authorities.
- Continuous monitoring of the research area.
- Preparation of Safety Analysis.
- Preparation of the Preliminary Investigation Document and its licensing by the regulatory authority.
- Preparation of the lay-out design, of the technical designs and licensing documentation.
- 2010-2016 - Surface exploration of the BAF area; aiming to implement a new underground laboratory, 2nd phase. Execution of the detailed research program of the potential site. Completion of the detailed research program of the potential site. Preparation of the geological research final report for the potential site.
- Obtaining of the regulatory authority licenses and co-authority approvals.
- Compilation and approval of the strategy.
- Continuous monitoring of the research area.
- Preparation of Safety Analysis.
- International peer-review.
- Beginning of construction of the research laboratory.
- Elaboration of the research plan.
- 2017–2032 - Construction of the research laboratory.
- Accomplishment of the research/exploration program and preparation of the investment.
- Preparation of the Safety Analysis.
- 2027-2028 - Back-shipment of the spent fuel assemblies of KFKI (potentially of BME) to Russia (2nd shipment).
- 2033–2046 - Construction of the repository for the high level radioactive wastes.
- 2047–2069 - First phase of operation of the repository for the high level radioactive wastes.
- Transfer of the spent fuel assemblies stored in ISFS to the new facility.
- 2047 - Transfer of the long life-time radioactive wastes temporary stored in Püspökszilágy to the new facility.
- 2070–2094 - Operation of the high level radioactive waste repository, waiting for transfer of the decommissioning wastes.
- 2093–2094 - Expansion of the capacity of the high level radioactive waste repository for receipt of the decommissioning wastes.
- 2095–2104 - Second phase of operation of the repository for the high level radioactive wastes.
- Transfer and deposition to the repositories of the decommissioning

- | | |
|-----------|--|
| | wastes of Paks Nuclear Power Plant. |
| 2105–2108 | - Closure of the repository for the high level radioactive wastes. |
| from 2108 | - Long term institutional surveillance. |

Note: The above described schedule in relation to the non nuclear power plant origin fuel indicate only the activities related to back-shipment to Russia.

4.4. Source data and information for the execution of the economical calculations

4.4.1. Spent fuel from the nuclear power plant

The cost of the disposal of the nuclear power plant origin and other spent fuel assemblies, as well as of the high level radwaste might be calculated on the basis of document marked TS(R)/6/25 and titled, „*Concept design and cost estimation of the deep geological waste repository aimed for final disposal of the Hungarian high level and long-living radwastes, as well as of the spent nuclear fuel assemblies*”.

The concept plan provides possibility for separated determination of costs of final deposition in Hungary of the non nuclear power plant origin spent fuel assemblies. These costs are shown in Table 8.4.1.

The input data for the costs of the final deposition in Hungary, which shall be systematically reviewed are given in Chapter 2.3 based on the data provision of Paks NPP, BME NTI and KFKI AEKI.

The cost estimation does not cover the activities related to conditioning of the high level radwastes temporarily stored in the Püspökszilágy RWPS. These costs are included and recorded among the operational costs of the Püspökszilágy repository.

The cost estimation does not cover the costs of the back-shipment to Russia of the non nuclear power plant origin spent nuclear fuel.

4.4.4. Interrelations

The plans related to management of the spent fuel and the final disposal of high level radioactive wastes are closely linked to:

- extension of the interim spent fuel store (ISFS), determining the necessary degree of extension,
- the operational life-time of ISFS, which determines the commissioning deadline of the waste repository aimed for disposal of the high level radioactive wastes,
- the date of decommissioning of the power plant, which determines the time periods and dates of relaxation, re-commissioning and closure of the high level radioactive waste repository facility.

5. Interim storage of the spent nuclear fuel

5.1. Precedents

The precedents concerning the interim storage of the spent nuclear fuel of NPP origin is given in Chapter 4.1.2. During the past period the negotiations oriented to the back-shipment of the spent

nuclear fuel to Russia have been renewed, however, since for the time being no agreement has been reached in this respect, in the mid and long term plans we are preparing the possibilities of the interim storage on the territory of Hungary.

The PURAM is going to initiate a licensing procedure for introduction in Hungary of two, different from each other methods for the interim storage of spent nuclear fuel assemblies. One would be the MVDS technology and its developed further versions, while the other one would be a dry, concrete-container solution. The construction of the forthcoming 5 modules (modules from 12 to - 16) will be conducted in accordance with the MVDS technology. The selection of the types of the further expansions will be due following to the completion of the licensing procedure.

