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Paks Nuclear Power Plant Unit 1 - 4

Operating Time Extension of the Paks Nuclear Power Plant

PRELIMINARY ENVIRONMENTAL STUDY

PUBLIC SUMMARY

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TABLE OF CONTENTS

The objective of keeping in operation all Units of the nuclear power plant currently operating beyond their original (30 years) design life is included among strategic aims of the Paks Nuclear Power Plant (Paks NPP) declared in 2001. **This document is an easily understandable summary of the Preliminary Environmental Study prepared for operating time extension of the Paks Nuclear Power Plant.** The Preliminary Environmental Study, on the order given by the Paks Nuclear Power Plant, was prepared by ETV-ERŐTERV Rt. (1094. Budapest, Angyal u. 1-3.) and ÖKO Rt. (1013. Budapest, Attila u. 16.) during the year 2003, involving subcontractors. Consequently, 1st of December 2002 was chosen as the closing date of data used in the preliminary impact analysis (so called base period).

1. INTRODUCTION

One of the ultimate achievements of the power industry in the 20th century was to provide an opportunity for nuclear energy to be used for peaceful purposes, the construction of nuclear power plants. Construction of our country's unique nuclear power plant, envisaged in the sixties, was prepared by scientists and engineers following the footsteps of Ede Teller, Leó Szilárd and Jenő Wigner. Construction was completed in the seventies and eighties by approx. 15 000 construction- and assembly workers. **Four Units of the Paks Nuclear Power Plant commenced energy production between 1983 and 1987,** and the Plant has been operating ever since as planned, without interruption.

During selection of the site various aspects (including environmental considerations) were studied, among others, the location within the country, population density, geology conditions, as well as the possible transport and cooling water supplies. Out of the four [illegible] considered (Bogyiszló, Dusno[illegible]s and Solt) **the nuclear power plant** was **established** within **the administrative area of Paks,** South-South-East **from the settlement**, at the bank of the river Danube (see Figure 1.).

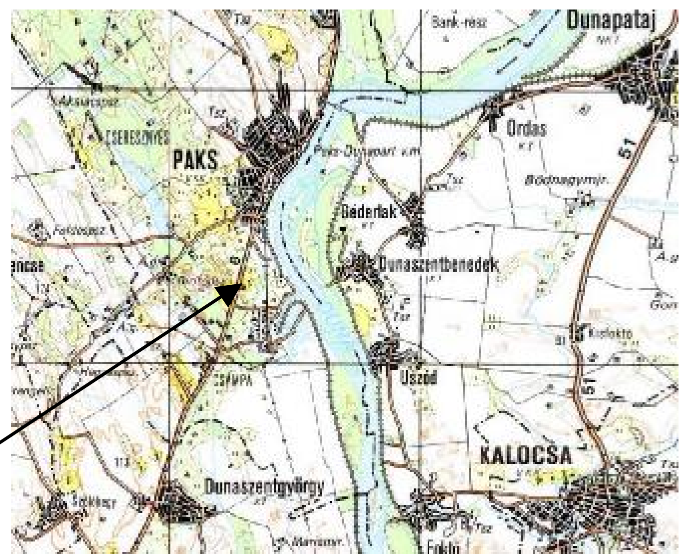


Figure 1 **Location of the Paks Nuclear Power Plant**

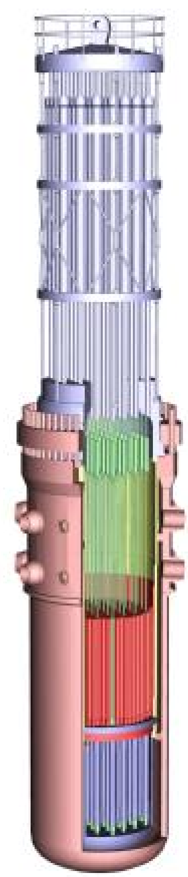
From the date of commencing, that is from 1983, until the end of 1991, the Plant was operated by the Paks Nuclear Power Plant Company. As the result of a limited privatization process, the Paks Nuclear Power Plant Company Limited by Shares, the legal successor of the above company, was established on 31st of December 1991. Currently almost 100% of the plant is owned by the Hungarian Power Company, Inc., a few shares are owned by local administrations and one golden share is owned by the National Privatization and Property Management Co.

The Paks Nuclear Power Plant provides around 40% of the domestic electricity production, it is playing very significant role in our country's energy supply. **The price of electricity produced by the Plant is the lowest in Hungary**, therefore, considering the quantity produced, it has significant impact on the domestic electricity market. During the last two decades the Plant was capable for maintaining its considerable price advantage in comparison to other power plants. As the result, the price of domestic electric power was kept at a favourable level. The increase of cost price of electricity produced by the Paks NPP is permanently lower than the inflation level, in spite of the fact that the Plant contributes approximately HUF 20 billion per year to the fund which will cover the cost of disposal of radioactive waste and for future demolition of the Plant,. Of course, this cost adds to the cost price of the power.

1.1. Facts and information on current situation at Paks

The Paks Nuclear Power Plant has 4 Units with pressurized water moderated, water-cooled reactors. (see Figure 2) Reactor Units are in pairs accommodated in a twin-structure building.

Figure 2 **Reactors at Paks**
(block scheme)



Currently all of the Units operate. **Due to the serious incident occurred on the 10th of April 2003,** which was not related to regular operation, Unit 2 was suspended until August of 2004. The Unit returned to normal operation on the 3rd of September, 2004. The incident occurred in the cleaning tank temporarily placed into the pit No.1 of the Unit; A German-French company designed, manufactured and operated this equipment. Representatives of the Plant are held responsible for shortcomings in the inspection procedure.

The population was informed about the incident, mainly via the media. **No exposures exceeding the limit were detected at the nearest populated areas during this serious incident.** With joint efforts of Russian advisors and the Plant's own experts, elimination of consequences of the incident progressed safely and professionally according to the schedule. (Elimination of consequences of the incident and restarting of the Unit are performed by the Paks Nuclear Power Plant within the framework of a separate procedure, under approval of competent authorities and in accordance with the relevant regulations). **Preparation of a new regulating and operating environment is in progress in the Plant, which will ensure that an incident of similar nature caused either by internal reasons or negligence of a third-party contractor will not occur in the future.** Costs related to elimination of consequences of the incident are paid only by the Plant, therefore the retail price of electricity was not increased by this incident at Paks.

Experience gained so far (including environmental consequences of the serious incident mentioned above) **shows that operation of the Plant has only marginally changed condition of the environment. Using nuclear energy is much more environment-friendly than conventional electricity production methods** based on fossil fuels (coal, oil, natural gas), because nuclear power plant does not release neither gases enhancing the glasshouse effect nor other conventional materials causing harm to the environment. If electricity production at Paks is replaced by, for example, an advanced coal burning power station, 10 million tons of carbon dioxide would be released into the atmosphere in each year. Also, as much oxygen would be burned as the total volume of oxygen produced by all forests in Hungary. Consequently, operation of the Units at Paks satisfy with Hungarian environmental protection obligations undertaken at international conventions.

Significance and role of the Paks Nuclear Power Plant are considerably upgraded by compulsory shut-down of Hungarian power stations with poor environmental records, as well as by problems of available power transmission line capacity which restrict import of electricity and by problems related to purchasing conventional energy sources.

With respect to production of the nuclear energy, disposal of the spent fuel and radioactive waste generally represents a problem. Temporary disposal of low- and intermediate level radioactive waste is resolved within the area of the Paks Nuclear Power Plant. The area appointed for final disposal at the Southern boundary of county Tolna has been declared suitable for this purpose by geologists. The population living at this area, - still under investigation, - supports the establishment of this storage facility. Preparation works of the storage facility are in progress as scheduled, its completion is expected in the foreseeable future.

Interim storage of the spent fuel for a period of 50 years is provided in the facility called Spent Fuel Interim Storage, which has been constructed for this purpose. Research related to final disposal has been started, and a clay stone formation located at the Western side of the Mecsek mountains appears to be promising.

The Paks Nuclear Power Plant has been established at a time when the international requirements concerning nuclear safety have been significantly tightened. **The Hungarian nuclear power plant was the first country in the former Eastern block which complied with advanced, international safety requirements from the very beginning.** Paks has been and will remain vigorously committed to increase the level of safety. Newest technical and scientific results have always been in the focus, and, last but not least, the Plant is capable for satisfying increasing social expectations. There were (and also will be) crucial periods when safety level improves in leaps and bounds. For example, in the period from 1997 and 2002, the Plants spent HUF 60 billion for an extraordinary safety program.

The Paks Nuclear Power Plant is regularly inspected and investigated by professional organizations of the United Nations, as well as by experts of the International Atomic Energy Agency and of the World Association of Nuclear Operators. **The Plant's nuclear safety parameters, technical condition of the facility, preparedness of the staff and commitment to the safety are regularly qualified by assessments prepared during these inspections as good and appropriate.** During Hungary's accession to the European Union, on the basis of a request from Brussels, the Paks Nuclear Power Plant was inspected also by the Association of West-European Nuclear Authorities. As the result of this detailed investigation they certified that safety of the Paks Nuclear Power Plant in every way corresponds to Units of Western nuclear power plants of similar age. This facility has been meeting requirements of the accession to the European Union over many years.

The Paks Nuclear Power Plant is the biggest employer of the region of county Tolna. The number of the Plant's employees and third party contractors working in the Plant reaches approximately 6.000. In addition, thousands of people depend on the Plant, primarily in the area of services. **The settlement of Paks has been become "atom town" 25 years ago, significant developments have been completed in the town ever since.** The Plant provides around the half of the town's budget by means of paying tax in the order of billions. Considering general conditions in Hungarian, the Paks Nuclear Power Plant provides significant support for settlements at both banks of the river Danube in the area of health, education, culture, preserving folklore and sport. Civil organizations, various associations and churches are also supported. The Plant gives significant amounts to associations engaged in regional development in the form of paying their share in various tender applications. As the result, the Plant directly contributes to regional development. The planned extension of the Plant's operating time ensures that this contribution will be continued for a few more decades.

1.2. Trends in the nuclear energy industry, international view

At the end of the 20^{th} century 436 power plant reactors were in operation, which provided approximately 17% of the electricity produced in the world.

In the 1990s the nuclear energy industry reached its lowest level, new Units were established only in the Asian region. However, judgement and perspectives of the nuclear energy have been changed to the better recently, helped by international environmental agreements and by international coordination (for example, the Conference in Johannesburg).

All over the world, the revival of nuclear energetics currently based on renewal of operating licenses of Units, of extension of operating time, as well as of upgrading the capacity of Units, because this is the most effective way of utilizing the existing devices. Investment costs have little or no impact on the operation of established nuclear power. Furthermore, the total operating expense is low and the fuel is not a dominant factor in the costs. Long-term stability and calculability of production costs of nuclear power plants are based on the latter item. If, for example, the price of fuel was doubled (very uncertain), it would result in a max. 20 % increase in the cost price of the energy. On the basis of international experience, nuclear power plants are competitive in the market due to the facts mentioned above.

The crucial turn with respect to judgement of nuclear energy occurred when the **United States of America** announced its new energy policy. According to this policy, in the future the USA intends to provide more significant role for nuclear energy. Operating licenses of almost all nuclear power plants expected to be extended from 40 to 60 years. Licenses of 23 Units have been issued and licensing procedure of 17 Units is in progress by the date of January 2004. Licensing procedure of additional app. 27 Units is expected in the future. Upgrading capacity is another option, such intervention was licensed at 12 Units in the year 2001.

Operating plants beyond their design lifetime is a general tendency in the European Union too. This was unambiguously confirmed by the conference of the International Atomic Energy Agency held in Budapest between 4-8 of November 2002.

In France 58 Units operate with at a capacity of more than 60 000 MW(e). The oldest Units have been in operation since 1977, the design lifetime is 40 year, although the original operational license is valid only for a shorter period. Plants are inspected in every decade according to the so-called Periodical Safety Review. The French economy currently prepares itself for extension of the operating time of 13 Units before 2020, then of additional 24 Units between 2020-2025, or, if needed, construction of new Units. (For construction of new Units, completed plans are available already now).

In Great Britain more than 30 Units are in operation. Exploiting the plants over the entire design lifetime (which is 40 years) is generally accepted, however certain Units are expected to remain in operation for 45-50 years. British companies and institutions covering the entire nuclear industry do not intend to stop nuclear energy production on the long run and they do not exclude the possibility of the construction of new Units in the further future.

Exploiting the plants over the entire design lifetime is allowed even by the current anti-nuclear government of **Germany**. This means that after 2020 eleven Units will remain in operation producing more than 14 000 MW(e), which is 64% of the current capacity. In **Switzerland**, social acceptance of nuclear power is significantly better than in Germany. Currently 5 Units operate in this country, the oldest one since 1969, while the newest one since 1984. On the basis of opinion of competent authorities and as a result of the review program commenced in 1991, extension of operating time with 10 years is possible at the older Units and with 20 years at the newer ones. In the **Netherlands** exploiting the entire 40 years design lifetime of the 449 MW(e) Unit operating since 1973 is planned.

In the Finnish nuclear power plant of Loviisa (its technology is the most similar to the Paks Nuclear Power Plant) a modernization and capacity-upgrading program was completed in 1998, and the level of nuclear safety was also increased. In addition to planned extension of operating time, **Finland** is a unique country in Europe, where construction of a new nuclear Unit has been accepted, preparation and type selection have been completed with the approval of the Parliament.

In East- and Central Europe, **Slovakia**, complying with the relevant expectation of EU, plans to shut-down its two older Units in Bohunice. However, it intends to operate its two newer Units and the nuclear power plant of Mohi even beyond the design life-time. In the **Czech Republic** a 10 year extension of operating time is planned in the nuclear power plant of Dukovany. In **Slovenia**, in the nuclear power plant of Krsko, as a result of a reconstruction program, capacity of the Unit has been upgraded by 6,3% and they intend to extend the operating time. **This means that commencement of at least six Units similar to the ones at Paks shall be considered approximately up to 2030 in the Central Europe.**

Also, the big Russian nuclear energy industry is interested in extending the operating time of its nuclear power plants. Due to their technical similarity to the Units operating at Paks, the nuclear power plants operating in Kola and Novovoronyezs are very important. Among Units operating in **Russia**, Unit 3 of Novovoronyezs (first start in 1971) was granted the first license in December 2001 for operating 5 years beyond its design lifetime. Preparation of extending the operating time beyond the design period has been completed in the nuclear power plant of Kola. In June of 2003, the nuclear authority granted licensed to Unit 1 (1973) beyond its design lifetime.

2. TECHNICAL SPECIFICATIONS OF THE PAKS NUCLEAR POWER PLANT

Due to the limits of this easily understandable summary, the presentation of technical specifications covered only specific facilities, description of specific technical equipment and their role in the plant. (Detailed technical parameters are described in the preliminary study.)

