MVM PAKS II. ZRT.

ERECTION OF NEW POWER PLANT UNITS AT THE PAKS SITE

ENVIRONMENTAL IMPACT STUDY

SUBMISSION OF MISSING INFORMATION

based on the order with the reference number of 558-37/2015

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1.1 In addition to the reference level figures specified in the Environmental Impact Study please provide the measurement results of those radioactive isotopes associated with the operation of the nuclear power plant (for instance ^{14}C, ^{54}Mn, ^{58}Co, ^{60}Co, ^{110m}Ag, etc.) (irrespective of their half-life period), which could be detected in the environmental samples during the period under consideration. When necessary, please supplement the tables presenting the reference levels. 9

1.2 Please explain why alpha spectrography assessments by which transuranic elements can be determined are missing from the reference level survey. In the event measurement data concerning this aspect are available, please supplement the tables presenting the reference levels. 9

1.3 Reference level particulars of the groundwater need to be supplemented with radiological measurement data concerning the investment site serving as the place of installation for the new nuclear power plant units. 10

1.4 The part of the Environmental Impact Study concerning proposed release levels should be complemented with a chapter presenting the design criteria related to radioactive discharges and monitoring of the environment, developed in accordance with the provisions laid down in paragraph (1) Article 5 of the Ministerial Decree No 15/2001. (VI. 6.) KöM (hereinafter referred to as: Discharge Decree.) on the radioactive discharges into the air and water and their control. 10

1.5 Please describe the impact of the technologies selected for the purposes of handling and processing radioactive waste generated during the operation of the facility on the radioactive atmospheric releases and water based discharges. 11

1.6 Please furnish quantitative evidence that the proposed facility will have sufficient storage capacity for the purposes of interim storage of solid and liquid radioactive waste generated during operation until final disposal (for instance storage wells, tank fleet, etc.). 11

1.7 Please furnish quantitative substantiate evidence that safe conditions for the application of the interim storage in dry containers selected in Section 19.4.2. and on Figure 19.8.1 -1. of the Environmental Impact Study for the purposes of interim storage of spent nuclear fuel elements can be secured in the area presented in the Environmental Impact Study (the zone between Unit 4 Paks Nuclear Power Plant and Unit 1 Paks II). 13

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LIST OF ABBREVIATIONS

Abbreviation	Full name
ARO	Accident Relief Organisation
BDL	Below Detection Limit
EIS	Paks II Environmental Impact Study
EMR	Emission Monitoring Regulations
EnMR	Environmental Monitoring Regulations
OERMS	Official Environmental Radiation Monitoring System
IERMS	In-House Environmental Radiation Monitoring System
HAEA NSD	Hungarian Atomic Energy Authority Nuclear Safety Directorate
ISSNF	Interim Storage of Spent Nuclear Fuel

1 ENVIRONMENTAL RADIOLOGY

1.1 In addition to the reference level figures specified in the Environmental Impact Study please provide the measurement results of those radioactive isotopes associated with the operation of the nuclear power plant (for instance ^{14}C, ^{54}Mn, ^{58}Co, ^{60}Co, ^{110m}Ag, etc.) (irrespective of their half-life period), which could be detected in the environmental samples during the period under consideration. When necessary, please supplement the tables presenting the reference levels.

When the OERMS database was processed, only data with an error range of less than 20 % were taken into consideration in the first round. At the same time it can be said that there was a substantial body of data where measurements results were found to be below the detection level (BDL). For several samples and radionuclides, respectively, they provided therefore clusters which could not be at all or could only be less precisely evaluated in statistical terms. Averages and standard deviations were derived only in the case when more than ten values were available but the maximum level was provided in the case of only one value and maximum and minimum values in the case of two figures. At the end, reference levels could be provided only in cases where data obtained could be properly evaluated, in other words: figures above BDL and reliable measurement results. There was a group of data for instance (grass, feeding stuff), where 144 measurement data were available with respect to ^{134}Cs, but 143 was BDL and one figure at around BDL, therefore such findings were omitted. The ^{60}Co activity concentration of the sediment in the Danube section upstream Paks seemed to be too high, therefore it was also omitted. At the same token, outliers which could be seen as non-interpretable for professional reasons were also omitted from the OERMS measurement findings.

Radionuclides characterising nuclear power plants occurred only occasionally in the valuable range during the environmental control measurements (IERMS figures) in air, fallout, mud and soil samples, here primarily radionuclides such as ^{54}Mn, ^{60}Co, ^{58}Co, ^{110m}Ag were found. They were situated within the immediate surrounding of the nuclear power plant (at the site, within the safety zone), and were published in the study.