As a consequence of the accident in Paks Nuclear Power Plant there were 30 irradiated fuel assemblies suffering damage, and thus one has to get prepared for final disposal of the damaged fuel assemblies in domestic conditions. With this aim on mind a concept design is under preparation, making a foundation for interim storage and final disposal of the damaged fuel assemblies in Hungary. The concept design will be based on the fact that the damaged fuel assemblies will be initially stored in the cooling pools in wet environment. The concept design investigates, when and in case of fulfillment of which requirements might the damaged fuel assemblies taken for storage in dry condition. Under such conditions shall be the further interim storage assured until the final disposal – which will take place together with the other spent fuel assemblies. On the basis of the concept design will be decision made on the method of the interim storage of the damaged fuel assemblies.

The issue of the interim storage of the non-nuclear power plant origin spent fuel in Hungary is discussed in Chapter 4.1.3.

5.2. The strategic target

The interim storage of the spent nuclear fuel shall be assured by means of extension and continuous operation of the facility.

5.3. Scheduling of the tasks

2007	- Design and licensing of the solution relevant to the interim storage of the damaged fuel assemblies (continuation). - Preparation of a concept design for the interim storage and final disposal of the damaged, irradiated fuel assemblies (continuation). - Continuation of construction of the vault modules 12 to 16.
2008–2011	- Execution of the interim storage of damaged assemblies. - Construction of vaults 17 – 20.
2012–2017	- Construction of vaults 21 – 25.
2047–2069	- Unloading of the filled vaults, transfer of the spent fuel to the high level radioactive waste repository.
2007–2069	- Continuous operation.
2070–2088	- Guarded supervision together with the shut-down nuclear power plant.
2089–2104	- Decommissioning simultaneously with the nuclear power plant.

5.4. Source data and information for the execution of the economical calculations

The cost data relevant of the expansion of ISFS - postulating utilization of the MVDS technology - could be calculated on the basis of earlier concluded contracts. The extension costs include the occasional licensing and public information costs as well.

The ISFS is a facility that can modularly be extended. The extension of the necessary storage capacity shall correspond to the needs of Paks Nuclear Power Plant Ltd. For the time being, taking into account the planned life-time of the power plant, the quantity of the spent fuel assemblies generated on annual level, and the quantity of the spent fuel assemblies presently stored on site, it is planned to construct 25 vaults.

The certain part of the planned operational and maintenance costs of ISFS is determined by the data supplied by Paks Nuclear Power Plant Ltd., and it is systematically updated in every year.

A significant correlation between the interim storage of the spent nuclear fuel and other waste management tasks exists in accordance with the below written:

- According to the reference scenario the spent fuel will be transferred from the site of ISFS in period between 2047 and 2069 to the high level radioactive waste repository. The storage and transportation costs, as well as their review is given in chapter 4.
- The emptied ISFS together with the shut down nuclear power plant will wait for decommissioning during the period between 2070 and 2089, while later on the decommissioning of the ISFS and transfer of the wastes will take place together with the same activities of the nuclear power plant beginning from 2090. The relevant costs are given in chapter 6, together with the planned review of the source data.

6. Decommissioning of Paks Nuclear Power Plant and other nuclear facilities

6.1. Precedents

The first reactor of Paks Nuclear Power Plant was connected to the national grid in 1982, while the fourth one was commissioned in 1987. The planned operational life-time of the nuclear power plant is 30 years, on this basis the assumption can be made that the fourth unit of the power plant will be finally shut down in 2017, if the efforts aimed to life-time extension will not result success.

The first study concerning the decommissioning of the power plant was made by the DECOM Slovakia Ltd. in 1993. The subject of this study was focused on the first two units of the power plant. The new version made in 1997 has already covered the topic of decommissioning of all four units and of the ISFS as well.

The fact that in 2003 the DECOM Slovakia Ltd. and the TS-Enercon Kft. have prepared the first version of the preliminary decommissioning plan of Paks Nuclear Power Plant and of the ISFS should be considered as a significant progress. The preliminary decommissioning plan of Paks Nuclear Power Plant includes the same decommissioning alternatives as the study from 1997, however this is already done on design level, and the relevant recommendations of IAEA are outmost taken into account. The preliminary decommissioning plan of the ISFS investigates only a decommissioning alternative that is closely linked to the decommissioning plan of the power plant “closed and continuously guarded-supervised condition for 70 years”.