2.1. Facilities of the nuclear power plant

The most important facilities of the technological process are located adjacent and connected to each other as shown in Photograph 1. Most significant technological facilities are as follows:

- **Main buildings** (The two main buildings are the technological centre of energy production. These buildings, in pairs, accommodate the reactors, the primary and secondary circuit and auxiliary facilities and equipment. These buildings with special construction have load-bearing, biological protection and boundary functions too.)
- **Auxiliary buildings** (They include storage for radioactive contaminated waste generated by the water purifying equipment and from the area of the controlled zone, as well as technological systems related to waste management.)
- **Diesel generator building** (This building accommodates diesel generators providing backup power supply for the Plant.)
- **Health and laboratory building** (This wing is located between the two main buildings, it provides access to personnel moving from changing rooms to workplaces, to transport for the washhouse and to the laboratories. This complex facility serves as a "gate" between the controlled zone and the technological area.)

Photo 1 **Technological facilities from bird's-eye view**

- **Chemical- and make-up water plant** (It accommodates the desalination water (which is essential for the plant) facility, as well as technological- and service systems providing chemical agents of the primary- and secondary circuit.)
- **Ventilation chimneys** (Their task is to release filtered air transmitted by the ventilating systems from primary circuit rooms of the Plant.)
- **Facilities for water inlet and recirculation of used water** (They provide cooling water for the Plant and release warm technological waters into the outlet.)
- **Hydrogen generator, hydrogen- and nitrogen tanks** (They generate hydrogen for cooling the generators, as well as safe storage of tanks.)

The above list does not contain social facilities, offices, stores and other buildings at the site, since they have no significant impact on the operation of the plant. The Spent Fuel Interim Storage was established immediately next to the site. This facility is independent, both in respect of ownership and operation, and it is not part of the nuclear power plant.

2.2. Technological equipment of the production process

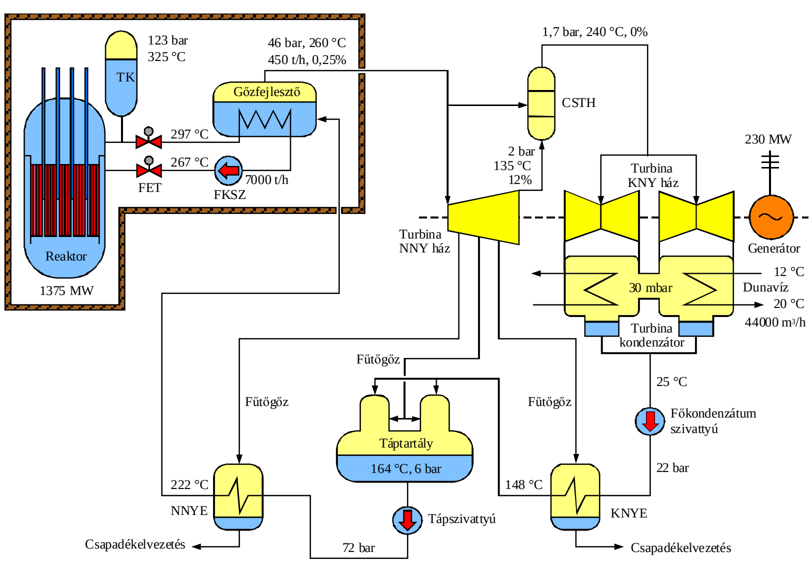
Since among **technological equipment the reactor and the primary circuit** have significant impact on both the operation and the extension of operating time, we give a more detailed description of this two.

In the Paks Nuclear Power Plant 4 Units of Soviet designed, VVER-440/213 type reactors are operating. These reactors belong to the group of pressurized water reactors (PWR), where water boiling is eliminated by high pressure in the primary circuit. The name of VVER originates from abbreviation of the Russian name of the "water-water power reactor". The number of "440" refers to the fact that the original nominal electric power output of Units in this type of nuclear power plant's was 440 MW. Due to capacity upgrading measures, the total capacity of the Plant has been increased from the original 1760 MW to 1866 MW.

Nowadays reactor types using pressurized water technology are the most frequently used in the world. In case of these types, the cooling water circulates in a closed (primary) circuit, which includes also the reactor, and it has not in direct connection with the outer environment. The primary circuit cooling water, which collects heat generated in the active core, is transferred by the 6 cooling circuits encircling the reactor to the steam generators, where the heat from the secondary side of steam generators is transferred to the cooling water of the secondary circuit. In the secondary circuit the water is allowed to boil and the saturated steam drives the turbines. Similarly to the primary circuit, the secondary circuit is also a closed circuit (see Figure 3).

The construction of the Paks Nuclear Power Plant accommodates two twin Units. The top section of buildings is a conventional industrial building with general engineering equipment. The reactor, including the primary circuit and steam generators, are located in the lower section of the building. The reactor is surrounded by a radiation shield. The lower section of the reactor building forms a separate, sealed space for reactor. The separated building parts (so called hermetic spaces) are connected to the reactors' own emergency and localization systems.

Figure 3 **The process of realization of energy production**



Fuel of the reactor is uranium dioxide (UO_2) which is compressed into cylindrical pastilles with approx. 9 mm height and 7.6 mm diameter (see Figure 4). The uranium pastilles are placed into an airtight tube (the cladding) made of an alloy of zirconium-niobium, with length of 2.5 m and outer diameter of 9 mm, filled with helium gas. This is the fuel rod.

Figure 4 **Fuel pastilles**

Since individual movement and replacement of the more ten thousand fuel rods is practically impossible, the fuel elements are joint into bundles. In case of a the VVER-440 Unit, the fuel bundles (cassettes) have a hexagonal cross-section and one bundle consists of 126 fuel elements. The active core is capable for storing the total of 349 cassettes, the number of fuel bundles in these is 312. In case of the type VVER-440, absorbent cassettes (made of boron steel) of the same size as the fuel cassettes are used for controlling the chain reaction.
Similarly to the Western-European reactors, **safety systems of the Paks Nuclear Power Plant are based on the principle of "defence in depth", that is several defence lines are provided between the environment and the nuclear fuel elements.** In addition to the passive defence, active protection systems are also available. In case of an incident, the control rods automatically fall into the active core and stop the chain reaction in 12-13 seconds. However, due to decay of radioactive fissile materials remaining in the reactor, significant heat generation is continued, which, in the first moments, corresponds to 7.5% of the nominal capacity. Consequently, cooling is needed after shut-down of the reactor. If the incident is caused by damage in the cooling system, a supplementary, emergency cooling system must remain operational after shut-down. Melting down of fuel not cooled properly might result in release of radioactive fission products of the fuel element, and this must be prevented by any means.

Breakage of the primary circuit main pipeline is the most serious possible design incident of the nuclear power plant. (However, occurrence of this accident has a very little probability, according to calculations it might occur once per 100 000 year.) In this case, beside the loss of cooling, the escaped water immediately boils due to its high temperature and low pressure and steam with strong radioactivity is generated. The purpose of the so called airtight space and the localization system is to prevent the release of radioactive steam. The airtight space, surrounded by a 1.5 m thick concrete wall, accommodates cooling circuits of the reactor and, on the one hand, it provides biological defence against radiation, on the other hand it prevents release of steam up to an overpressure of 1.5 bar. (Location of the reactor and connected technological equipment are shown in Figure 5.)

The localization system, alias the steam pressure lowering system, which consists of the localization tower and the so called Sprinkler system, has been established to prevent a steam pressure higher than the above value (to prevent damage of the reinforced-concrete building). The steam generated during the breakage of the main circulating line, together with air in the airtight space, flows into the localization tower, where it flows through trays filled up with boron water (> 12.5 g/dm^3). During this process the steam is condensed, therefore pressure in the hermetic space is lowered. The Sprinkler system sprays boron water into the airtight area.

The steam is condensed by the water, consequently pressure in the airtight area is lowered further. The boric acid is necessary, because the water, after a certain period, is capable for entering into the reactor, where the absorbing capability of the boron prevents restarting of the chain reaction.

In case of a primary circuit line breakage, cooling is provided to the active core by the Emergency Core Cooling System (ECCS). It has a high pressure- and a low pressure section. The low pressure pump, when needed, presses water with boric acid concentration of 12 g/dm^3, under a pressure of 7.2 bar, into the reactor. The high pressure pump helps in restoring normal cooling conditions by pumping boron water with a concentration of 40 g/dm^3, under a pressure of 132 bar, into the reactor. In addition to this, a passive emergency cooling system not requiring electricity is also available.

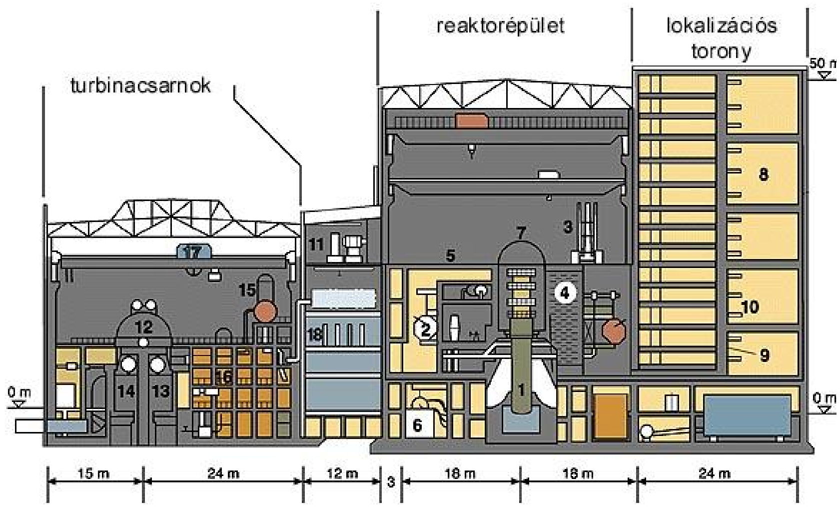


Figure 5 **Centre of the technology: the reactor building and the turbine hall**

Legend:
1. Reactor vessel
2. Steam generator
3. Refuelling machine
4. Decay pool
5. Biological protection
6. Supplementary feed water system
7. Reactor
8. Localization tower
9. Bubbler trays
10. Air trap
11. Ventilating section
12. Turbine
13. Condenser
14. Turbine house
15. Degasser feed water tank
16. Pre-heater
17. Turbine hall crane
18. Regulating and instrument rooms

One common turbine house serves all four reactors and accommodates the total of 8 turbines (2 Units per reactor). The main transformers are located next to the turbine building, at a safe distance. As far as infrastructure is concerned, during normal operation and maintenance periods the Paks Nuclear Power Plant is entirely independent of any external services.

Majority of the safety systems requires electricity, therefore 3 diesel generators per reactor Unit provide the necessary energy in case of loss of power. In case of serious emergencies these machines automatically starts and provides power supply for the important consumers.

Auxiliary systems connected to the primary circuit and their purposes are as follows:

- **Make-up water and boron control system** (Its task is to make up water loss caused by regular or irregular leakage in the primary circuit, ensure the balance of the primary circuit water circulation, as well as compensate slow reactivity-changes by extracting boric acid solution. During incidents, as part of reactor protection functions, it injects boric acid into the primary circuit.)
- **Water treatment systems** (In order to operate the primary circuit equipment in a safe and controlled way, coolant in the primary circuit must be continuously treated. Separate systems provide water treatment to the primary circuit.)
- **The system of regular leakage** (It collects water regularly leaks from the primary circuit, then returns it into the system via the make-up water treatment system.)

- **Intermediate cooling circuits** (Certain elements of the primary circuit main equipment, which require continuous cooling, are in direct contact with the primary circuit water. Consequently, a closed intermediate cooling circuit is established between the cooling water providing necessary cooling and the equipment to be cooled, where the pressure of cooling circuits reduces from the outside towards inside and pressure of the system to be cooled is the lowest.)
- **Decay pool and its cooling circuit** (The function of the decay pool is, after unloading of spent fuel cassettes from the reactor, to store them for five years. It has an individual cooling circuit.)
- **Secondary circuit** (Its function is to remove excess heat from the primary circuit through steam generators, to carry steam to the two turbo-generators, as well as to return condensing waters, - the condensate, - into the steam generators. During cooling down and in case of incidents, it ensures heat removal from the primary circuit through the steam generators.)
- **Cooling water systems** (The safety cooling water system is responsible for providing cooling water for equipment which require safe and permanent cooling under normal operation of the Unit, or which serves for normal-, as well as emergency cooling of the Unit.)
- **Ventilating- and air-conditioning systems** (In accordance with fundamental health protection and ventilation design of the power plant, not contaminated and potentially contaminated area must be separated. These machines provide appropriate ventilation and air filtering in potentially contaminated areas, as well as they ensure proper conditions required for normal operation of equipment and for the health of employees.)
- **Emergency systems** (They are activated in case of incidents. They ensure automatic prevention of incidents and prevent the entering of radioactive contamination into the environment.)
- **Electrical equipment** (The two turbo-generator-transformer blocks of the reactors, coupled at the side of 400 kV, are linked to the 400 kV national electricity network. The diesel generators provide the backup power supply.)
- **Instrumentation & control** (These instruments serve for monitoring safety parameters, as well as for keeping them between safe limits.)
- **Installed release- and environment monitoring system** (It provides release- and environment protection monitoring for the nuclear power plant. Its details are described later.)

In addition to these systems, a number of such technological systems are in operation which do not affect safety, or do not relate directly to power production, however, in case of their breakdown environmental pollution may occur. Out of them the following ones are the most important:

- Industrial waste collection-, transfer- and draining system;
- Industrial slurry disposal site (lime sludge-, chemical agent and oil pools);
- Chemical agent transfer and special chemical agent preparatory station;
- Chemical agent transfer and dosage systems;
- Chemical agent waste water removing pipelines;
- Turbine oil system;
- Oil transfer station and emergency draining system;
- Machine house and feed pump oil system;
- Lubricating oil, used oil and gas oil system for the backup diesel generators;
- Public sewage network;
- Pipeline for waste water contaminated with oil;

- Chemical agent storage, petrol station.

2.3. Activities helping in the production process

Here we list only the most significant activities:

- **Treatment and storage of radioactive waste**
  Radioactive isotopes are released from the nuclear power plant into the environment via the warm water channel and the air chimney in a planned and controlled way and complying with the required limits. Also, radioactive waste is generated during regular operation and maintenance. Within the controlled zone of the nuclear power plant all wastes shall be considered as radioactive until proved otherwise by conducting appropriate tests.

  Low- and intermediate level radioactive **solid waste** are processed (separated, compressed, sludge is solidified). After this process, until the final storage facility is completed, they are stored temporarily in the main and auxiliary buildings of the Plant. The current storage capacity of solid wastes is sufficient for 6-8 years.

  Waste water is collected in monitoring tanks. A strict chemical and radiation checking procedure is always followed before releasing them into the environment. Waters qualified as suitable for release are transferred from the inspection tanks and discharged into the receiver, the river Danube via the warm water channel, in accordance with release limits. The expansion of the tank park used for storing liquid waste has been started by the Paks Nuclear Power Plant Rt. Taking the currently used volume reducing technologies into account, it is probable that this expansion will be sufficient even for the extended operating time.