It can be concluded in summary that reference levels can only be derived from reliable and valuable data. Consequently, no reference level can be specified with respect to environmental elements where this condition is not met. Reference levels can not be derived from values BDL.

It should also be noted that it was calculated by modelling that in which extent radionuclides appear in each of the environmental media resulting from current releases and whether or not they can be detected given the sensitivity range of the current instrumentation. The result was similar to the measurement results of the OERMS and IERMS, in other words even model simulation reflected that only those radionuclides can be detected which are in fact measured above the BDL.

1.2 Please explain why alpha spectrography assessments by which transuranic elements can be determined are missing from the reference level survey. In the event measurement data concerning this aspect are available, please supplement the tables presenting the reference levels.

Section 20.2.1.2 of the Paks II Environmental Impact Study (EIS) investigates the radiological conditions of the environmental elements around MVM Paks Nuclear Power Plant Private Company Limited by Shares taking the 2001-2011 databases of OERMS and IERMS as a benchline. These database do not include alpha spectrometry of the soil.

MVM Paks Nuclear Power Plant Private Company Limited by Shares between 2002 and 2004 carried out a measurement programme intended to establish the reference levels (pursuant to the requirements of HAEA NBI), during which it was investigated among others whether or not radioactive contamination can be detected from soil samples taken on the ground (0-3 cm) at various locations of the plant site. The purpose of such tests was to measure soil samples by gamma spectrometry and as a function of such findings the completion of alpha spectrography assessments to determine transuranic elements. Such examinations are still in progress in order to determine the reference level of the MVM PA Zrt. plant site, which data are presented in their radiation protection report. It can be concluded from the tests continued for a period of more than 10 years that occasional emergence of $^{239,240}Pu$ and ^{241}Am in an amount around the detection limit – known as global contaminants – would not unanimously demonstrate that they originated from the power plant. Beside this, the presence of isotopes of transuranic elements can be assumed when certain contaminating decay products emerging in a lot higher concentrations and detectable with the use of more straight-forward methods (for instance gamma-spectrometry) are present in the environmental elements. This precondition does not exist in our case. It follows from all the aforesaid considerations that in lack of fission products alluding to the present of transuranic elements the testing of such isotopes is not really justified from the professional perspective in order to achieve the ambient reference levels.

1.3 Reference level particulars of the groundwater need to be supplemented with radiological measurement data concerning the investment site serving as the place of installation for the new nuclear power plant units.

As it can be clearly seen on Figure No 20.2.1-3 of Chapter 20 Environmental radiology of the Environmental Impact Study, the great part of the current sampling wells are placed in the area and the neighbourhood of the currently operating four units and the ISSNF. Tritium (T) findings from the monthly sampling of one well in the testing area marked T32/A and from another one situated on the island near the sludge area marked Z02/A are available, which typically do not refer to any excess T originating from the power plant. It can be seen from the values that the average levels observed in the groundwater are very similar to the average tritium concentrations occurring naturally in groundwater. In addition to tritium only a small amount of ^{14}C could be detected from the wells, no other radionuclide of artificial origin could be identified.

The flow conditions of the groundwater in the area under investigation and the contamination status thereof, changes in the tritium (T) distribution were all analysed in details by Chapter 13 of the EIS entitled Geological medium and underground water resources at the site and in the immediate surrounding.

Groundwater level of groundwater bodies situated in the vicinity of the Danube – and hence, fluctuations of the water table – are influenced by Danube water stages in addition to infiltration rates. Changing water levels on the Danube result in alternating decrease or increase of the groundwater table, thus changing flow conditions. The average annual fluctuation rate measured in the monitoring wells established on the construction and mobilisation area is somewhat more than four metres. It can be seen from the test model findings that due to the groundwater flow paths no load can get to the area of the proposed units from the environment of the power plant. This statement is substantiated by the fact that no other radioactive isotopes of power plant origin could be identified from the wells with high T concentrations in the current power plant area, thus such an increase can not be expected from the aforementioned wells, T being the most readily migrating isotope which is mobilised practically in conjunction with water.

Groundwater conditions and associated tritium activity concentrations are expected to change due to the excavation of the work pit dug for the purposes of the foundation works during the erection of the now power plant, the high volume of earth works and extraction as well as dewatering of the work pit.