The study from 1997, as well as the preliminary decommissioning plan of the power plant from 2003 have investigated all together five different decommissioning alternatives. From those, from point of view of the cost effect the alternative “closure under supervision for 70 years” was

deemed to be the most favorable one, and thus this was chosen as reference scenario as well. According to this following transfer of the spent fuel assemblies to the ISFS the secondary circuit part of the power plant would be decommissioned, while the parts including the radioactive materials and equipment would be closed and remain in a continuous guarded-supervised condition for 70 years.

The training reactor of the Budapest Technical University was commissioned in 1971, to meet the training needs of the Hungarian nuclear experts' community. It is running today at 100 kW nominal power level, and has its valid operation license up to 2007.

The good technical state of the reactor probable allows that following the periodical safety review (PSR) actual in 2007, the facility could get the operation license even for further 2 x 10 years. That necessity is expressly supported by the designed life-time extension of the Paks NPP and education of the future plant personnel.

Based on the above-written, the decommissioning of the facility shall be considered for the period beyond 2007. The preparation of the decommissioning design is in progress. This document is necessary for the renewal of the operational license, due in 2007, and thus its finalization will have to be done only later on.

The research reactor of the Central Institute of Physical Researches was built in 1959. Its core was modified in 1967, by introducing a new fuel element. Between 1986 and 1992 the facility was refurbished, a new vessel was mounted and the thermal power was increased to 10 MW. The facility performs research and isotope production tasks, for which a neutron flux of 2.2×10^{14} n/cm² is available.

The periodical safety review of the research reactor took place in 2003, on the basis of which the Nuclear Safety Directorate of the Hungarian Atomic Energy Agency has issued an operational license, valid until withdrawal. The next periodical safety review will be due in 2013.

By taking into account that designed operational life of this reactor is of 30 years, its operation is scheduled up to 2023. AEA Technology and INITEC accomplished decommissioning study referring to the reactor in 1997, within the framework of the PHARE project. Another decommissioning plan was made by the contribution of the Belgoprocess, the SCK CEN and the STUDESVIK RADWASTE in 1998.

6.2. The strategic target

One has to get prepared for decommissioning of the Paks Nuclear Power Plant by taking into account the “supervised closure for 70 years” version.

In order to be able to incorporate the achievements of the technical development all around the world and of the gained experiences, the decommissioning study shall be periodically reviewed.

6.3. Schedule of the tasks

- | | |
|-----------|--|
| 2006-2007 | - Establishing the computer database necessary for accomplishing the ultimate plan of decommissioning. |
| | - Review of the preliminary decommissioning plan. |
| 2010–2022 | - Finalization and licensing of the decommissioning plan. |
| | - Phase by phase shut down of the units. |

- Transfer of the spent fuel assemblies to the ISFS.
 - Decommissioning of the non- active parts of the power plant.
 - Preparation of the active parts of the nuclear power plant for surveillance.
- 2022–2082 - Surveillance of the active parts of the nuclear power plant (beyond 2070 together with the ISFS).
- 2082–2104 - Decommissioning of the active parts of the nuclear power plant
- Decommissioning of ISFS.

6.4. Source data and information for the execution of the economical calculations

The cost data relevant to the decommissioning and demolishing of the power plant are derived from the study from 2003 titled “*Selected chapters of the preliminary decommissioning plan of Paks Nuclear Power Plant*” No. STD/PAKS/VD/06-02, and from the document No. STD/PAKS/VD/07-02 “*Preliminary decommissioning plan of the ISFS*”.

The preliminary decommissioning plan has to be regularly upgraded, until the final version of the demolishing plan will be completed.

The decommissioning of the power plant, as the latest in time of the tasks prescribed by the law, is in close relationship with other waste management tasks:

- The decommissioning of the power plant will result in generation of significant quantity of wastes of various activity, and accordingly at the time of design of the various repositories this shall be taken into account, and at the same time the time of the closure of the repositories shall be adjusted to the time of the decommissioning.
- The decommissioning of the power plant and of the ISFS will take place at the same time, so the supervision of the ISFS shall be adjusted to this.

7. Other tasks

7.1. Introduction

The plans related to the main professional tasks prescribed by the Nuclear Act and its execution orders were described in the above chapters. In the present chapter those activities are treated which are necessary for the execution of the main tasks, and are incorporated into our long-term plans from financial point of view. Here belongs the operation of PURAM, financing the Trustee of the Fund, the authority supervision fees and the public system support.