  The task of systems managing **airborne releases** is to treat the air exhausted by the venting systems or generated by regular blow-outs. This treatment is achieved by using aerosol and iodine filters. Treated air is discharged into the atmosphere through a 100 m high chimney of the Units and through a 30 m high chimney of the health-laboratory building. As far as limited components are concerned, current tests indicated that release in the atmosphere did not reach 0.1-0.7 % of the total release.

  Highly radioactive solid waste, after cut and disassembled, is placed into packages allowing recycling. The highly radioactive storage facility in the reactor hall must be modified to be suitable for the extension of operating time or a license for external waste disposal must be obtained.

- **Storage and treatment of hazardous materials**
  Significant amount of various chemicals are used in the nuclear power plant on a regular basis. Activities involving chemical agents are performed in the diesel machine house, the nitrogen- and hydrogen plant, the storage facility of gas bottles, the chemical agent transfer station and in the water treatment plant. Storage and usage these chemical agents and neutralization of chemical waste in the nuclear power plant are completed according to relevant regulations, under controlled conditions. With regard to the distance between the storage facility and the reactor buildings, chemicals stored only in the necessary quantity, so they do not impose potential danger on the Plant.

- **Water supply**

Water supply of the nuclear power plant is provided mostly from the river Danube, but small quantities are provided from waterworks and bank-filtered wells. **Communal water consumption** is annually app. 260 000 m^3, the drinking water is provided by the Waterworks of Csámpa. **The cooling and service water** of 100-110 m^3/s is taken out of the river Danube. This quantity is approximately 12.5% of the lowest flow of the river and 5% of the average flow. The quantity of water taken out is permanently below the permitted value.

- **Waste-water discharge**

  The nuclear power plant has separated, independent systems for communal and industrial waste-water. The **communal waste-water** system collects waste-waters from social facilities and waste-waters generated in the health-laboratory building. The waste-water treatment plant is established at east from Units of the Plant, it consists of two lines of facilities. Its capacity is 670+1200 m^3/day. Its technology is total oxidation, active sludge with full biological purification. Excess sludge, after compression, is transferred onto a sludge desiccation bed for dehydration. Dry sludge is disposed after radioactive concentration test.

  The **industrial waste-water** system collects all non-communal waste- and oil contaminated waters generating in the plant. These waste-waters are pumped into the slurry storage facility. Treated water, via an overflow device, reaches the warm water channel with the help of gravity.

  The **rainwater**-draining system includes pipelines, trunk channels and outlets. This system is responsible for collecting water from roofs, paved and green surfaces and roads.

2.4. Regular nuclear release and environment monitoring activity

2.4.1. The official monitoring network

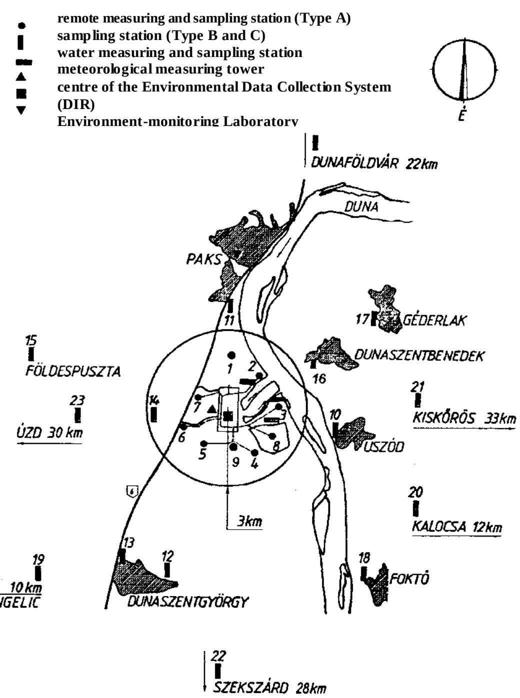
The nuclear environmental protection system of the Paks Nuclear Power Plant includes monitoring of radioactive release of the Plant: specifying its extent and composition, continuous monitoring of radiation conditions natural and artificial origin in the environment. This is provided by the so called Environmental Data Collection System, which, in all operating states of the nuclear power plant (regular operation, emergency, nuclear accident), transmits sufficient and reliable data for evaluating environmental impacts. If necessary, this system is responsible for taking appropriate counter measures.

Main areas of this monitoring activity are as follows:

- measurement of airborne and liquid releases in the chimneys, in the tank park collecting waste waters and in all channels of discharge;
- measurement of meteorological parameters and also hydrological for the river Danube;
- measurement of radioactive concentration of air, soil, ground water and natural flora (grass);
- monitoring radioactive activity of various samples (water, sludge, fish) collected from surface waters (Danube and fish ponds) and from storm water sewers;
- measurement of radioactive concentration of certain food samples (milk);
- measurement of dosage and dose rate of the background gamma radiation in the environment.

The normal release- and environment monitoring system of the Paks Nuclear Power Plant has been built between 1977 and 1982, and its reconstruction is in progress. As the result of the planned reconstruction, reliability of the environmental data collection system will be improved, its measuring range will be wider and it will be capable for supplying more data. Deadline for completion of the renewed systems is 31st of December 2004. Arrangement of system's elements is shown in Figure 6.

Figure 6 **Arrangement of sampling and measuring stations in the environment of the Paks Nuclear Power Plant**



Elements of the measuring system:

- **The measuring system KALINA and NEKISE** measures activity in air released through the air chimneys
- **Iodine isotope** (^{131}I) **remote sensor device**, which measures iodine isotope activity in air released per chimney;
- **Dose rate measuring detectors** (18 pcs), which monitor the level of environmental radiation at the operating area;
- **Station network of type „A"** (9 pcs), which measures dose rate of the environmental gamma radiation and its iodine activity-concentration at a distance of 1-1.5 km from the Plant.
- **Water monitoring stations**
- **Weather monitoring tower**
- **Dosimetry Information System** (DIR) records measuring results of the remote measuring stations listed.

In addition to monitoring systems, laboratory inspection of a number of natural samples (grass, soil, milk, fish, surface and ground waters, etc.) is regularly performed. These methods ensure the detection of the lowest possible radioactive concentrations. Monitoring of environmental components and foodstuffs is performed in laboratories of the Health Radiation Measuring- and Data Supplying Network which is operated within the framework of the National Office of Public Health (ÁNTSZ). One of the 7 laboratories performing measurements operates in county Tolna, as a branch of the National Office of Public Health. **The normal release- and environment monitoring activity performed by the nuclear power plant is weekly inspected by the relevant environmental authority.**

2.4.2. Public (civilian) inspection

In addition to measuring- and monitoring systems of the plant and relevant authorities, a special monitoring network operates in the vicinity of the nuclear power plant, which is fully independent from the above mentioned monitoring bodies. The Public Inspection and Informational Association (TEIT), which holds together settlements within the closer vicinity of the nuclear power plant, has installed detectors at 13 locations, majority of them are located in the local administration offices or at the neighbourhoods. Monthly assessment of detectors is performed by the local civil defence services. The Paks Nuclear Power Plant, without knowing the settlements' own results registered at the same locations, gives its own measuring results to the TEIT in every month. TEIT, without preliminary harmonization, publishes results of the two monitoring systems in local and regional newspapers. In the last decade there was no significant difference between the two sets of data. This is the best way to verify environmental protective measures and environment monitoring activity of the plant.

Monitoring the water of the river Danube is performed by representatives of the population with help of the "water laboratory" established in the village of Bátya. This equipment is suitable for measuring activity of other surface-, ground- and rain waters. These results are also published in newspapers.

Radiation display systems installed at the most frequented locations of Kalocsa, Paks and Uszód provide direct informing the general public. In addition to display correct time and temperature of the air, this instrument displays current level and change of background radiation during the last 24 hours and over the last week. All of this information is provided in a simple, understandable and comparative way, on a visual displaying. As soon as any official or non-official nuclear information is published, people may check the stability of the environmental or possible changes. Additional environmental radiation monitoring systems operate at settlements of Gerjen, Dunaszentgyörgy and Paks, which have been installed with the help of the national environmental fund, after winning a tender application.

Within the vicinity of the Paks Nuclear Power Plant the general public, leaders and elected bodies participate in monitoring the impact of the nuclear facility. Suitable instruments, advanced technical background and appropriate volume of information are available for them.

3. THE PLANNED EXTENSION OF OPERATING TIME

In order to meet long term energy demand of the country in a practical and reasonable way, in consideration of the international trends specified, operating time extension of the Paks Nuclear Power Plant's Units is confirmed and justified. This measure will ensure long-term stability of the power supply to the public and retail price of electricity will bee kept as low as reasonably achievable. Therefore, management of the Plant, on the basis of approval and support of the Hungarian Power Company and the National Privatization and Property Management Co. as owners, has initiated all necessary preparatory and basic activities.

In order to achieve the above listed targets, the Plant intends to obtain support of the general public with providing comprehensive and objective information. According to results of public opinion researches, the level of social acceptance of the Paks Nuclear Power Plant is permanently high (65-70%), which can be considered as a hopeful basis for development efforts of the Plant.

Nuclear safety at Paks will play a primary role also in the future during both operation and maintenance and in implementing future plans. When making their decisions on environmental, production, economical and property issues, managerial bodies of the nuclear power plant consequently consider this priority.

3.1. Opportunities to extend the operating time

The operating time extension is a decision which might rely on design-manufacturing specifications of the Plant, on technical reserves of the entire construction, as well as on experience gained during the regular technical reviews. **Safety of the nuclear power plant is an essential condition of operating time extension.** As a result of implementing a comprehensive safety enhancement program in 2002, safety of the nuclear power plant complies with requirements of nuclear power plant's Units of similar age, operating in developed countries. Safety of the nuclear power plant is always kept at a level satisfying domestic requirements and international expectations. However, technical safety can not be described by specific, permanent parameters. New findings and experience determine new requirements for which appropriate answers must be given.

When assessing the possibility of the planned operating time extension, the Paks Nuclear Power Plant, Inc. surveyed expansion of the knowledge base, licensing and technical tasks to be performed, and, **as a first step**, **ordered a feasibility study** covering all of facilities and technical equipment ("Feasibility analysis on life-time extension of the Paks Nuclear Power Plant", Electricity Industry Research Institute, 2000). This feasibility study covered processing of international experience related to operating time extension of nuclear power plants, detailed review of technical status of the Paks Nuclear Power Plant, including technical and safety measures needed for the extension of operating time and their expenses.

The feasibility study has proved that the nuclear power plant is capable for operating over an additional 20 years, beyond the original design period of 30 years. There are no technical or safety limits in the way of extending the operating time. There is no question about the economical feasibility of this plan. According to the feasibility study, **the planned operating time extension is based on preserving the functionality of the long lifetime, non-replaceable elements of the system** (for example, buildings, structures, reactor Units). The necessary technical condition of other system elements (for example, pumps, lines, I&C equipment) can be provided by proper maintenance, renewal and replacement, and their safety functions can be tested by trial runs.

The planned operating time extension must be licensed. According to the Nuclear Safety Codes (NBSZ), licensing is a two-stage process, firstly the license in principle, then the operating license is granted. In order to obtain the permit in principle for extending operating license, the relevant application shall be submitted to the Nuclear Safety Division of the National Atomic Energy Agency 5 years before the expiry date of the current operating license. In addition to the technical documents, other special permits, pursuant to Act. CXVI/1996 on nuclear energy, must be attached to this application, for example, the environmental protection permit, which is essential.

Consequently, preparation of the environmental impact assessment process has been commenced early in 2003. Planned methodology of the study has been harmonized with relevant authorities and professional bodies involved in the licensing procedure. Relevant authorities reinforced the concept, that full investigation of environmental impacts of the nuclear power plant is properly served by the environmental impact assessment report. This process ensures involvement of the public in a regulated way (public meetings), as well as it complies with the procedure prescribed in the Espoo Convention on environmental impacts reaching beyond national borders. **The nuclear license in principle for operating time extension will be issued only after the environmental license has been granted.**

3.2. Extension of operating time and the environmental impact assessment

The aim of this task is the **inspection of** not a planned, but of an **already operating facility, by the means of the impact assessment process.** The extension of operating time does not require modification or reconstruction of the Plant, alteration of the current technology or other significant intervention. Consequently, in this case, in contrary to the usual practice of the general impact assessment process, not a new facility is constructed, but the lifetime of an existing and approved nuclear power plant operating in an environment-friendly way will be extended, of course, with maintaining appropriate nuclear safety. In order to achieve this, all equipment of the existing nuclear power plant must be checked and continuously inspected, including replacement and renewal of obsolescent equipment and parts.

Consequently, current environmental effects and processes related to the nuclear power plant will remain dominant in the future, new impacts and effects shall not be considered. **From the point of view of judging the future activity, the acceptability of current environmental impacts on the nuclear power plant is critical.** Therefore, the preliminary environmental study is focused on the evaluation of current environmental effects.

In addition to the evaluation of the current state, the environmental impact of checking, modernizing and reconstructing the present technology, in summary, of the preparation of operating time extension, must be taken into account. On the other hand, a separate investigation had to be performed on changes of cumulative environmental effects of the Plant operating over a period of additional 20 years. (See, for example, the waste management).

In any case, fundamental aim of the environmental impact assessments is to estimate changes occurring in each element/system of the environment due to the planned activity and to qualify these changes on the basis of exposure of the final objects of the impact. The most important is to follow the path of effective factor → direct effect → indirect effect, that is to monitor the effect processes. In order to do so, initially **effective factors** of the activity and the **effect processes** initiated by these factors had to be specified. (See Figure 7). Recognizable effect processes of the current operation offered help in this specification, since in this case current effect processes and ones occurring in the future, during the period beyond the designed operating time, are identical. In this report these processes have been evaluated.

Knowing the effect processes, the so called impact area of a specific activity can be determined. (See Figure 8). Reviewing the expectable effects, the impact area covers the following areas:

- **Safety zone:** This area is specified in relevant legislation, its boundary is marked by a circle with a radius of approx. 2.7-3 km, drawn from the nuclear power plant. Regular releases practically remain within this circle.
- **Closer environment:** Traditional environmental contamination, environmental stresses and loads must not reach beyond this area. This is an area of approx. 5-8 km calculated from the nuclear power plant. Due to the thermal load, a max. few 10 km section of the Danube below Paks, as well as the transport routes are added to this region. (The latter is primarily up to Paks.)
- **Wider environment:** According to estimations, in case of emergency detectable increment in the collective dose caused by possible radiation may occur within this area, and where an accumulation of the dose might occur. (This is the zone of max. 30 km from the nuclear power plant.)

This three-zone division of the investigated area was continuously taken into account during the preparation of the study and details of the current state were presented accordingly. Consequently, deeper investigations were performed only within the safety zone, while in the wider environment only an overall evaluation, presentation of extraordinary values and dangerous factors were illustrated.