Taking all these factors into account the characterisation of the groundwater conditions in the area is best accomplished once the construction works have been completed and the new groundwater flow routes have been settled. The full radiological background level can be determined once the wells had been established. Conceptual design of the groundwater monitoring system, proposed situation of the groundwater monitoring wells and the range of parameters monitored have been all presented in details in Chapter 13.6.1.1.2. Based on the measurement results and model simulations additional conclusions could be drawn on the radiological status of the project area and on the determination of the reference levels, respectively.

1.4 The part of the Environmental Impact Study concerning proposed release levels should be complemented with a chapter presenting the design criteria related to radioactive discharges and monitoring of the environment, developed in accordance with the provisions laid down in paragraph (1) Article 5 of the Ministerial Decree No 15/2001. (VI. 6.) KöM (hereinafter referred to as: Discharge Decree.) on the radioactive discharges into the air and water and their control.

All and any data supply for design available at the present stage of design are included in the EIS. The detailed data referred to in paragraph (1) Article 5 of the Discharge Decree will be generated during the currently ongoing design operations and will be available at a later stage, thus they may be provided in the course of the establishment licensing procedure constituting a part of the nuclear licensing process.

During the establishment licensing procedure the acting authority is the Hungarian Atomic Energy Authority, but Government Decree No 112/2011. (VII.4) also designates the specialist expert authorities contributing in the official procedure conducted by the Hungarian Atomic Energy Authority. Under Section 1.2 Annex No 1 to the Government Decree the acting specialist expert authority will be the South-Transdanubian Environmental and Nature Conservation Inspectorate in the "specific issue" of *"granting endorsement to and defining the conditions of on the basis of the assessment of discharge of radioactive substances into the water, protection of water and water carrying formations against radioactive and thermal pollution, as well as control and limits release of radioactive contamination of the aquatic environment in accordance with the provisions laid down in the Ministerial Decree on the radioactive discharges into the air and water and their control*.

1.5 Please describe the impact of the technologies selected for the purposes of handling and processing radioactive waste generated during the operation of the facility on the radioactive atmospheric releases and water based discharges.

During the operation of nuclear power plants radioactive air born releases and water based discharges should be reckoned with, which get into the environment in a controlled manner, reduced to the absolute possible minimum level. In the case of the new units to be erected minimum discharge is also ensured by the radioactive management and processing system which represents an integral part of the technology.

Normal plant discharges may only take place under controlled conditions and along the pre-determined discharge routes, including releases from all main and auxiliary systems. In the current phase of the project only the full aggregate impact of the units can be specified on the basis of the data supplied by the designer. The values originating from the treatment of radioactive waste are contained in the data of atmospheric releases and in the data of liquid discharges found in Table 20.6.1-2 of Chapter 20.6.1.1 and in Table 20.6.4-5 of Chapter 20.6.4.1 of the Environmental Impact Study, respectively.

The function of the liquid radioactive waste treatment system is to selectively collect, store, settle and treat waste water contaminated by radioactive substances and contaminated organic solvents and oils generated in the course of the power plant operation, to reduce their volume and to solidify them. Waste water generated during the operation of the system which can not be used any further in the process technology can only be discharged from the power plant systems in accordance with the requirements of the competent authority.

Media in gaseous state generated during waste treatment are forwarded into the ventilation system of the nuclear power plant. Air born effluents purified by special scrubbers are emitted into the atmosphere through the ventilation stacks of the power plant, together with other treated air flows exhausted from other premises and systems. Monitoring of the emitted air is ensured by an isokinetic sampling system and continuous radiation protection control in the ventilation stacks.

1.6 Please furnish quantitative evidence that the proposed facility will have sufficient storage capacity for the purposes of interim storage of solid and liquid radioactive waste generated during operation until final disposal (for instance storage wells, tank fleet, etc.).

The Supplier of the units provided a 10 years interim storage capacity for storing radioactive waste. This value is included in Chapter 19.8.1.3. of the EIS for all forms of waste except high activity waste, because its storage is ensured up to the end of the proposed service period.