7.2. Operation of PURAM

The PURAM was established on June 2, 1998. The operation of the company and accordingly its financing shall be taken into consideration until the end of completion of the last task stated in the long-term plan. The annual operational cost of PURAM at a price level of July 2007 has been 2718.8 Million Hungarian Forints. This cost includes the operational costs of the Püspökszilágy RWPS as well and partly the costs of the ISFS operations, the authority supervision fees, the half-year operational costs of the 1st phase of the Bábaapáti waste repository, including the costs of transportation of the first 3000 waste barely as well.

7.3. The costs of the fund trustee

According to paragraph (2) of article 4. of the order of Ministry of Home Affairs No. [67/1997. (XII. 18.) IKIM] 41/2004. (VII. 7.) “The tasks performed by the HAEC in relation to management of the Fund, as well as the services of experts, or experts’ group used shall be financed from the Fund”.

In accordance with this in 2007 the fund trustee will use for the purposes of operation 104 Million Hungarian Forints. This operational cost shall be taken into account until the end of the execution of the last task to be financed from the fund. It is necessary to review the operational costs of the fund trustee annually.

7.4. Public support system

According to paragraph (4) of Article 10 of the Nuclear Act: “In order to provide the systematic information of the public living in the vicinity of the facility, the nuclear power plant as well as the licensee of the radioactive waste repository shall promote the creation of a public control and information society, and may provide assistance to the operation of it. The licensee is authorized to provide promotion to the municipality supervision and information societies to be established, to the area development municipality societies which will be established in the given area, and furthermore to the municipalities which are the members of these societies - even from the Central Nuclear Financial Fund – which amount might be used for information, operational, area and town development purposes”.

According to Article 67 of the Nuclear Act the Government is authorized to regulate in resolutions: „o) the rules of the promotions to be provided from the Central Nuclear Financial Fund to municipality supervision and information societies which were established in order to provide systematic information to the public leaving in the areas of repositories of radioactive wastes, interim or ultimate repositories of spent fuel assemblies, as well as in areas of site selection explorations for the above mentioned facilities, furthermore to the area development municipality societies which will be established in the given area, and to the municipalities which are the members of these societies, taking into account the rules set forth in paragraph (4) of Article 10.”

Until the above mentioned Governmental resolution will not be published, the level of the promotions to be paid to the municipality societies will be adjusted to the established practice and to the character of the activities going on in the given area.

8. Calculation of the payments to the CNFF in 2007

8.1. The method of the calculations

The calculations were performed in accordance with the calculation algorithms given in the “*Rules of development of the long-term plans and relevant estimations in relation to activities to be financed from the Central Nuclear Financial Fund*” approved on January 18, 2000 meeting of the Experts’ Committee of HAEC.

8.2. The most important changes compared to the calculations included in the fifth mid – and long term plan

The cost of disposal of the low and interim level radwastes was estimated in the earlier mid and long term plans based on the document titled “*Paks Nuclear Power Plant, Units 1-4, “Final disposal of the low and interim level radioactive wastes – Site independent cost estimation*”

comparison” made by ETV-Erőterv in 1995 by taking into account the actual inflation rates. As it was presented in Chapter 3.3.3. , the cost estimation of our present plan was performed on the basis of the document titled „*Final deposition of low and interim level nuclear power plant origin wastes in the underground repository planned to be constructed in vicinity of Bataapáti; INVESTMENT PROPOSAL*”.

- The deviation between the costs forecasted by the two, different from each other documents, and the decreasing level of the operational costs – which might be today already better estimated – together lead to the decrease of the present value of the project. This decreasing tendency is further enhanced by the fact, that the financial amount spent during the previous years shall be deducted from the project cost.
- The activities related to disposal of the high level radwastes and of the spent fuel assemblies – and accordingly the cost estimation of the necessary activities were calculated on the basis of the document marked TS(R)/6/25 and titled „*Concept design and cost estimation of the deep geological waste repository aimed for final disposal of the Hungarian high level and long-living radwastes, as well as of the spent nuclear fuel assemblies*”. Such approach leads in relation to uranium disposal to a value higher than the earlier applied 500 USD/kg cost. Having on mind, that these values were derived from the realistic circumstances of the waste disposal in Hungary, provide unambiguously more precise cost estimation, than the earlier data gained from the international literature.
- The support of the local municipalities is calculated by PURAM in accordance with a new system. **The amount of the promotion paid to the municipality societies in 2007 will be 900 Million HUF.** The promotion of the different societies will substantially depend from the operational life-time of the facilities located in the given areas.