Figure 7 **Environmental effect processes of operation of the nuclear power plant**

Env. element/ system concerned	Effective factor	Direct impact	Indirect impact		Humans as final object of impact
Atmosphere	1. Radioactive release during operation	→ Change of background load			Risk increase
	2. Conventional air pollution in the operating phase	→ Change of air quality in the closer vicinity and along access routes			Health effects
	3. Heat release into the atmosphere 4. Existence, urban effect of the Plant	→ Change of air temperature → of the immediate vicinity	Micro-climatic changes		Occasional trouble in certain usages
	5. Air pollution causing emergency	→ Increase exceeding the background load of radioactivity in the vicinity			Enhancement of health risks
Surface and subsurface waters	6. Water inlet (cooling and social water demand) 7. Existence of built-in and paved areas	→ Quantitative decrease in surface and subsurface → waters			Usage restriction
	8. Radioactive release during the operation	→ Quality change of surface waters	Pollution of subsurface waters		Risk increase
	9. Release of conventional pollution - waste water generation	→ Quality change of surface waters			Usage restriction
	10. Release of warm cooling water	→ Change of temperature of the outlet			Periodical trouble in certain usages
	11. Water pollution in emergency	→ Pollution increase exceeding the release limit in the outlet or in subsurface waters	Segregation of radioactive materials in surface waters		Periodical restriction of certain usages
Soil	12. Existence of the nuclear power plant as a building	→ Continuous, increasing layer load	Possible movements		Safety problems
	13. Generation of conventional wastes during operation	→ Soil pollution			Restriction of usages
	14. Generation of radioactive waste during operation	→ Soil pollution			Risk enhancement
	15. Soil pollution in emergency	→ Pollution increase exceeding the background load			Restriction of usages
Living ecosystems	(there in no direct effect)		Change of life conditions	Migration, degradation	Decrease in bio-diversity
Artificial elements	(there in no direct effect)		Deterioration of state		Incr. of maintenance demand
Settlements in the vicinity	16. Existence of the facility	→ Wellbeing and development of the settlement		Intensifying of urban effects	Possibility of integr. developm. Improvement of possibility of usages
(Noise, vibration)	17. Operation of the facility	→ Noise- and vibration			Discomfort
Land	18. Existence of the facility	→ Limiting of land usage → Disturbing of landscape			Change of life conditions

More detailed information is available in the Preliminary Environmental Study accessible at notaries of self-governments.

Figure 8 **Areas to be assessed during operating time extension of the nuclear power plant**

Separately attached to this document.

Legend of the figure:

Red line:. impact area of the normal operation (safety zone)
Blue line: estimated impact area of the designed operational failure (closer environment)
Green line: entire investigated area (wider environment)

3.3. Implementing operating time extension

As the results of surveying the technical condition of the nuclear power plant, we can establish that

- there are no technical or safety objections with respect to maintaining the Paks Nuclear Power Plant for a period of 50 years;
- inspection, maintenance and regular reconditioning practice of the power plant supports the operating time extension in most cases of systems and equipment without extraordinary expenses;
- due to aging or significant obsolescence, the minority of equipment and systems will need reconstruction;
- in case of certain systems, a capacity expansion might be needed (for example, waste storage).

One condition of the operating time extension is to establish and operate such a life-time management and aging management system which is capable for maintaining the required level of technical conditions and functions of equipment with monitoring the aging process and implementing measures relevant to specific conditions (maintenance, repair, renewal, replacement). This system maybe introduced during the design life-time of the nuclear power plant, regardless to the future operating time extension. In the nuclear safety licensing procedure it must be confirmed that the life-time management and aging management system is capable for maintaining the required level of technical conditions. Significant elements of this system are already available in the practice of the nuclear power plant, and certain activities, for example, monitoring radiation damage of the reactor vessel, monitoring aging of the steam generator and treating is against aging, have been performed since the date of commencing the facility. On the basis of the above and according to our current knowledge, the following aging management measures and significant steps needed for extending the operating time - including for reaching the design lifetime:

- **Reactor vessel** (see Figure 9): it might be needed to increase temperature of the water in the tank of Emergency Core Cooling System of Unit 1 and 2, furthermore in case of the reactor vessel of Unit 1, heat treatment of the vessel's welded joints might be needed, for which an approved technology is available;
- **Reactor vessel upper block**, pipe ends must be monitored for fatigue cracking and stress corrosion;
- In case of **the expansion vessel**, the vicinity of pipe ends must be monitored for fatigue damage and stress corrosion;
- With respect to equipment within the reactor vessel, replacement of **the intermediate rod set** is needed (for all 4 Units), while in case of **the control rod drives** a conscious inventory management must be applied;

Figure 9 **Reactor vessel**

- Aging experienced at rotating parts (blade wheels) of the main circulating pumps is caused by the stress corrosion. Blade wheel-replacements caused by aging (or in certain Units due to power upgrading) will help in extending their operating time.
- In case of the **main gate valve**, thermal embrittlement of the cast house shall be checked;
- **Fittings in the main steam system** shall be replaced due to their wear and tear;
- The **high pressure pre-heaters** shall be replaced with a new type (ferric tube, carbon steel house). (The cause of this is feed water side erosion damage, and operational safety

increase required by the 10% capacity upgrade, which is necessary for the extension of 30 years design lifetime);

- In case of the **refuelling machines** repeated major I&C overhaul is required (due to rapid progress in the technology, to moral aging);
- Replacement of **I&C and monitoring systems**, or certain components, due to moral aging.

Consequently, the fundamental method of life-time management is to follow (monitor) the condition of equipment and structures all the time and to complete maintain tasks, equipment replacements and reconditioning operations according to schedule, taking into account the future extension of operating time. This activity does not mean significant change in the volume and purpose of material usage. Replacement or reconditioning of rubber seals, packed joints, pumps and assemblies is a typical example. In case of building structures, wall cover reconditioning, façade or floor reconstruction are commonplace, although replacement or occasional repair of insulation are more important. In case of electrical and I&C systems, we can expect replacement of cables or upgrading of aged control or measuring systems.

When heat treatment at the reactor of Unit 1 will be due, it will be performed on-site with induction heating which does not cause excess material consumption or release. Increase in release is not expected even in case of main equipment replacement, since waste-waters generated by decontamination (removing radioactive contaminants) aimed to recycle metal components will be treated with equipment within the nuclear power plant. Consequently, it is possible the waste-generation of more ten tons to be prevented.

Modifications concerning the mechanical equipment have been always in progress, among others within the framework of measures aimed to increase safety. Also, experience gained so far from reconstruction of buildings (for example, repair of decay pool lining and improving earthquake-resistance of buildings) is available. Tasks related to refurbishment of the reactor protection system and to modernization of the radiation monitoring system belong to the I&C department.

Accordingly, survey of the general state of the nuclear power plant indicated that significant part of the around 500 structures, systems and equipment to be considered from the point of view of maintaining appropriate safety, complies with requirements of the 50 years life-time, with help of monitoring, regular maintenance or partial/full reconstruction. Consequently, **for the planned operating time extension, continuation of the current maintenance and renewal schedule must be considered.**

Also, this means that the volume of annual works of and the quantity of waste generated by safety enhancement and seismic reinforcement activities in progress from beginning of the 90s in the Paks Nuclear Power Plant will not increase due to the conscious life-time management and to necessary reconstruction and equipment replacements.

It is impossible to separate the operation of the nuclear power plant from the problem of the spent fuel and radioactive waste. 50 years of interim storage of the spent fuel is provided in the storage facility built on the site, enlargement of the storage facility can be ensured over the extended operating time, the strategy for final disposal has been prepared and particular solutions are expected before the extension of operating time is due. Preparation for building the storage facility for final disposal of low- and medium level radioactive waste has been already started.

4. ENVIRONMENTAL IMPACTS OF THE PAKS NUCLEAR POWER PLANT

4.1. Description of radioactivity in the environment of the plant

In the vicinity of the nuclear power plant a reference level survey was conducted in 1981-82, which covered the following items: atmosphere, fall-out, soil, ground water, water and sediment of the river Danube, vegetation, fish and milk samples, as well as dose rate measurement. The method of surveys was almost identical to the environment-monitoring system currently in operation, therefore it is possible to compare data recorded before the establishment of the Plant with current data. Result of the reference level survey did not differ from the one expected, extraordinary concentrations have not been detected.

During its operation, the nuclear power plant releases contaminated materials into the atmosphere and the Danube, quantity of which is regulated by very strict authorial limits. On the basis of measurements, the most important statement is that **the nuclear power plant complied with official limits on every account** with very high margin, excluding the quantity of tritium (^{3}H) discharged with liquid waste. The following releases are described in each elements of the environment:

Surface air, fall-out (segregation)

- During the first decade the radioactive isotope of silver was regularly detected in samples. Later its detectability level was significantly reduced, then at the end of 90s the detectability level was limited only to a few cases. In addition, from time to time very small quantities of some corrosion products (^{54}Mn, ^{58}Co, ^{60}Co) were detected in samples (typically in the order of thousandth or hundredth mBq/m^{3}). In recent years one isotope of Cobalt (^{60}Co) was detected (up to 10-20 samples per year).
- In a few cases some other radioactive isotopes of nuclear power plant origin (^{54}Mn, ^{58}Co, ^{134}Cs, etc.) were detected. The measured values hardly reached to the detection limit, consequently were nowhere near to the health limit.
- Apart from the release occurred in relation to the serious incident on the 10th-11th of April, 2003, radioactive iodine originating from the nuclear power plant has not been detected neither on aerosol nor on elementary iodine filter samples.

Soil and grass samples

- Mostly radioactive isotopes of natural origin and isotopes originated from the global fall-out were detected at both types of sample. These data are independent of the nuclear power plant's own release and are in harmony with data published in relevant literature.
- The isotope of caesium (^{137}Cs) was always, while the isotope of strontium (^{90}Sr) was often detectable in the soil. They are in harmony with information mentioned above, with results of the global fall-out. Also, both isotopes were detectable in the majority of grass samples,. The same releases could not be significantly detected in the atmosphere.
- Radioactive isotopes originating from the nuclear power plant (for example, ^{110m}Ag, ^{54}Mn, ^{60}Co) have been detected, in a very low quantity of up to a few Bq/kg, only at a few occasions in app. 800 samples taken during the last twenty years. This result has been confirmed by investigations conducted with other measuring methods (gamma-spectrometry).

Samples taken from the river Danube

Isotopes can accumulate in the sludge at outlet of the warm water channel, in the vicinity of inlet and at south, downstream. Therefore, it is theoretically possible that such concentrations reach significantly higher levels than concentrations in the water, which can be detected much easier.

Thus samples are taken from this location and, in order to compare samples, from a location northward from here.

- The isotope of caesium (^{137}Cs) in all sludge samples, while the isotope of strontium (^{90}Sr) was detectable in the majority of samples from the outset. Values measured before 1986, as well as the strontium isotope detected later originated overwhelmingly from the global fall-out. No trends were detectable in results taken along the river, therefore contribution of the nuclear power plant can not be specified.
- At some occasions, the manganese isotope (^{54}Mn), the cobalt isotope (^{60}Co) and the silver isotope (^{110m}Ag) were detectable, between 1 – 10 Bq/kg, in the sludge sample taken at the outlet of the warm water channel and at the sampling point to the south, which were originated from liquid release of the Plant.

Water-, sludge- and fish samples taken from fish ponds

The environmental monitoring system of the nuclear power plant regularly takes samples from fish ponds located next to the Plant and in the vicinity of Paks. Radioactive material may reach these locations partly by water supply (ponds next to the Plant), partly through the atmosphere. Sampling covers water, sludge and fishes.

- The gross beta activity concentration of water samples belongs to the range of natural surface waters (0.1-0.5 Bq/dm^3). The same is true for the tritium (1,5 Bq/dm^3). No gamma-ray radioactive isotope originated from the nuclear power plant was detectable in samples.
- The situation is similar in sludge samples, only radioactive isotopes with natural origin can be detected. Similarly, no gamma-ray isotope above the detecting limit of 0.5 Bq/kg, originated from the nuclear power plant was detectable in fish meat and offal prepared and measured in conditions ready to cook.

Groundwater

Samples are taken in each month from more than 40 groundwater monitoring wells.

- Since the middle of the eighties tritium originated from the technology has been detected on the site of the nuclear power plant, most of all in groundwater below and around the main building and auxiliary buildings. An intensive search using trace indicators has been conducted since 1993 in order to localize and gradually eliminate possible technological troubles, irregular leakage and releases. As the result of interventions, the highest activity concentration measured in recent years did not, or only slightly exceed the value of 1 kBq/dm^3. Total tritium concentrations in groundwater wells are also decreasing. On the basis of these findings, we can say that release of water polluted by tritium and originated from the technology into the groundwater has been eliminated.
- Pollution reached the groundwater earlier is primarily located below the auxiliary building No. 1 and the main building No. 1-2, and in the vicinity of them. Tritium contamination gradually spread and diluted the movement of the groundwater, at present it forms a "tritium-cloud" below the operating site. The activity concentration at the imagined "outer" edges of the main- and auxiliary buildings may occasionally reach the order of 100 Bq/dm^3, although further away, at the boundaries of the plant it never exceeds 10 Bq/dm^3 or the level of background activity.

- In the last two years it is possible to use highly sensitive isotope-specific methods at wells with automatic sampler equipment. These methods indicated that no gamma-radiation of artificial origin above the detectable limit was found.

Milk samples
Milk samples are collected on a monthly basis from the area located south from the nuclear power plant (Dunaszentgyörgy, Gerjen). Radioactive concentration of these samples is measured by gamma-spectrometer. So far no radioactive isotope originated from the nuclear power plant's has been detected with detecting limit of 0.5 Bq/dm^3.

In summary: **Measured values of radioactive concentration generated by radioactive release from the Nuclear Power Plant at Paks, are, in most cases, several magnitudes less than concentrations of natural isotopes in the vicinity of the plant** or than the volume of artificial radioactive isotopes originated from other sources. Thus **regular operation of the nuclear power plant, up to now, has not considerably increased radioactive concentration of environmental elements.**

Dosage measuring tests also support the above facts: according to dosage measuring tests conducted over a long period of time and covering the extended vicinity of the nuclear power plant, **during the 20 years operation of the Paks Nuclear Power Plant the level of environmental gamma-radiation generated by the plant has not been increased with a detectable extent.**

During operation of the nuclear power plant both the airborne and liquid releases have been kept at a favourable low level, complying with the strict official limits. Comparison with the foreign results clearly indicate that releases do not reach the average value of international data correlated with one Unit of energy produced in nuclear power plants of the same type. These measurements confirmed that **the nuclear power plant does not have any directly measurable impact on radiation in the environment.** On the basis of information mentioned above, it is clear that radioactive dosage received by the general public and generated by the release of the plant was approximately one thousandth of the official limit, and ten thousandth of the radiation exposure originating from the natural radiation.