Liquid waste

During the operation of the power plant the generation of evaporation residues and ion exchange resin is expected. Their annual volume in standard operating schedule is 25 m^3 and 10 m^3, respectively. The waste management and storage system is designed with a view to them. The system has the appropriate reserve capacities for the case should the process technology fail or processing of liquid waste would be suspended due to maintenance. For the purposes of safe operation two 80 m^3 volume and three 30 m^3 capacity storage tanks are available with respect to evaporation residues and ion exchange resins, respectively. This way a storage capacity of 6 and 9 years operation is ensured, pending on the type of waste. It is important to note that in the case of the new units such types of waste are left in liquid state only for the absolute necessary minimum period of time. Taking into account the international experiences and safety considerations the liquid waste will be converted into solid state in the same pace as it is generated with the help of the cementing technology. Certainly, the cementing system also has a capacity necessary for undisturbed operation, which is suited to process both standard waste and waste generated during operating troubles. Based on the preliminary design the system will be capable of processing 80 m^3 evaporation residues, 25 m^3 ion exchange resin (10 m^3 low activity and 15 m^3 medium activity), 0.1 m^3 filter sludge from the silting filter and 0.5 m^3 sludge from escaped water.

Solid waste

Solid radioactive waste generation rate on an annual base is summarised in the following table:

Waste	Amount of waste [m^3/year]	Amount of waste after treatment [m^3/year]	Number of units to be stored/treated [number]
Low activity solid	70	28	140 barrels
Intermediate activity solid	11	4	20 barrels
High activity solid	0,5	-	5 capsules
Large size, unmanageable	5	-	-
Cemented evaporation residue	25	20	100 barrels
Cemented ion exchange resin	10	8	40 barrels
Cemented sludge	0,6	0,5	3 barrels

Table 1-1: The annual amount of solid radioactive waste

Storage of high activity radioactive waste is solved for the entire lifetime of the power plant. Its volume is approximately ~1 % of all radioactive waste. Such kind of waste is placed in specially screened steel transporting capsules which are then transported to the solid waste storage.)

The amounts provided for the full 60 years lifetime are not proportional to the annual amounts due to unscheduled maintenance works, exchanges and refurbishments):

Type of waste	Amount of waste [m^3/60 years]	Amount of waste after treatment [m^3/60 years]	Number of units to be stored/treated [number]
Low activity	8 400	3 360	16 800 barrels
Intermediate activity	1 320	480	2 400 barrels
High activity	60	-	600 capsules
Large size, unmanageable	600	-	-
Cemented evaporation residue	3 000	2 400	12 000 barrels
Cemented ion exchange resin	1 200	960	4 800 barrels
Cemented sludge	72	60	300 barrels

Table 1-2: Amount of solid radioactive waste throughout the 60 years service period

The storage of the solid and solidified radioactive waste will take place on the lower level of the Fuel storage building in the same way as currently practiced, in carrying frames. Overall dimensions of the carrying frame are 1 320×1 320×1 000 mm, while the overall dimensions of the building are 38 000×21 000×17 900 mm. Assuming that the clear height of the ground floor was 4.8 m and only 50 % of all available space can be used for the purposes of storage (because the efficiency of space filling of the carrying frames is less than 100 % and the process technology in the building also takes up some space), in the part of the building designed for the purposes of storing radioactive waste there would be a possibility to dump approximately ≈4 400 barrels (4 barrels can be placed onto one carrying frame). Under standard operation 303 barrels of solid and solidified barrels and 5 capsules containing high activity waste will have to be taken care of in each year, therefore in this case you can talk about a storage capacity sufficient for as much as 14 years. Due to the conservative approach characterising the nuclear power industry the available capacity is determined as one sufficient for a period of 10 years only, but the calculations above confirm that the appropriate capacity of safety reserve is available also for the purposes of storing solid waste.

Final storage of low and intermediate level solid radioactive waste in Hungary an underground storage site was set up in Hungary in the neighbourhood of Bátaapáti community, which was established with a view to provide a permanent repository to low and intermediate level nuclear power plant solid radioactive waste and is in operation since 2012. The capacity thereof is sufficient to safely deposit waste generated in the nuclear power plant. The waste storage facilities established within the power plant area serve only as a security back-up should be final repository be prevented from operation for some reason.

1.7 Please furnish quantitative substantiate evidence that safe conditions for the application of the interim storage in dry containers selected in Section 19.4.2. and on Figure 19.8.1 -1. of the Environmental Impact Study for the purposes of interim storage of spent nuclear fuel elements can be secured in the area presented in the Environmental Impact Study (the zone between Unit 4 Paks Nuclear Power Plant and Unit 1 Paks II).

The establishment of the container based interim storage site for spent nuclear fuel elements does not constitute a part of this current licensing procedure, a separate Environmental Impact Study will be prepared provided it will be implemented. However, in line with the requirements formulated in the call for submitting missing information the possibility of setting up the storage site within the plant area is described shortly.