The input data of the calculations are given in Table 8.2.1., while the calculations in Table 8.2.2. The summary of the costs of activities financed from the CNFF is given in Table 8.2.3, while the cash flow of the costs is presented in Figure 8.2.4.

8.3. The amount of the payments to the CNFF

According to the calculations in 2007 Paks Nuclear Power Plant Ltd. shall pay an amount of 22 827.5 Million Hungarian Forints to the CNFF.

Table 8.3.1. presents the professional recommendation in relation to payments in and from the CNFF in 2007. Table 8.3.2. summarizes the main tasks of the projects financed in 2007 from the CNFF as well as the costs thereof.

8.4. Prospective expenditures of the State Budget institutions and their timing.

Table 8.4.1 summarizes the expenditures of the State Budget institutions connected to the management of the spent fuel and decommissioning. As it was mentioned earlier, these expenditures will be paid by the Budget in the year of their emergence. Here the costs are indicated also at the 2007 year price level. In connection with the Table it shall be mentioned that the amount of the costs of the planned back-shipment of the spent fuel assemblies to Russia as well as the cash-flow of these costs are unknown at the present time. According to our information these cost are anticipated to arise earliest in 2008, so their actualization might take place in the next mid- and long term plan.

Tables, figures

Table 2.1.1.– Classification of the Radioactive Wastes

Category of the Radioactive Waste	Activity Concentration [kBq/kg]
Low Level Activity	1 MEAK – 10 ³ MEAK
Intermediate Level Activity	> 10 ³ MEAK

Note:

- Where MEAK: exemption activity concentration
- If the waste contains trans-uranium elements, a unique classification is required.

Table 2.1.2.: The classification of the radioactive wastes in case of occurrence of different radio-isotopes

Radioactive waste class	Comparison of the activity concentration
Low level activity	$\sum_i \frac{AK_i}{MEAK_i} \leq 10^3$
Interim level activity	$\sum_i \frac{AK_i}{MEAK_i} > 10^3$

where AK_i is the activity concentration of the i radio-isotope, being present in the waste, while $MEAK_i$ is the exemption activity concentration of the i radio-isotope.

Table 2.2.1. – The Amount of the Radioactive Wastes and Spent Fuel Assemblies Stored within the Sites of the Paks NPP and RWPS Facility (As per 1 January, 2004).

Location of the storage	LOW AND INTERMEDIATE LEVEL				HIGH LEVEL ACTIVITY WASTE		SPENT NUCLEAR FUEL			
	Storage capacity		Stored Quantity		Storage capacity	Stored Quantity	Storage capacity		Stored Quantity	
	gross m ³	Pieces of 200 liters drums	gross m ³	Pieces of 200 liters drums	m ³	m ³	piece	tU*	piece	tU*
RWPS Facility (solid waste)	5040	---	5040	---	---	---	---	---	---	---
Paks NPP Plant Site (solid waste)	---	7852	---	6903	222.8	63.3	---	---	---	---
Paks NPP Plant Site (liquid waste)	9950	---	5465.4	---	---	---	---	---	---	---
Paks NPP Plant Site cooling ponds	---	---	---	---	---	---	2600	301.6	2117	245.6
ISFS at Paks	---	---	---	---	---	---	4950	574.2	4267	495.0

* The unit value of the heavy metal content of the spent fuel assemblies was calculated on the basis 116 kgU heavy metal/fuel assembly.

Table 2.2.2.– Amount of the Spent Fuel used and to be used within the Plant Sites of the Research Institute for Nuclear Energy of Central Institute of Physical Researches (KFKI AEKI) and in Nuclear Institute of the Budapest Technical University, (BME)

Institution	Duration of utilization	Type	Enrichment [%]	Nominal U mass [gU] (U²³⁵ + U²³⁸)	Burn-up level [%]	Average heavy metal content of the spent (irradiated) fuel assembly [g]
KFKI AEKI	1959 – 1966	EK-10	10	1250	25	1220
	1967 – 2010 (?)	VVR-SZM	36	111	50	91
	1992 – 2010 (?)	VVR-M2	36	122	60	96
	2010 (?) – up to end of the operational life-time	VVR-M2	20	250	60	220
BME NTI	in course of the total operational life-time	EK-10 (modified)	10	1250	<1%	1249