4.2. Conventional conditions describing the state of the environment

4.2.1. Air quality

Even before establishing the nuclear power plant, the area of Paks used to be one of the regions of the country which enjoyed clean air. In the town itself concentrations of traditional pollutants (sulphur dioxide and nitrogen dioxide) in question reached only the value of 2.5-4 times of the background pollution, because neither significant regional nor significant local pollutant sources were not established in the surrounding area. Also, transport and industry in the area was slight, therefore the main source of pollution is space heating.

According to measurements of the National Meteorological Service, **background pollution in the vicinity of Paks is only moderate even when the nuclear power plant is in operation,** and, according to the zone classification specified in relevant legislation, this region is classified as causing low environmental load. Compared to the state before the establishment of the nuclear power plant, increase in the pollution is significant only with respect to nitrogen dioxide, which refers to transport as the main pollutant source. **Also, our**

tests conducted in the immediate vicinity of the nuclear power plant confirmed that atmosphere of the region has got a moderate loading.

Studying **the nuclear power plant's own, conventional air pollution releases** (backup diesel machines, spray paint room), at present it is sure that this kind of release is **not significant even in its immediate vicinity.**

4.2.2. Climatic conditions

The area of the Paks Nuclear Power Plant enjoys flatland type, warm, dry and continental climate, consequently there is significant fluctuation in air temperature and in rain, sudden changes in climatic conditions are not unsurprising. The site is **one of the driest regions of the country**, since it is located in the precipitation shadow of the Bakony mountain and North Middle Mountain Ridge. **Considering the national average, this site receives almost the highest sunlight,** however, consequently **also the value of radiation loss is significant.** Strong daytime warm up and a strong night-time cooling are characteristic features here. The **dominant wind direction is north-north west**.

Establishment of the nuclear power plant and starting its operation might have an impact on micro climatic conditions. Since no tests with regard to these conditions were conducted before establishing the nuclear power plant, we can assume only theoretical considerations. **Results of meteorological measurements continuously performed since the establishment of the nuclear power plant have not shown typical changes in measured parameters.**

Theoretical impacts can be classified into two big groups: one group of impacts is related to thermal load (for example, rising warm air, cloud- and fog formation, vapour condensation due to the thermal load), and the urbane impact occurring in the vicinity of a built-in area (for example, higher average temperature at paved areas and change of vaporization conditions). In order to detect micro climatic impacts of the thermal load, five automatic measuring stations have been installed within the framework of the site-monitoring program currently in progress. Although this measuring work is yet to be completed, as early as in the first year of the program it was possible to demonstrate the impact of the warm water channel, dominantly in case of lower air temperatures and westerly winds.

4.2.3. Surface waters

With respect to the river Danube, environmental impacts of the nuclear power plant might originate from diversion of water and release of used waters (industrial water loaded with conventional and radioactive pollutants, public waste-water, thermal load). These impacts changed the riverbed, changed water quality and modified ecological conditions.

Change of the riverbed

In the vicinity of the site the river Danube has a nature of slightly plain-tract, the river leaves additional deposits on the riverbed instead of deepening it. However, river regulation works (the increase in speed due to narrowing and the increase in fall due to shortening) resulted in an increase in transportation capacity of the river, consequently **a bed deepening process was initiated. T**he most important cause of this deepening is, in addition to the ones mentioned above, regular gravel excavation from the riverbed upstream from the nuclear power plant. After stopping this activity, a slow filling-up process and bed regeneration started. Due to its effect on the cooling water supply of the nuclear power plant, the ford at

"Baráka" plays a dominant role (at 1522-1521 river km). The ford is improved by local backwater effect, as well as by establishment of guard fender and groynes, and this provides an appropriate result also with respect to the cooling water supply. The diversion of water continuously changes the riverbed, and **this must be considered by the nuclear power plant in the future.**

Water quality

At present, on the basis of its oxygen exchange rate and organic material content water quality of the river Danube in the vicinity of Paks is currently classified as water quality Class I-II., whereas on the basis of its plant nutrient content water quality Class II-III. **The water quality at sampling places downstream from the Paks Nuclear Power Plant** (Fajsz, Baja, Mohács, Hercegszántó) **is generally not worse** than at the sampling place upstream from the nuclear power plant (Dunaföldvár). Consequently, **the used water release originating from the nuclear power plant** does not modify the classification of water in the river Danube. Therefore, **the water quality does not considerably change due to the nuclear power plant.**

Also, impacts on the water of the river Danube have been checked by **dedicated on-site water chemistry tests** conducted between 1999 and 2002. Results of official water quality tests have been confirmed and refined by these tests. According to the results:

- the impact of used waters discharged from the nuclear power plant along the river was detected only in changes of water temperature and slightly in changes of dissolved oxygen concentration (minimum) and of oxygen saturation (maximum);
- seasonal differences are typical, for example, in case of tests conducted at the end of August, the values of oxygen saturation, biological oxygen demand, chlorophyll-a and pH were significantly less favourable, than in case of tests conducted in autumn (early in October). However, in case of nitrates the situation was the opposite.

In addition to the so called routine water chemistry tests, they also tested such indicators which were capable for detecting possible, casual impacts of the warm cooling water discharged by the nuclear power plant. According to results of tests conducted on organic micro pollutants, analysis of all aromatic hydrocarbons of mineral oil origin content of the water indicated that the cleanness of the river Danube's water is acceptable. Also, pollution of sediment samples was within the acceptable limit, with the exception of a single sample, where the measured value referred to a casual pollution source.

The quantity of poly-aromatic hydrocarbons (PAH) and poly-chlorinated biphenyls (PCB) in the water of the river Danube was in harmony with average pollution of the river. Residues of Diesel oil contamination, traces of combustion products can be detected, although in low concentration. Pollutants in the highest concentration are typically originated from space heating and transport, and not from the activity of the nuclear power plant. Also, the extent of pollution in sediment corresponds to the average Danube-pollution level, although these values slightly higher than the average ones.

Consequently, these dedicated investigations show that **the impact of used waters discharged from the nuclear power plant into the river was detectable with respect to the water temperature, the oxygen-level indicators, certain micro pollutants, and components typical of oil and domestic waste-water.** However, the pollution was generally

at the level corresponding to the average Danube-pollution, or they were only slightly higher than the average.

Thermal load

With respect to thermal load of the nuclear power plant, on the basis of measurements and aerial photos (see Figure 10), the following facts can be established with regard to dissolution of discharged warm water:

- The heat tailing becomes significantly diluted in the immediate vicinity of the outlet facility.
- The significant increase in speed and change of direction occurring at the groyne and transverse dyke after the outlet and related mixing (turbulent flow) contribute most of all to the dissolution of the heat tailing.
- The heat tailing always travels near the right bank and enters into areas between shallows too.
- Dissolution of the heat tailing is completed mostly between 4-5 km after the outlet.
- The lower limit of the extent of the warm water tailing significantly depends on temperature of the river's water, the total length of dissolution decreases as the average temperature of water increases.

The allowed extent of the thermal load (temperature, thermal gradient) is regulated by official limits (T_{max} and ΔT). Damage to the biosphere in the water can be avoided by observing these limits. At downstream from the nuclear power plant the higher water temperature locally accelerates decomposition of organic materials in the river, which results in oxygen consumption and reduction in oxygen level. However, this impact can be balanced by hydraulic and mixing conditions of the river, as well as by typically high soluble oxygen levels. Due to warm water discharged into the river, the biomass in this section of the river is higher than upstream. The flora and fauna along this section of the river is one of the richest in the region, with the highest number of species. Due to the higher temperature, especially in winter months, the density of fish is also above the average).

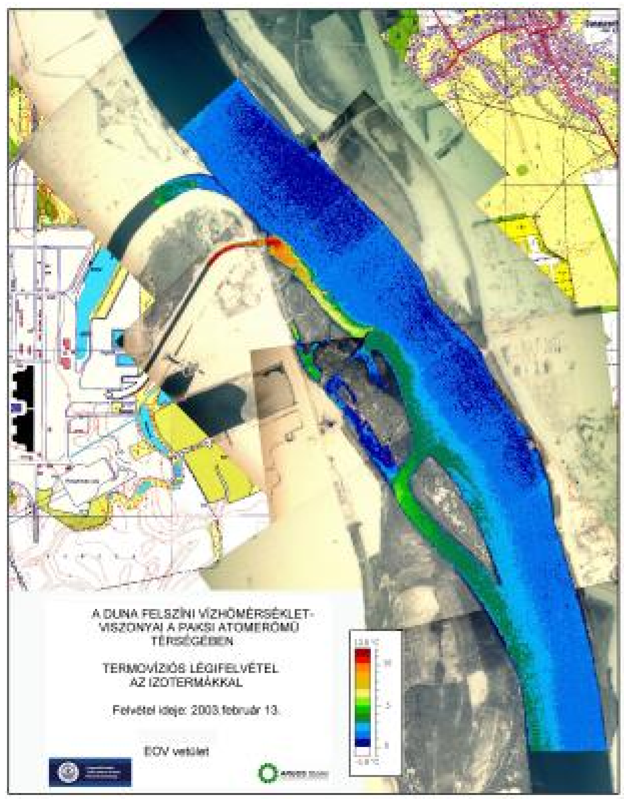


Figure 10.

4.2.4. Geological, hydrogeological conditions

Seismicity (earthquake-resistance) of the site was one of those parameters which were mostly researched in the last decade. This parameter, which has significant impact on the safety of the nuclear power plant, has been fundamentally reassessed since the establishment of the nuclear power plant. Over and above determining the level of equivalent earthquake, the **most significant result of current investigation** was the elimination of possibility for dislocation running out to the surface and the **confirmation of the suitability of the site**.

At the site, below the topsoil, a group of layers with a thickness of approximately 25-30 m from the Pleistocene period is located, its upper section is fine, well classified sand originated from flood. Its lower section is sandy gravel, gravel and sand, as well as gravel with scattered sand. On the basis of samples from drillings, the particle distribution changes significantly in space, and the gravel content shows a strong deviation. Position of the surface of the Pannonian layer group has been unambiguously clarified by drillings in the depth of 30-50 m, this layer group is located under the surface between the depths of 21-28 m, at the level of 69-73 m above Baltic Sea.

Only the layer between the depths of 10-20 m is prone to soil liquefaction. The soil liquefaction potential is slightly modified by the main building's base pressure of 130 kPa. When a stable covering layer with appropriate thickness is available above the liquefying layer, damage to the shallow foundation is unlikely. **Consequently, taking the probability of 10^{-4} year as a basis, a global soil liquefaction under the main building is not considered.**

In order to monitor the state of soils and ground waters, a soil- and ground water monitoring system has been established in the nuclear power plant. **Soil contamination was detected only a few times since the establishment of the plant.** Before 1995, pollution was detected in two cases, in the vicinity of the slurry area (oil) and at the demolished paint waste storage facility (metals). Neutralization was completed in both cases. Since 1996 an environmental damage survey and several environmental inspections have been conducted at the site. **All pollution recognized and surveyed have been eliminated by the nuclear power plant**, causes have been revealed and their experience has been taken into account during reconstruction.

4.2.5. Ecosystems in the vicinity of the Paks Nuclear Power Plant

The Paks Nuclear Power Plant, as a major industrial facility, requires a relatively large area. Its establishment significantly modified the closer vicinity. The Plant did, and still does, significant impact on the flora and fauna of its vicinity. Before construction works started, non-natural vegetation, mostly arable land and vineyards occupied both the plant's site and the site of the new housing estate. However, the flood area of the river Danube next to the nuclear power plant, with its softwood bushes, bush willow meadows and mud vegetation, still reflect on the bygone vegetation of the site. (see Photo 2)

Photo 2 **Danube's flood area next to the Plant**

Photo 3
An old oak next to the Plant

In the vicinity of the nuclear power plant, despite of significant anthropogenic (human) influence, valuable and naturalistic areas can be shown: open sand grass-plots; pioneer and swamp-field vegetation appearing as secondary habitats; marsh, swamp-field, grove vegetation (Old- and New "Brinyó"); swamp-marsh forest with alders; wooded grass-land at Dunaszentgyörgy; as well as the Danube flood area at Paks. For example, the old common oak seed-tree shown in Photograph 3 is a living remembrance of the old hard wood groves. Dedicated researches revealed a number of protected plant species at these areas (see Photographs 4-6).Also, the fauna is slightly more valuable.

Photo 4 The **yellow wort** is disappearing, so it is under legal protection. A large population of this flower lives within a belt of 1 km from the Plant.

Photo 5 In the immediate vicinity of the Plant, in a degraded habitat, a significant population of one of our protected orchids lives, its Hungarian name is "**mocsári nőszőfű**".

Photo 6 The protected **late carnation** is a native of limy sandy plains of the Carpathian-basin. This flower can be found at several locations in the vicinity of the Plant.

This reduced land, partly on the basis of facts, partly on the basis of assumptions, still supports certain fraction of sand plain and loess plain field animal species typical of the old plain fauna. Mainly species with higher resistance, and which are capable for surviving at disturbed living places, were capable for surviving the rapid loss of their living places.

4.2.6. Generation and disposal of waste

Not only radioactive, but also conventional solid and liquid wastes are generated in the nuclear power plant. As far as solid waste is concerned, the plant produces hazardous waste and the non-hazardous (industrial) waste, as well as communal waste. The Plant has established its technological waste collecting places, and the system for collecting, managing, interim storage and disposing of wastes. Collection and disposal of waste is performed in accordance with relevant legislation. Waste management is performed on schedule and in a planned way, the most important purpose is to transfer waste for recycling. For example, more than 90% of the industrial waste is recycled.

In year 2002 the Paks Nuclear Power Plant generated a total of 1,437,000 kg of non-hazardous industrial waste and 332,642 kg of hazardous waste. No extraordinary environmental pollution related to hazardous waste occurred during the operation. Distribution of the hazardous waste in 2002 is shown in Figure 11.

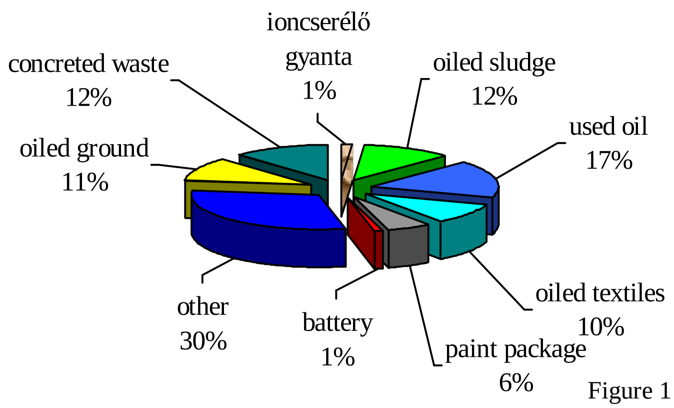


Figure 11 **Dangerous wastes detected in large quantity in 2002**

Estimated quantity of the generated communal waste is 5000 m^3/year (non-compressed waste). This waste is received by the Municipal Waste Dump of the City of Paks, similar to soil and construction refuse generated by construction works completed at this area.