Tank type storages are robust containers which might be stationary or mobile in their nature. Currently there are a number of metal or concrete storage container types in use or under development. They may be horizontal or vertical in their design and are fit for the placement of one or more fuel element assemblies (bundles). Removal of remanent heat is usually effectuated by forced air or gas flow. Containers are put on a properly sited concrete pavement with a spacing arrangement determined by the needs of transport and safety engineering. Containers places on open surfaces and covered by concrete from the outside represent a sufficient level of screening, no more additional shielding is necessary.

Assuming a Magnastor type storage system and calculated with containers with 19 bundles capacity and taking into account the expected amount of 3 135 spent fuel element generated throughout the entire service period per unit, this means 330 containers for two blocks distributed across 60 years in the case of the new blocks. Or more precisely, from the date when the assemblies generated at the time of the first fuel shuffling operation are taken out from the holding basin up to the date when the last fuel assemblies put into the holding basin at the end of the service period are removed from the holding basin.

The multiple layer structure of the anticipated storage system with the 4 metres diameter allows to set up various air ducts under the container casing in order to provide natural draught or air cooling while keeping an eye on biological protection. In order to ensure the gravitational air movement providing external cooling the distance between individual containers must be 2 m. Based on this figure in the case of storages arranged in a quadratic matrix an area with a floor space of 6×6 metres is needed. The area requirement of the calculated 330 containers in a 15×22 matrix will be 90×132 m.

For the loading and other logistics operations an additional paved area of maximum 90×48 m is needed, with a 10 m safety zone around them. This way the size of the area necessary for storage will be 110×200 m.

Based on the preliminary calculations the installation of the site for the purposes of container based dry interim storage of spent fuel was assumed to be implemented in the area between Unit 4 Paks Nuclear Power Plant and Unit 1 Paks II in Chapter 19.8.1.4. of the EIS. The size of the proposed area of installation for the storage site presented on Figure 19.8.1 1. of the EIS is 120×300 m, in other words the spatial area designated for interim storage was at least 60 % greater than the size of the area necessary for interim storage of spent fuel element assemblies generated throughout the entire service period of the two units and for handling the containers needed for dry interim storage.

1.8 Please describe in details the expected radiological and environmental polluting impacts of the container based dry interim storage solution selected for the purposes of storing spent fuel assemblies within the site according to the Environmental Impact Study, and present the radiological protection system of the containers storing spent nuclear fuel element assemblies.

One of the best advantages of dry container based storage solution is that a relatively low level of surveillance is sufficient compared to other technical solutions both in terms of physical protection and environmental monitoring. The key characteristic of the technology is the so called zero discharge meaning that any release into the environment may happen only when the spent nuclear fuel elements are placed into the containers or when the storage containers are open.

After spent fuel assemblies are placed from the holding basin under the surface of the water in the basin into the containers, their external surface is being decontaminated, dried and the surface contamination level checked. Following the check of container integrity they are transported from the reactor building into the interim storage site of spent fuel assemblies.

Airtight sealing of the proposed storage system is ensured by the engineering barriers designed to it. Since containers contain only passive components, their integrity from the perspective of environmental radiation protection is ensured.

The interim storage will be situated in the Paks II plant area. Radiological safety of the system is verified by the yard space detectors of the nuclear power plant environmental radiation control system. The additional elements of the environmental radiation control system in Paks II monitor radioactive contaminants potentially emerging in the environmental elements. From the radioecological perspective, not only the nuclear power plant itself but the interim storage of spent fuel assemblies will also be subjected to radiological control.

1.9 Please reconcile Table 8-l indicating air emission standards presented in the Environmental Impact Study prepared in order to provide the foundations for the release limits of atmospheric and liquid radiocarbon discharges and Table 8-2 indicating liquid effluent limits with Tables 20.6.1-2. and 20.6.3-5 indicating design levels with respect to tritium (in terms of physical and chemical forms).

Tritium

Limit values were provided in Table 8-1 indicating atmospheric release limits for both chemical forms of tritium (HT, HTO). In Table 20.6.1-2 of the Environmental Impact Study the proposed release levels of radioactive isotopes were included on the basis of the data supply available, and here the proposed atmospheric release of tritium was specified for the chemical form of water only, therefore design level of tritium was provided in a conservative manner as tritium in the form of 100% water vapour which has the highest dose conversion factor.