Table 2.2.3: The characteristics of the spent fuel storage facilities of KFKI AEKI and level of their utilization as per January 1, 2006

	Total capacity capsule [piece] / single assembly [piece]	Number of the stored fuel assemblies	Number of the occupied storage positions (capsules) [piece]	Quantity of the stored heavy metal [kgU]	Level of utilization [%]
External storage	752 / 2256	1179 (VVR) 82 (EK-10)	$1179 : 3 + 82 = 475$	226.5	54
Internal storage	184 / 552	323 (VVR)	$323 : 3 = 107 + 1$		75
			In total: $582 + 1$		

Table 2.3.1.1 – Estimation of the necessary volume capacity of the final repository for low and interim level wastes to be newly constructed

		January 1, 2006 [m ³]	Annual generation [m ³]	Due to the incident 2006-2007 [m ³]	To be generated by the end of the life-time [m ³]	Treatment	Solid waste to be disposed [m ³]	Waste packages	
								Barrels [piece]	Other [piece]
SOLID	Compacted	1381.4	190	160	3251.4	None	3251.4	16257 (200 l)	
	Big sized	Not centralized	Not divided	---	600	None	600.0		150 (4 m ³ container)
	Cs-column storage container	---	Not divided	2.1	2.1	None	2.1		3 (0,7 m ³ container)
	Decommissioning waste ¹	---	---	---	---	None	17864	87845 (200 l)	113 (3,675 m ³ container)
K	Resin	134,60	5	40.5	220.1	Cementing 60 l / 200 l	733.7	3668 (200 l mixing)	

¹ The liquid wastes which will be generated are indicated in this column in solidified form together with the other decommissioning solid wastes.

Table 3.5.1.: The quantity of the spent nuclear fuel generated and to be generated in the future in the Budapest Research Reactor operated by KFKI AEKI

Time, Quantities Type	1959 – January 1, 2005			1959 – 2010			1959 – 2023		
	spent fuel assemblies [piece]	necessary storage positions [piece capsule]	heavy metal mass [kgU]	spent fuel assemblies [piece]]	necessary storage positions [piece capsule]	heavy metal mass [kgU]]	spent fuel assemblies [piece]]	necessary storage positions [piece capsule]	heavy metal mass [kgU]
EK-10	82	82	100.04	82	82	100.04	82	82	100.04
VVR-SzM	1210	500 + 1	109.83	1293	690	117.66	1293	690	117.66
VVR-M2(36)	292		28.03	777		74.59	777		74.59
VVR-M2(20)	---	---	---	---	---	---	900	300	198.00
TOTAL		582 + 1	237.90		772	292.3		1072	490.3

Table 2.3.5.2. : *The quantity of the spent nuclear fuel generated in the training reactor operated by BME NTI*

Time, Quantities Type	1971 – January 1, 2006			1971 – 2008			1971 – 2027		
	spent fuel assemblies [piece]	necessary storage positions [piece capsule]	heavy metal mass [kgU]	spent fuel assemblies [piece]	necessary storage positions [piece capsule]	heavy metal mass [kgU]	spent fuel assemblies [piece]	necessary storage positions [piece capsule]	heavy metal mass [kgU]
EK-10	0	0	0	24	24	29.98	48	48	59.96

Table 8.4.1. – The anticipated costs of the state budget institutions in relation to spent fuel management and to decommissioning of the facilities on price level of year 2005.

KFKI AEKI	Justification of the interim storage of the spent nuclear fuel in Hungary	Due in case of failure of back-shipment to Russia (after 2010) Cost 10-10 M Hungarian Forints
	Disposal of the spent nuclear fuel	Due in case of failure of back-shipment to Russia (after 2047) Cost: 8083.65 M Hungarian Forints
	Decommissioning of the research reactor	Due: after 2023 Cost: 766.61 M Hungarian Forints
BME NTI	Justification of the back-shipment and of the encapsulation of the spent nuclear fuel	Due in 2007 Cost 14 M Hungarian Forints
	Disposal of the spent nuclear fuel	Due: after 2047 Cost: 351.46 M Hungarian Forints
	Decommissioning of the training reactor	Due: after 2027 Cost and method: to be determined later

Notes:

The above Table does not take into consideration of the potential back-shipment of the spent nuclear fuel assemblies to Russia and the costs thereof.

Costs of the activities financed from the CNFF