Communal liquid waste is received by the nuclear power plant's own sewage treatment plant. Treated waters are discharged into the river Danube. According to measurements and tests, contamination concentrations in waste waters are lower than the legal limit allowed in waters to be discharged. Compressed sludge is pumped via the sludge pipeline onto the sludge bed with a surface of approx. 1200 m^2 in order to dehydrate it.

Waste waters with non radioactive contamination are also generated in the nuclear power plant: slop waters, waste waters from the water treatment plant, waste waters with oil contamination from the technology and, occasionally, washing waters. Industrial waste waters are finally discharged into the river Danube. Water quality of the warm water channel is regularly inspected by the competent environmental protection authority, the legal limit was never exceeded.

4.2.7. Environmental noise load of the Paks Nuclear Power Plant

The nuclear power plant is located away from populated areas, no farms or other permanent settlement is located within the 1 km radius of the Plant. The site is surrounded by agricultural land (arable land, orchards, vineyards, meadows, gazing land) and forest, consequently **noise load must not be considered within the direct impact area.** With respect to the indirect impact area, the traffic related to transportation of workers and other traffic to and from the Plant must be considered. Some of this occurs on main highway No. 6, while the rest can be experienced on roads crossing the area of Paks. Additional noise load originating from this sources is negligible.

At facilities to be protected against noise, the noise originated from operation of the Plant nowhere exceeds the relevant limits (due to their big distance).

4.2.8. Settlements in the environment of the Plant

Starting from the XIX century, **Paks matched with the general Hungarian settlement structure as a small town, a country town with several functions** (agriculture, small industry, trade, service). Paks has established close economical and agricultural relations with Budapest as a supplier. Due to its close relation with Budapest, similarly to settlements along the banks of Danube, Paks became modern town relatively early. This advancement was significantly slowed down in the firs half of the XX century. However, **due to establishment of the nuclear power plant at Paks,** population significantly increased in a short period of time and advancement started again. However, the settlement has dominantly **become a single-function town**. Therefore, the situation of Paks is very special compared to towns of similar size. It enjoys advantages and suffers disadvantages stemming from the situation that a huge, single company determines economy and employment of the town. On the top of this, this hug company is not an average one, but it has a role unique in the country on several factors. Development and advancement of the town and the Paks Nuclear Power Plant have been closely interlocked for many decades. In the last decades numerous developments at Paks have been implemented as a "linking investment" or by means of significant support given by the nuclear power plant (see also item 4.3).

Existence of the Plant has significantly influenced advancement of the economy, uniformity has further increased in the recent years. Almost all participants of the industry, directly or indirectly, relate to the nuclear power plant. At the same time, **livelihood opportunities at the settlement, as well as its infrastructure and economical advancement significantly exceed typical parameters of both the direct vicinity and of similar size Hungarian towns.**

As the result of establishing the nuclear power plant, the structure of the city of Paks have been considerably changed. A modern town centre, emphasizing the importance and size of the settlement, has been built. However, the "old town", the network of middle-age street the traditional structure of the settlement have been retained. Development involved unpopulated areas, therefore, next to the old town, a new, modern town has been built with a different structure. The housing estate established for employees of the nuclear power plant has been built onto a loess platform. It is oriented to south, it faces towards the nuclear power plant. In general, the level comfort in the housing estate, structures of the buildings and adjacent parks are better than the level of similar estates built in that time elsewhere.

4.2.9. Land and area utilization

Most important aspects of land utilization and land structure can be briefly summarized as follows:

- The almost flat land along the banks of the river Danube and agriculture, within this, large field cultivation, are dominant both in the land utilization, land structure and in forming the landscape. Consequently, the vicinity of city of Paks can be classified as cultivated land, and since the establishment of the nuclear power plant, as producing lands (see Figure 12)
- Deciduous forests (more than 10%), grazing land and natural grass (more than 6%) enjoy a significant share in land utilization. Spots of forests are located, on one hand, at the bank of Danube, on the other hand, on the hills mixed with grasslands in a form of mosaic.
- Similar to the above, the area of the rivers and channels (around 6%) and populated areas (around 4%) are relatively extensive.

- Other forms of area utilization reach 1% or less, therefore they are not dominant in land utilization and landscape. At the same time, the number of these less significant spots is relatively high, therefore the area can be considered as divided and diversified.

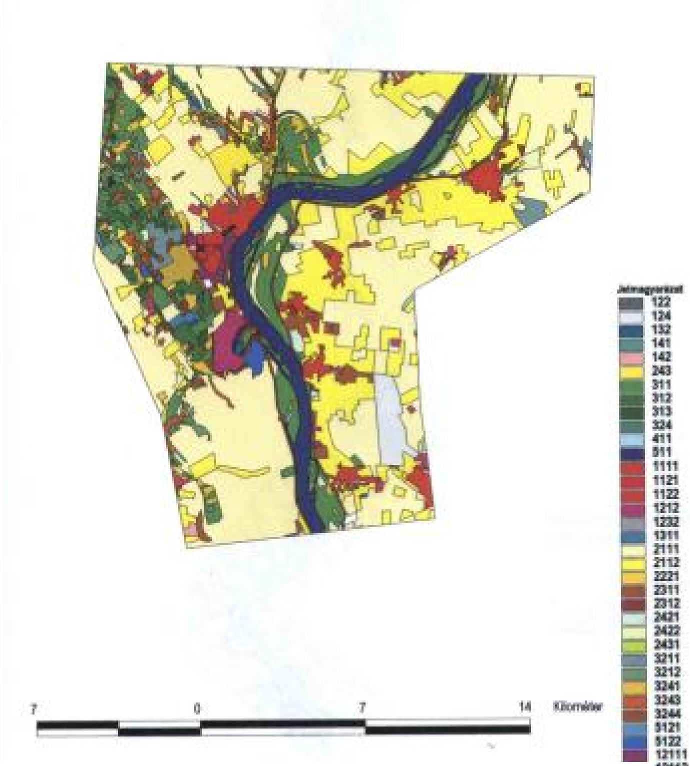


Figure 12 **Area utilization of the immediate surround of the Paks Nuclear Power Plant, the state of 1999**

Data source: SPOT Xi space shot, 13th of September, 1999

122	Road- and railway network
124	Airports
132	Disposal sites (refuse, slurry pond)
141	City green zone
142	Sport- leisure - and holiday zone
243	Primarily agricultural area, with natural formation
311	Deciduous forest
312	Coniferous forest
313	Mixed forest
411	Continental marshes
511	Rivers, channels
1121	More storeyed dwellings, housing estates
1122	Single-family houses, suburbs
1212	Special technical facilities
1311	Strip mines
2111	Large field arable land
2112	Small plot arable land
2311	Intensive grass lands and degraded grasses
2312	Intensive grass lands and degraded grasses with trees and bushes
2421	Gardens (closed gardens)
2422	Gardens with buildings
3211	Natural grasses
3212	Natural grasses with trees and bushes
3241	Young forests and cut areas
3243	Native bush-forest area
5121	Natural ponds
5122	Artificial ponds, water basins
12111	Industrial and commercial facilities
12112	Agricultural farms, farm-centers, farms
12113	Education and medical institutions
22111	Large field vineyards
22112	Small plot vineyards

After the establishment of the nuclear power plant, the presence of this extended industrial site had a significantly impact on both land structure and landscape. However, since that time changes in land structure caused by the presence of the nuclear power plant did not, or hardly occurred. But since the change in the political system in Hungary, large agricultural fields have been divided and the presence of smaller plots became more significant on the landscape.

4.3. The role of the nuclear power plant in shaping environmental conditions

The Paks Nuclear Power Plant does not settle for the conventional approach of the industrial environmental protection, to keep the level of damage caused in the natural and artificial environment as low as reasonable possible. **The concept of active environmental protection has been introduced, they not only protect the environment, but also improve its quality.** As the result, more programs were implemented with the support of the Paks Nuclear Power Plant.

Stagnant waters of the river Danube at Fadd-Dombori, an important holiday resort in county Tolna, are located almost 20 km from the nuclear power plant. In summertime hundreds of thousands of holidaymakers visit this area, where they can enjoy special gifts of mother nature. There are several hundreds of holiday batches here with lots of communal services. These stagnant waters used to have water quality problems over many years. In the mid-nineties conditions further deteriorated and water became unsuitable for swimming. In addition to the natural values, it appeared that holiday opportunity of many people would vanish. With significant contribution from the Paks Nuclear Power Plant, a channel system was constructed for transferring filtered cooling water of air conditioners of the nuclear power plant into these waters. This method provided the necessary freshwater supply. This water never participated in nuclear processes and was never in contact with radioactive equipment. This fresh water supply revitalized the stagnant area and nowadays it is of the most stable water qualities in the country. The slumping holiday- and sporting life was renewed. This water is further transferred into the Danube channel of Tolna, so the process of environmental improvement has also started in this region.

The channel system providing the water supply passes through **the swamp forest of Dunaszentgyörgy,** where habitats have been significantly suffered in the last decade by loss of water. In the forest, which is part of the Danube-Dráva National Park **the balance of ground water has been recovered**. Life has been revived, aigrettes, red herons, goshawks and buzzards are nestling again. Big games (stag, deer, wild pig) also found an appropriate place for living.

The nuclear plant played significant role in establishing **the recreational fishing paradise,** built as an example to follow, which is located next to the fence of the nuclear power plant. The plant provides continuous water supply to adjacent fish ponds too. Recreational fishing is available on an area of water surface reaching almost 55 hectares. The pond Kondor, with water depth of 7 m at some places, with its old trees, bush and reeds along the its bank, provides an ideal living place for habitats both in the water and on the banks. The environment of these ponds is strictly protected.

Spreading of ragweed causes serious health problems in the vicinity of the city of Paks. The nuclear power plant has established **the foundation "Together against the ragweed"** in the middle of the 90s, which introduced a new method for eliminating this weed. They manage their own program as a national example, which progresses with spreading rational information and with actions of thousands of people, which the cooperation of the local population.

5. ESTIMATION OF CHANGES IN ENVIRONMENTAL CONDITIONS AS THE RESULT OF OPERATING TIME EXTENSION

The lifetime of the nuclear power plant, as it has been already presented, **can be extended by applying appropriate aging-management processes. The majority of activities needed for this became necessary anyway, because of the planned extension of 30 year design lifetime.** The required interventions, with very few exceptions, can be executed as part of maintenance and reconstruction activities already on schedule. Consequently, neither during preparation of the operating time extension, nor during operation of the plant having an extended operating time, no additional environmental impacts and impact processes should be considered, moreover, the magnitude of expected impacts will be the same as at present. Therefore, **considerable changes in environmental conditions in the impact area will not be considered neither before, nor after 2012,** unless sources outside the power plant appear in the region.

Activities needed for ensuring the design life-time of 30 years are not included in this study. However, they shall be considered as an initial state. The aging process and interventions preventing or terminating it, previously executed or to be executed, will lay the foundation of the operation and, consequently its environmental consequences.

5.1. Radiology effects

According to experience gained during maintenance activities and renewal processes, with respect to preparation of the operating time extension:

- an increase in the quantity of **airborne releases** must not be considered. (However, it shall be taken into account that general overhauls are responsible for 40-60% of annual releases, and it is expected that this situation will be typical during the extended operating time too.)
- an increase must not be considered neither in case of **discharges into water**, since waste-waters generated within the controlled area are received by the collecting and treating system of the nuclear power plant. (Maintenance periods result in higher releases in this case too, representing 30-55% of the annual releases).
- during regular operation, the quantity of **solid radioactive waste** reaches 100-120 m^3/annum from the four Units up to now. This waste is processed with compressing it into drums. In recent years a slight increase in the quantity of solid wastes was detected. Both in the period up to the operating time extension and in the period after that, we will calculate with a quantity of this magnitude. (However, it is expected that the quantity of solid wastes will increase to a higher extent during elimination the consequences of the incident occurred in relation to fuel rods cleaning in Unit 2, but this operation forms part of a separate licensing procedure.)
- with respect to annual generation of the **liquid radioactive waste**, no significant change is expected. (Also in this case, elimination the consequences of the incident occurred in relation to fuel rods cleaning in Unit 2 means an exception, this will cause more significant extra waste generation.)
- it is expected that the operating time extension will not cause any surplus to **soil- and ground water load** (since this was a result of technological failures which have been already eliminated), and with respect to **exposure of habitats and the population living in the vicinity.** Test results obtained so far have confirmed this fact.
- aging processes of technological equipment of the nuclear power plant, due to the radioactive radiation accumulating in and on them, may cause surplus exposure at the operators, however it can be managed by inspection, reinforcement of defences or decontamination. This will not cause a change in exposure of the population, since the impact of this accumulated radioactive radiation remains within the site.

Due to sustained research works completed to find the site of the planned final disposal site of radioactive waste, the interim storage located inside the nuclear power plant had to be expanded. This project has been already commenced by the Plant. The expanded storage capacity, after commissioning the technology serving for processing wastes with a volume reducing method, is expected to be sufficient also for the extended operating time. Storage capacities for solid wastes are also limited, they are currently sufficient for approx. 6-8 years within the nuclear power plant. In order to solve this problem, the Plant plans the construction of an interim storage building within the site for storing solid waste compressed or packed into drums. (Licensing of this project will be the subject of a separate procedure.) The necessity of expanding the interim storage (which might become necessary before the operating time extension) depends also on the construction of the final disposal facility, which problem belongs to the competence of the Radioactive Waste Management Public Company (PURAM). With respect to its radioactive waste management practice, the nuclear power plant intends to continue the exemption process after qualification. According to this practice, industrial waste generated by this process will be stored at appropriate external disposal sites.

In summary, we can establish that no considerable surplus load - in comparison to current conditions - will be considered with respect to radiological environmental impacts of the planned operating time extension.

5.2. Expected changes in conventional environment conditions

5.2.1. Preparation of extension of operating time

Activities, interventions and aging-management tasks required up to 2012 expected to generate impacts similar to impacts caused by other, similar maintenance and reconstruction activities.

The following impacts may occur:

- air pollution (for example, due to renewal and additional transportation),
- impacts on surface waters (for example, surplus water outlet, water pollution),
- loading and stress on geological and hydrogeological formations,
- generation and management of waste (this is expected to be one of the most substantial environmental processes in this phase),
- noise- and vibration load,
- indirect impacts on habitats, on people and on the environment of populated areas.

Out of the above, conventional air pollution, noise load and waste-generation are expected the most. The latter is expected to be the dominant one, because the extent of the site and distance from populated areas guarantee that substantial air pollution or noise load will not reach the final objects of these impacts.