Radiocarbon

With respect to radiocarbon the value concerning ^{14}C was omitted from the Table No 8.2 of the Environmental Impact Study prepared for the purposes of laying down the foundation of radioactive release limits due to an editorial error, which was certainly defined and is included in the study itself. The liquid discharge limit for ^{14}C according to Table 7-2 of the same study is as follows: 2.10E+12 Bq/year, thus Table 8-2 correctly looks like this:

Radionuclide	Standard operation (Bq/year)
^{3}H	1.3E+16
^{14}C	2.1E+12
^{51}Cr	8.1E+14
^{54}Mn	5.0E+13
^{58}Co	1.9E+13
^{60}Co	1.9E+12
^{89}Sr	1.6E+13
^{90}Sr	1.1E+12
^{131}I	2.6E+12
^{132}I	6.2E+14
^{133}I	3.5E+13
^{134}I	9.4E+14
^{135}I	2.1E+14
^{134}Cs	3.3E+11
^{137}Cs	4.7E+11

Table 1-3: Limit values of the new units to be established at the Paks site on liquid discharges (Bq/year)

1.10 Please furnish evidence to the effect that the architecture and operation of the discharge and environmental control systems of the facility fully meets the provisions laid down in Article 6 and Annex 4 and Annex 5 of the Discharge Decree. Introduce the monitoring systems designed for the control of atmospheric and liquid radioactive discharges of the facility, the sampling and measurement methods, and make an actual recommendation how to complete the environmental monitoring system in order to increase the number of measurement stations and to expand the sampling and measurement programmes.

The discharge and environmental monitoring system of the new units was set up in accordance with the provisions laid down in Article 6 of the Discharge Decree No 15/2001 just like in the case of the current units. Samples provide by the remote measuring and sampling systems will be processed and measured in accredited discharge and environmental monitoring laboratories according to Article 6 of the Discharge Decree, incorporating them in their sampling and measurement programmes.

DISCHARGE MONITORING SYSTEM

MONITORING SYSTEM FOR ATMOSPHERIC RELEASES

The function of the monitoring system for atmospheric releases is to monitor and sample atmospheric radioactive discharges released through the ventilation stack.

The set-up of the monitoring system for atmospheric releases

The monitoring system is a two tiered system, meaning that it consists of one on-line monitoring remote measurement system and a sampling system which provided samples for the laboratory measurements (off-line data supply). The laboratory measurements provide data for the determination of discharges selective for individual isotopes. The monitoring systems for atmospheric releases contain the following measuring and sampling units, each meeting the criteria defined in Annex No 4 to the Discharge Decree:

Air sampling and flow measuring system

- Isokinetic Sampling System
- Air velocity/ volume rate of flow measuring system