In connection with reconstruction of buildings, an impact process unusual at conventional construction works (outside traditional environmental protection areas) may occur, the appearance of radioactive waste. Some these wastes is expected to be decontaminated and as the result, will be treated or possible recycled as regular industrial waste. The same applies to technological equipment. During replacement of these equipment very little conventional environmental impacts will be expected, although the quantity of radioactive waste may increase, but the basis of facts mentioned above, no additional waste will be generated. In summary, for the period between 2004-2012 the following statements can be made on each environmental element:

- **With respect to the air quality, significant change is not expected** neither due to interventions planned in the nuclear power plant, nor due to effects independent of the nuclear power plant. Works affecting air quality within the scope of maintenance and renewal will be performed in approximately equal periods and in accordance with the renewal practice applied so far. Additional transportation might occur in shorter cycles, but these operations will not affect the state of air contamination beyond the immediate vicinity of roads.
- We expect that preparation works will cause neither additional water discharge, nor additional water pollution. Consequently, excluding possible emergency situations, during the next years **no significant quantitative and/or qualitative change in surface waters or in groundwater are expected.**

- Load on the geological formations may change only in two cases. One of them is soil stabilization which will be needed in some cases, however in this case the environmental consequence is not primarily a qualitative change in these formations, but conservation of the state of an artificial element. The other case is the emergency, when either conventional or radioactive pollution contaminates the soil. Planned tasks will not increase the risk of this kind, therefore **change of current impacts on any of the geological formations is not expected** in the period of operating time extension.
- In this phase the most important environmental effect process is waste generation and management. This type of impact occurs at almost any type of intervention. Although we do not calculate with significant change in the quantity of waste other than planned ones, it must be noted that **reconstruction and renewal activities involve the generation of more waste compared to the current situation. Waste must be disposed by methods relevant to their specifications.** The nuclear power plant is prepared for this activity with respect to all types of waste.
- **Since planned renewals, maintenance activities and reconstruction** include operations with no noise or very little noise, **no change in environmental noise load is expected.**
- It is clear that with respect to the conventional environmental impacts, no significant change in the components of the environmental are considered anywhere. This also means that the impacts of these interventions do not extend to habitats, to the ecosystem, to the population, to the environment of populated areas and to the land. Consequently, **in case of environmental systems**, compared to the current situation, **no consequences of** the nuclear power plant operating time extension **must be considered.**

Apart from final disposal of radioactive waste, no significant impact is expected in this period.

5.2.2. Operation of the nuclear power plant with extended lifetime

The expected impacts and change in environmental conditions with respect to each component of the environment are described in the following:

- **Radiological effects**

  Radioactive releases practically will not change during the period of current operation, in the period leading to operating time extension and during the period of extended operation of the nuclear power plant. This means that, compared to the current situation, the quantity and quality of airborne and liquid radioactive releases will not change considerably. Operation of the past 20 years of the nuclear power plant did not cause detectable accumulation of radioactivity in components of the environment. The low level of releases and dynamic balance of components of the environment are the probable cause of this fact. On the basis of measurements performed outside the plant, radioactive isotopes of artificial origin can be detected only very rarely in components of the environment which have a strong accumulative impact (for example, sludge or bed sediment in the river Danube and in fish ponds).

  The magnitude of the annual volume of radioactive waste does not change. Of course, the total volume of waste will increase until the end of the period of 50 years compared to the operation of 30 years.

  Releases having an impact on the final object of exposure do not increase, consequently it is expected that in the future they will remain under the official limits too, therefore a change compared to the current situation is not expected.

- **Air quality**
The current good air quality is expected to remain unchanged on the long run, unless other air pollution sources appear in the environment, because releases from the nuclear power plant (diesel motors, paint room) will not fundamentally change. The impact of own releases, as close as the boundary of the site, are considerably lower than relevant air pollution limits. Releases by transport in the vicinity of the nuclear power plant might increase due to natural increase in traffic. Transport activities of the nuclear power plant will not change, because no changes are expected either in number of the staff, nor in the volume of transport. Since, according to calculations, a concentration exceeding the relevant limit does not exist even at the roadside, additional loads of possible extra transport would be detectable only in the immediate vicinity of the road, the most.

- **Impacts on the climate**
Parameters of the mess-climate will not change compared to the current parameters, because no change is expected either in the thermal load, or in the volume of built-in areas in comparison to the current situation.

- **Surface- and subsurface waters: impacts of water inlets**
The quantity of **water inlets**, as well as their methods and environmental consequences will not considerably change compared to the current situation. Current water consumption is under the official limit, so reserve capacity is available. The surface water inlet is necessarily affected by continuous (natural and artificial origin) change of the bed of river Danube. As far as industrial water supply is concerned, cyclical lifting and lowering the riverbed, as well as building-up and wearing of fords must be considered. Degeneration and filling up the cold water channel must be prevented by continuous maintenance, and in this case neither operating disturbances, nor load on the environment is expected.

- **Quality of surface waters: consequences of discharging used waters into the Danube**
The cooling water warmed up by the nuclear power plant and its waste-water, according to results of the year-long water chemistry and hydro-biological investigations, does not considerably change the river's water quality. With respect to composition of habitats in the water, changes can be experienced only along a short section of the river, mostly in the immediate vicinity of the warm water channel. After extending the nuclear power plant's operating time, the quantity of used cooling water will not change (not increase), therefore **such water quality changes caused directly by discharging used water from the nuclear power plant into the Danube are not expected, even after 2013.**

  In theory accumulation of pollutants in sediment may occur as the result of extended operating time of the plant. According to measurements performed up to now, pollution of the sediment was only slightly above the average level of the river Danube, possible caused by conventional pollution of the nuclear power plant. It is expected that the extent of accumulation of pollution in the sediment will not have detrimental impacts on habitats in the river.

  In summary, **with respect to water quality and water output of the Danube, as well as to its water temperature specifications, the planned operating time extension can be implemented without violating limits serving the protection of water quality and in compliance with nature protection guidelines.** Loading on water aquifers in the vicinity of the river Danube (more detailed survey is currently in progress within the framework of the program describing the site) must not change compared to the current situation.

Taking into account statements and conditions concerning water quality and thermal load, which do not forecast significant changes compared to the current situation, we can say **that no change in conditions of water habitats or in the structure of these populations is expected as the impact of the nuclear power plant.** Current level of diversification of fish species and high fish density will remain unchanged

- **Geological and hydro-geological formations**
  Load on these formations is caused, one hand, by the facilities themselves, on the other hand by pollution generated by activities in the process, which are, in principle, always caused by a breakdown.

  New facility and expansion or significant modification of an existing facility is not expected to have any significant additional geological impact, neither during the process of extending the operating time nor during operation of the Plant having an extended operating time. This means that t**he stress on geological formations will not change during the next cycle of 20 years.**

  Processes involving soil pollution have been occurred during the operation of the nuclear power plant up to now, and, of course, it is impossible to eliminated them fully even in the future. However, we can establish the fact that past increases in pollution were usually caused by breakdowns in the plant. The nuclear power plant, after harmonizing their actions with the environmental protection authority, compensated for environmental damages which caused environmental risk and eliminated the source of pollution. On the basis of the risk assessment, in cases not requiting damage prevention, the source of pollution was eliminated and the pollution was monitored on an ongoing basis. Experience gained from these occasions have been, and will be taken into account in reconstruction and modernization programs. At the same time, as the result of the above, inspecting-monitoring network of the Plant has been expanded. Taking into account facts mentioned above, thanks to the status monitoring program, to scheduled and completed reconstruction and to the operation of the environment-monitoring system, increase in the number and severity of this type failures is not expected, even in the future.

- **Opportunity in preserving values in living habitats**
  The nuclear power plant, as far as living habitats are concerned, carries on operation with no change in its size and specifications, therefore the operating time extension **will not have additional impact on the surrounding flora and fauna.** In any case, the majority of this area is considered as disturbed/strongly disturbed habitat, where living creatures became adapted to this disturbance.

- **Generation and management of conventional waste**
  During the extended operating time of the nuclear power plant, various kinds of waste will be generated in the same magnitude as generated before. The collecting system and the on-site storage places of waste have been established and they remain, without significant change, suitable for waste management corresponding to the legal requirements. Disposal of waste is completed, or ordered to complete, by the nuclear power plant in accordance with requirements listed in relevant legislation. For example, it must be emphasized that more than 90% of the non-hazardous industrial waste is recycled.

On the basis of economic efficiency and environmental protection aspects, reducing the quantity of waste, increasing the ratio of recycling and improving selective waste collection will be the purpose during the extended operating time of the nuclear power plant.

In summary, waste generation is almost the only single effective factor which generates **accumulating quantities of waste** during the period of extended operating time. Needless to say, during 50 years of operation considerably more waste will be generated than during 30 years of operation, even when the nuclear power plant is capable for reducing the total volume of release per year. This means that more attention must be paid to waste disposal and considerable more foresight will be necessary.

In order to ensure proper operation of equipment in the waste-water treatment plant, regular maintenance and replacement schedule will be necessary. Reconstruction (replacement) of the aerator will be due within five years. If further restrictions on release limits are expected, the technology of the waste-water treatment plant must be upgraded because at present it is not suitable for removing nitrogen and phosphorus. Perhaps the construction of a brand new waste-water treatment plant with more advanced technology will be necessary.

- **Noise and vibration load**
  Changes planned at the area of the nuclear power plant are not expected to alter the current situation of noise load, because renewal and replacement of facilities and technical equipment of the nuclear power plant is, and will be, performed gradually until and after the operating time extension. Construction of new facilities is not necessary for the extension, demolition and construction of buildings is not planned, only their regular maintenance will be considered. Construction works with higher volume than usual are not expected even inside existing buildings. Most of scheduled renewals and modernization will be completed inside existing buildings, therefore noisy operations will not - or only to very little extent - be expected, therefore significant increase in noise load, or **change in the present noise situation, will not be expected.**

- **Impacts of the operating time extension on people living at Paks and in surrounding settlements**
  Operating time extension means that the future condition of environment will remain essentially the same as at present, only current trends of changes will continue. However, the final shut-down might result in a reasonably uncertain impact, particularly if this change appears as a turning point in the development of the city. In medium term there are very few opportunities available to avoid this problem. A significant economical set-back in the town's life causes direct environmental problem only when terminated economic factors would not represent additional environmental load on the settlement, because mostly they financed the operation of the settlement. This is true in this case.

  Without the operating time extension, the decommissioning phase of Units in the nuclear power plant would commence from 2013. This process would cause gradual disappearance of revenues generated by the plant as well as taxes paid from these revenues. Although decommissioning would provide employment for half or two-third of the employees in medium term, negative social effects on the town of Paks would not be eliminated, only mitigated.

On first approach, as far as local population is concerned, we can say that the final shut-down of the nuclear power plant might represent an easement for those people who feared for a more severe accident (which would cause, beyond incidents, severe release). The **final shut-down certainly will not decrease, but increase stress-type problems of people living at Paks and in surrounding settlements,** which will be caused, most of all, by loosing their base of existence. **Consequently, the announcement of extending the plant's operating time would be considered by majority of the people living here as not bad, but good news.**

If the current situation with respect to the connection between the area of the settlement and the nuclear power plant is acceptable, then it will remain also true for the period of extended operating time, unless impact factors remain essentially unchanged. This will depend on continuous maintenance and modernization which are capable for keeping up with the aging process. **The longer operation might provide sufficient time for correct preparation of the settlements for the final shut-down.** More settled economic conditions expected in the near future will be more suitable for this achievement than the current one.

Environmental-health investigations showed that, from the point of view of the health, it is better to live in this settlement than in other, similar ones. (Of course, age-group differences, that is relatively youngish nature of the town, have been taken into account in this statement). The infrastructure of the town is in a better state than infrastructures of similar Hungarian towns. These parameters will be further improved in the future, because the nuclear power plant is interested in maintaining the quality of environment in adjacent settlements. **Implementing activities planned in the next 20 years will certainly improve livelihood opportunities in this town compared to the similar size towns in Hungary.** This presents significant advantage for people living here.

- **Land- and area utilization**
  As far as land- and area utilization are concerned, operating time extension of the Paks Nuclear Power Plant will not bring any change, but in adjacent areas slight alteration in land utilization is expected. On the basis of the town planning of Paks, these structural changes will be focused to the area between the town and the nuclear power plant. As the entire environmental system is concerned, considerable change is expected only after the commencement of decommissioning.

In summary, **no significant, dominant changes are expected in release, neither in its volume, nor in intensity or load type during the extended operating time of the nuclear power plant.**

5.3. Impacts of incidents

As far as the opinion of the general public is concerned, biggest attention is paid to the environmental consequences of incidents, accidents. In general, these consequences might generate fear against nuclear power plants. Assessment of environmental impacts of incidents is a very complex task, which heavily depends on propagation conditions of releases in the environmental. The nuclear power plant is responsible for this task by performing calculations and estimates. In its Final Safety Review Report the Paks Nuclear Power Plant assessed releases expected during incidents caused by the design, their probability, including estimated dosages expected in technological buildings and in the environment.

The common feature of incident is that some radioactivity from the primary circuit escapes into other rooms of the main building, and later into the atmosphere. Concentrations of ^{131}I (iodine isotope) and of ^{137}Cs (caesium isotope), as well as of inhalation doses occurring in the vicinity of the Plant during incidents have been determined by calculations in the Final Safety Review Report. Applying conservative methods and initial data, **in case of incidents caused by design problems of the original plan, only neutral impacts which do not have any influence on health, must be considered outside the safety zone.** In case of the most severe incident taken into account, under normal meteorological conditions - which are unfavourable as far as propagation of releases is concerned - no additional load is expected and within the distance of 10-11 km environmental impacts remain within acceptable level (in extremely unfavourable dilution conditions this distance could increase to app. 28 km). During the 20 years of extended operating time (with preserving and improving appropriate maintenance and safety practice), no change in frequency and order of magnitude of incidents is expected.

5.4. Decommissioning

Reveal of environmental consequences of decommissioning is included among required specifications of the impact assessments. However, in this case a special approach is needed, since on the basis of the relevant decree No. 20/2001 on environmental impact assessments, decommissioning of the nuclear power plant requires an independent, separate environmental impact assessment. Consequently, only main considerations have been revealed in the current impact assessment.

Decommissioning of the plant could be completed according to various scenarios, including immediate and postponed decommissioning of facilities. These scenarios differ from each other in their duration, schedule and required cost. Of course, today it is impossible to decide which scenario will be implemented 10-30 years later, because related political considerations and decommissioning technologies might change significantly.

The decommissioning conception currently available ("Preliminary decommissioning plan for the Paks Nuclear Power Plant", DECOM Slovakia Ltd., 2002) was ordered by the Radioactive Waste Management Public Company (PURAM) in 2002. In this study they analyzed 3 scenarios:

1. Immediate decommissioning (a period of 28 years),
2. Postponed decommissioning, under protected conservation of the reactor (a period of 73 or 92 years),
3. Postponed decommissioning, under protected conservation of the area of the entire primary circuit (a period of 92 years).

Of course, extending the operating time will not avoid decommissioning, only its date will be postponed with 20 years.