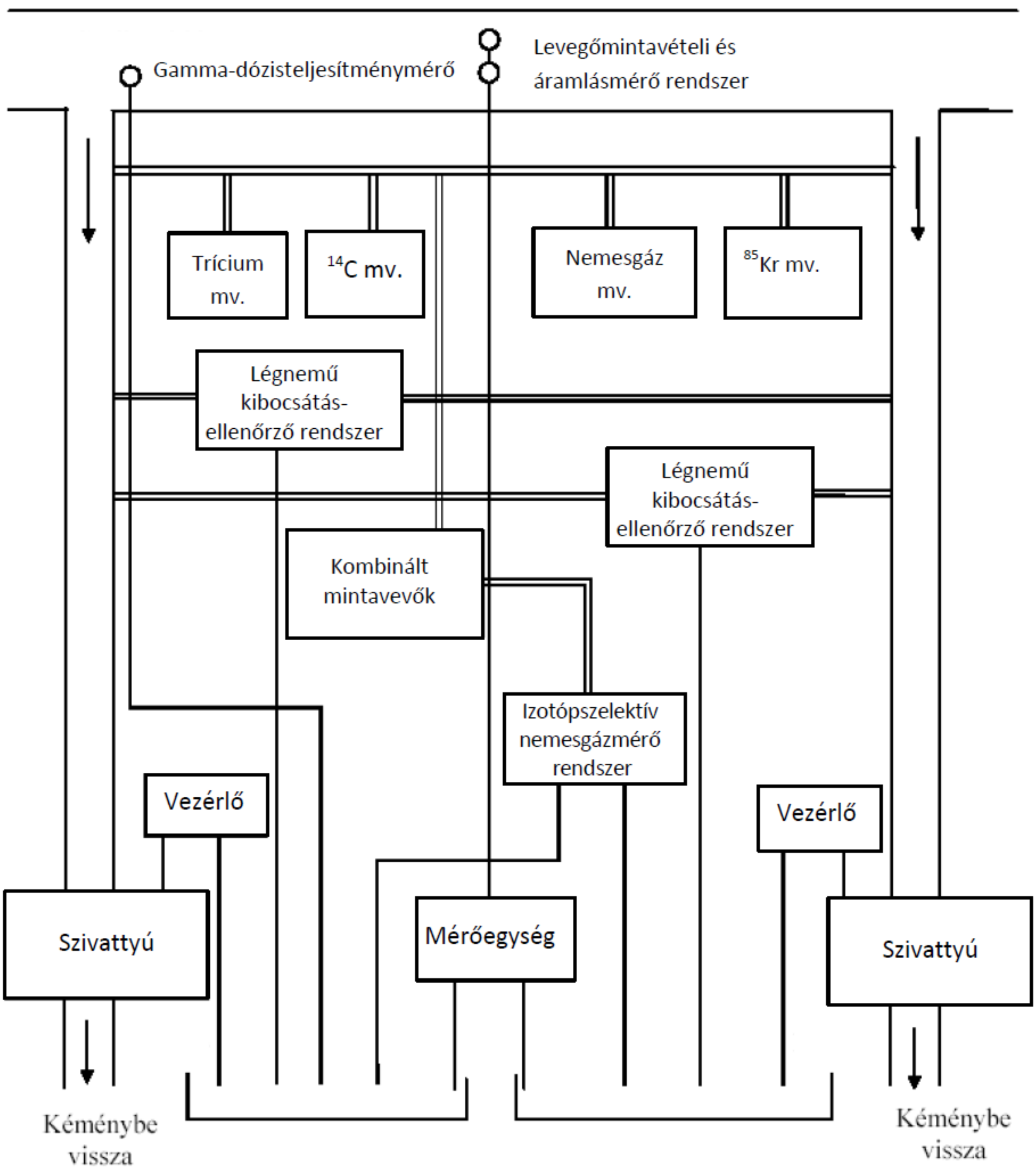
Remote measurement systems

- Atmospheric release monitoring system:
    - Radioactive aerosol measuring device
    - Radioactive iodine measuring device
    - Radioactive noble gases measuring device
    - Gamma dose rate measuring device
- Isotope selective noble gas measuring system (continuous gamma-spectrometer)

Laboratory sampling units monitoring ventilation stack releases:

In order to allow for the completion of independent inspection controls by the inspectorate the laboratory sampling units monitoring ventilation stack releases are doubled with a view to the provisions laid down in Annex No 6 to the Discharge Decree.

- Combined sampling units (aerosol, elemental iodine filters and organic iodine cartridge, in three identically designed parallel branches)
- Laboratory sampling units (tritium , ^{14}C, inert gases, ^{85}Kr)



Gamma dózisteljesítménymérő - Gamma dose rate metering instrument
Levegőmintavételi és áramlásmérő rendszer - Air sampling and flow rate measurement system
Trícium, ^{14}C, nemesgáz, ^{85}Kr mintavétel - Tritium, ^{14}C, Noble gas, ^{85}Kr sampling
Légnemű kibocsátás ellenőrző rendszer - Atmospheric release monitoring system
Kombinált mintavevők - Combined sampling units
Izotópszelektív nemesgázmérő rendszer - Isotope selective noble gas measuring system
Vezérlő - Control unit
Szivattyú - Pump
Mérőegység - Metering unit
Kéménybe vissza - Back to ventilation stack

Figure 1-1: The architecture of the atmospheric release monitoring system and the combined sampling system

THE PURPOSE OF THE ATMOSPHERIC RELEASE MONITORING SYSTEM

Isokinetic Sampling System

The function of the Isokinetic Sampling System is to supply isokinetic and representative samples to the measuring instruments and sampling devices monitoring ventilation stack releases from the air flowing in the main ventilation duct, and communicating current and actual sampling values to the central computer.

Air velocity/volume rate of flow measurement system

The function of the air velocity/volume rate of flow measurement system: long term continuous measurement of the velocity and volume rate of flow of the main air flow passing through the ventilation stack, and communicating current and actual sampling values to the central computer.

Atmospheric release monitoring system

Both systems consist of entirely identical parallel branches independent from each other (redundancy), both supplied with air samples by the isokinetic sampling system. Connecting order of the metering units in the independent branches is as follows:

> *radioactive aerosol measuring devices, radioactive iodine measuring devices, radioactive noble gas measuring devices*

The *aerosol measuring unit* is a filtering band design instrument.