With respect to the decommissioning, the purpose is to perform a "full" decommissioning and to "clean" the site to such extent when further utilization is possible without special restrictions. As far as using the site to another or similar purpose, local, closer and wider regional conditions must be separately considered.

Since decommissioning, demolition can be practically considered as a reversed construction work, the nature of impact factors and impact processes is more or less identical to typical parameters of a construction activity (For example, high degree of dust load, air pollution originating from the transportation, as well as increase in the noise- and vibration level).

Essential difference stems from significantly higher quantity of waste and from tasks related to disposal of contaminated waste. The majority of radioactive wastes originating from the decommissioning process expected to be processed after decontamination, and in its final form it can be stored in the planned waste storage facility. Technological processes and facilities used during regular operation of the Paks Nuclear Power Plant will be utilized to a maximum degree in the management and conditioning of waste mentioned above.

5.5. The question of impacts propagating beyond state borders

According to the decree on environmental impact assessments, the study must indicated whether foreseeable environmental effects would spread beyond state borders. With respect to the operating time extension activity of the nuclear power plant, the possibility of propagation beyond state borders can be judged on the basis of the nature of the site and the activity, of the expectable impact factors, of propagation conditions of the impact, as well as of significance of the impacts. On the basis of these parameters, spreading beyond state borders can be assumed at the following impact processes:

- **Radioactive releases into the atmosphere**
  Under normal operating conditions of the nuclear power plant, radioactive inert-gas activity of a couple of times 10^{11} Bq/day and ^{3}H (tritium) of app. $5x10^{11}$ Bq/day are released into the atmosphere. This, according to the most conservative assumptions, is diluted to its millionth, consequently expected concentrations will remain under the value of 1 Bq/m^3. This activity can be detected by currently used instruments, although the health-physics effects for the people and the living world are reduced below evaluation and detection levels as close as 10-12 km from the nuclear power plant. In summary, they have neutral impact on the environment. The information mentioned above covers tritium and inert gas releases. Releases of longer half-time isotopes, which accumulate more readily in the environment, can be described by a value of 10^4 – 10^7 Bq/day. The concentration of these releases at state borders assumed to be in the range of one-tenth mBq/m^3, which is practically under the detectable limit.

  Propagation of releases calculated during design (hypothetical) incidents results in radioactive inert gas concentrations detectable at the state border in the range of 10^4 – 10^5 Bq/m^3, but their health-physics impacts are reduced to the background level before reaching state borders. On the basis of facts mentioned above, **the radioactive airborne releases can not be qualified as significant beyond state borders**.

- **Radioactive releases into the surface waters**
  During the normal operation fission and corrosion by-products of less than 1.5 GBq/year reach surface waters. Calculating with the minimum water output of the river Danube, this release results in an activity concentration of 50-60 mBq/m^3, which can not be detected by direct instrumental measurements, its detection might be possible only with radio-analytical methods. Accumulation of components having a longer lifetime on suspended or riverbed sediments is a well-known phenomenon, but this contamination moves

together with the sediment and its impact on the people and on the living world is minimal even in the vicinity of the nuclear power plant.

App. 20 TBq of ^3H (tritium) is released from the nuclear power plant each year, final receiver is the river Danube. Under low-water conditions, this release can be detected at the border region (app. 300-600 Bq/m^3), but with no health-physics impact.

As an impact of releases into water in relation to elimination of consequences of the incident related to the rapture of the large-diameter cold leg pipe, fission and corrosion by-product radioactivity concentration of 170-200 mBq/m^3 is expected at the border region of the river Danube under low-water conditions, which by its magnitude is very close to release detected under normal conditions. On the basis of facts mentioned above, **there is no significant radiological impact on water-environment spreading beyond state borders.**

- **Heat load on the river Danube**
  Previous estimates related to the thermal load assumed that the heat tailing may have a detectable impact on water temperature even 10-80 km from the outlet. On the basis of this it could be assumed that the impact of the heat tailing is detectable at the border, which is located at 94 km downstream from the nuclear power plant. On the basis of thermal aerial photos and on-site temperature measurements performed in the recent years, the impact of the warm water tailing can be detected at app. 30 km downstream from the outlet, but only to a minimum degree. Consequently, it is expected that this effect will decrease below the detectable limit after inlet of the river Sió (taking into account its thermal, flowing/diluting effects). Therefore, **no significant impact spreading beyond state borders caused by thermal load will be expected.**

- **Release of conventional pollutants**
  Conventional pollutants may enter into the Danube on the one hand during normal operation, on the other hand in case of an incident. Assessment of water quality measurements performed through a long period of time indicate that no measurable change in water quality (apart from the thermal load) - measured in each components of water quality - occurs due to the nuclear power plant. **With regard to conventional water pollution and conventional airborne pollution, no significant impact spreading beyond state borders will be expected, even in case of an emergency.**

  The above statement is confirmed by the fact that our southern neighbour has not reported any problem to Hungary with regard to the water loads occurring under regular operating conditions. On the basis of this we can conclude that **the unchanging environmental conditions can not be regarded as a significant environmental impact**, even in the case when not every instrumentally detectable change are included in the category of environmental impacts.

6. INFORMATION AND INSPECTION OPPORTUNITIES AVAILABLE TO THE GENERAL PUBLIC IN THE REGION

In order to provide a meaningful dialog between the nuclear power plant and the general public living in the vicinity, a civil organization had to be registered legal entity, with an independent program, operating within its own budget and agenda, which is capable for representing actual demands and interests of the people in the region. Consequently, the Social Inspection and Informational Association (TEIT), consisting of representatives of local administrations of 13 settlements, has been established in 1992.

Local administrations of 7 settlements from county Bács-Kiskun and of 6 settlements from county Tolna reregistered their intention of cooperation in the foundation charter of the organization. The city of Paks joined to the organization at a later date. Total population within the radius of 12 km around the nuclear power plant is more than 60.000.

The TEIT works in accordance with an detailed agenda, with headquarters located in the Local Administration Building of the city of Kalocsa. They hold regular meetings in every two months, but extraordinary meetings are held if necessary. A representative of the nuclear power plant is regularly present at each meeting and he/she participates in these sessions with a consultation right. Also, the General Manager of the Incorporation regularly meets with mayors of TEIT. The president of the Association prepares an annual report, which is sent to the nuclear power plant.

As indicated by name of the Association, its work can be described by two main subjects. On the one hand it performs inspection duties, on the other hand closely cooperated with the nuclear power plant in the area of information exchange. Its aim is not to confront with the nuclear power plant, but to protect interests of the population, to maintain a sincere communication and cooperation, as well as to build confidence on both sides. As a result of their successful activity, which is exemplary also at international level, an exemplary environmental protection award was granted to the Association for its activity performed in order to eliminate mental, psychological environment pollution. TEIT issues regular publications and has established a social committee in order to perform inspections. The committee is allowed to enter into objects designated by them, to access related documents, as well as to perform local social inspection in case of new establishments, operations or programs which are especially important for the population. In harmony with the operating time extension process, TEIT operates a control committee since January of 2004, which was formed by citizens of surrounding settlements.

Within the framework of the openness policy, the Paks Nuclear Power Plant operates a Visitor's Centre next to the Plant. Anybody is entitled to enter into this facility without prior notice, and may get answers to his/her all questions. The almost 1000 m^2 exhibition with furniture of European level and with Hungarian mentality, is not praising nuclear energy, but places it in the world of everyday. Anybody who visits this exhibition may participate in an effortless and intelligible informative tour. Active mock-ups and computerized presentations help in passing information. The "nuclear playing house" welcomes app. 30.000 visitors in each year, visitors may to take a guided tour in the nuclear power plant with the help of qualified lecturers, during which they reach the reactor hall. The Visitor's Centre provides one of the most important meeting places between the general public and the nuclear power plant, since this makes an opportunity for daily, personal visit for all Hungarian citizens, among them for people living in the vicinity of the plant.
The Paks Nuclear Power Plant is very keen on disseminate information to the widest possible range of people in the form of simple news, an interview or a background talk. The nuclear power plant has a close connection with representatives of local and regional press, and passes them informational material on a regular or casual basis. Radio Fortuna of Paks, the city television of TelePaks, the weekly magazine of Paksi Hírlap, the daily paper of Tolnai Népújság, the Radio Korona of Kalocsa, the television station of the city of Kalocsa, the

weekly magazine of Kalocsai Néplap and the daily paper of Petőfi Népe are helping partners of the Paks Nuclear Power Plant and with help of them significant part of the population living in the region could be reached.

The nuclear power plant publishes their own in-house newspaper, a monthly magazine named ATOMERŐMŰ (NUCLEAR POWER PLANT). This paper gives precise information about all events in the nuclear power plant, its plans and development efforts, as well as about links with people living in the neighbourhood. In addition to this, events at exemplary settlements are reported. This paper reaches every mailbox in settlements within the circle of 12 km (TEIT), consequently it is one of the most important, direct carriers of news and information published by the nuclear power plant. The newspaper regularly deals with the issue of operating time extension of the Units at Paks.

Representatives of the nuclear power plant regularly visit mayors of the settlements located in the vicinity of the Plant, and, on request, they give information at meetings of representatives' bodies, at settlement forums and at public hearings. From time to time, possibly together with TEIT or individually, they also present written prospectuses to the general public and local administrations.

The history of nuclear research, the operation of the nuclear power plant, its environmental impacts and latest news are available on the website of the nuclear power plant (www.atomeromu.hu). Also, major nuclear websites of the world (NRC, IAEA) report about the plans for the operating time extension of Paks.

Communication opportunities going back to many decades between the Paks Nuclear Power Plant and the general public of the region are well and alive, which also cover inspections at the level of local administration. The wide range of opportunities to acquire information and to express an opinion establish confidence, provide calm cooperation and create consensus.

7. ENVIRONMENTAL QUESTIONS TO BE INVESTIGATED IN DETAIL IN THE FUTURE

In case of the current activities uncertainties are much less than in case of new activities. Uncertainties generally originate from uncertainties of pre-estimations (for example, from possible deviations in the plans and construction, from incorrect knowledge of background loads), as well as from the fact that the current state is generally not documented by measurements. After the operating time extension, the nuclear power plant will practically operate with current technical specifications solutions. In addition, the current state, mainly from radiological aspect, is well documented by various kinds of measurements. As the result, expected changes in the state of environment will be forecast much more precisely than in generally.

During the preparation of the preliminary study open questions always remain, when answering is not possible in the current phase due to absence of more detailed assessments or which are currently can be estimated only with some uncertainty. Even so, **the preliminary environmental study is successful, since none of the effective factors and effect processes assessed so far show environmental load which would exclude the planned operating time extension of the Plant at the present location.**

Of course, **these open questions** must be considered when detailed study will be prepared. These are as follows:

- Geological and hydro-geological picture of site must be upgraded on the basis of investigations performed in the preliminary study, with using of models.
- Tasks of the site-description program must be completed. As far as conventional components of the environment are concerned, surveying of local climatic changes and revealing the impacts of the nuclear power plant on subsurface aquifers must be included. With regard to radiology, evaluation of tests performed on radiation load of habitats caused by regular and incidental operation of the plant and tritium load on surface waters must also be completed.
- In order to supplement this program, it may be recommended to establish a hydro-geological model, which is to present supply conditions of bank-filtered aquifers of the river Danube at different water levels.
- In order to make a survey of dilution of the thermal load under extreme conditions, thermal aerial photos should be necessary, to be taken at low water level.
- All uncompleted public health examinations, extending over the county of Bács-Kiskun, must be completed, which is one of the necessary components of the detailed environmental impact study.
- Effects of non-nuclear incidents qualified as the most dangerous from the point of view of air protection, shall be assessed with performing propagation calculations.

8. CONSEQUENCES OF FAILING TO IMPLEMENT THE OPERATING TIME EXTENSION

Under current economical circumstances, failing to implement operating time extension of the nuclear power plant requires substitution of missing electric power at a national level, which would require new nuclear power plant Units, coal- or gas burning power plants with smaller generators or importing power from abroad. This solution could be also implemented, but at significant investment costs. All relevant costs must be built into the price of electric power.

The technology of producing electric power in nuclear power plants is free from the following conventional releases: dust, flying ash, sulphur dioxides and carbon dioxide. Current operation of the Paks Nuclear Power Plant, calculating with an annually average production of 14 000 GWh and with an average (weighted) specific carbon dioxide emission of more advanced domestic power stations (~0,4 kg/kWh), saves airborne release of approximately 10 million tons of carbon dioxide. This is a very significant quantity, since the total release of domestic power stations reaches 12.037 million tons of carbon dioxide in 2001. If we intended to substitute the Paks Nuclear Power Plant with a current power station structure, the emission of sulphur dioxide, carbon monoxide, nitrogen oxides, solid pollutants and carbon dioxide would increase in harmony with the power share of the nuclear power plant, with almost 40% in the electric power industry. With respect to substitution of the missing capacity, due to releases of power stations applied for substitution (which probably relies on fossil fuels), it must be investigated whether it is possible to keep the level of carbon dioxide emission specified in the Kyoto Convention. The Hungarian emission is currently below the value of our quota. If the missing capacity of the nuclear power plant was substituted by gas burning power stations, the value of carbon dioxide emission would increase with almost 6 million tons, and we would reach the limit of the Hungarian quota of 80 million tons. Substitution of the missing capacity by coal burning power station would mean an increment of additional 4 million tons compared to the gas burning power station.

Importing the missing electric power from abroad would be an expensive solution on the long term, because it would enhance import-dependency of the country.

At local level, final shut-down and decommissioning of the nuclear power plant involves a continuous work of minimum 20-30 years at the current site, although termination of electric power generation is accompanied by gradual decrease of employment and reduction in the regional support. Industrial or agricultural utilization of the area currently used by the plant is allowed only after decommissioning. On the contrary, the Paks Nuclear Power Plant is currently, and in the period of the planned operation beyond its original lifetime, the biggest employer in the region of county Tolna. The number of its own employees and employees of the contractors working in the nuclear power plant reaches almost 6.000. In addition, thousands of people are indirectly linked to the operation of the nuclear power plant, primarily in the area of services. Considering conditions in Hungary, the Paks Nuclear Power Plant provides significant support for settlements at both banks of the river Danube in the area of health, education, culture, folklore and sport. Also, civil organizations, various associations and churches are included in the assistance. The Plant gives significant amounts to associations engaged in regional development in the form of paying their share in various tender applications. As the result, the Plant directly contributes to regional development. The planned extension of the Plant's operating time ensures that this contribution will be continued for a few more decades.

Failing to implement operating time extension would mean that we voluntarily and deliberately abandon a beneficial and necessary device, which serves for economical development for this region and the country. This decision would be made in awareness of the fact that the nuclear power plant would be capable for producing cheap and environment-friendly energy for an additional two decades, because, according to tests performed so far, additional and safe operation of main equipment, buildings and built-in facilities could be maintained with appropriate maintenance and reconstruction.