In the standing position the filtering band accumulates air and aerosol as long as the band is forwarded by one step upon reaching a certain activity level or a pressure drop value (or upon re-start). Measurement is made continuously with a pre-defined cycling time and beta, alpha activity values are derived by differential calculation. Displayed values refer to current times.

The *iodine measuring unit* has a filtering cartridge filled with activated carbon; the NaI(Tl) scintillation detector measures gamma-radiation, in the ± 50 keV window set to the 364 keV of the ^{131}I isotope.

In the *noble gas measuring unit* air crosses a metering chamber, where a detector is placed to detect beta radiation.

Isotope selective noble gas measuring system

The Isotope selective noble gas measuring system is a continuously operated gamma-spectrometric measurement system fit for quantitative measurement of noble gas discharges selective for each isotope.

> *Monitored isotopes include: ^{41}Ar, ^{85m}Kr, ^{87}Kr, ^{88}Kr, ^{133}Xe and ^{135}Xe*

The architecture of the laboratory sampling unit system

The laboratory sampling system is suitable for continuous sampling of aerosols, noble gases, radioactive iodides, tritium and radiocarbon according to the various chemical forms. The laboratory sampling system allows both plant and official sampling.

Combined sampling unit

The two main parts of the device is the filter holder unit and the associated pump unit. The drip catcher built into the device ensures that no such air could penetrate into the filters used to bind elemental iodine and organic iodine in which water is present in the liquid phase.

Tritium sampling unit

The sampling unit is an adsorption column filled with two molecular sieves. After screening out aerosols, one of the columns is used to bind HTO, the other to bind HT after catalytic oxidation of the hydrogen gas.

Radiocarbon sampling unit

The sampling unit is a device equipped with two NaOH bubble aeration columns. After screening out aerosols, one of the columns is used to bind carbon dioxide (CO_2), the other for binding carbon dioxide and hydrocarbons (C_nH_m + CO_2) after catalytic oxidation.

Noble gas sampling units

It contains two continuous sampling units one is exchanged on a daily basis to determine the isotope composition of noble gases in the air and the other is replaced in every month to determine ^{85}Kr in the laboratory.

SAMPLING AND MONITORING LIQUID DISCHARGES

Discharge of waters containing radioactive substances is made upon the issue of an internal permit based on laboratory measurement. Liquid discharge is monitored by remote measurement detectors and automatic samplers installed on the various discharge routes.

Remote sensing monitoring system for liquid discharges

The function of the remote sensing monitoring system for liquid discharges:

– Monitoring the discharge routes of waters of primary coolant circuit origin above the balance and of back-up cooling waters.
– Monitoring the discharge routes of untreated faecal containing blackwater and of the waste water treatment plant.

Sampling routine for liquid discharges

Determination of liquid discharges takes place by laboratory measurement of representative and archive samples taken from the tank fleets. Sampling sites typical for discharges are as follows:

- Control tanks (determination of the quality and volume of the water to be discharged);
- Steam generators as control tank (the determination of the amount and quality of water discharged upon the emptying of the steam generator at the shut down and cooled units, and after chemical washing. Emptying of the section on the main steam pipeline and feed water pipeline involved in circulation also takes place through the steam generator.);
- V1 cold water canal, V2/1 and V2/2 old and new hot water canals, ‘faecal canal’ V3 and the ‘faecal canal' belonging to the new unit.
  Installed automatic samplers collect samples on an ongoing basis.

ENVIRONMENTAL MONITORING SYSTEM

Environmental monitoring of the new units can be performed by the system currently in place at the site. Later on (once the detailed technical design plans have been made available) the discharge and environmental monitoring remote measurement and sampling system will be reviewed, and the modifications or extension found justified as a result will be implemented (for “A”, “G”, “V” type stations and groundwater monitoring wells. The environmental monitoring system consists of the following measuring and sampling units the design of which meets the requirements laid down in Annex No 5 to the Discharge Decree.

THE PURPOSE AND FUNCTION OF THE ENVIRONMENTAL RADIATION PROTECTION MONITORING OF THE POWER PLANT

The purpose and function of the in-plant environmental radiation protection monitoring of the nuclear power plant will be as follows:

- to demonstrate by direct measurements that the radioactive isotopes exposure and radiation originating from the power plant in normal operation is lower than the levels established as acceptable,
- to contribute to the exploration of deficiencies in the process technology threatening the environment mainly by measurements carried out within the plant site and after their remediation to verify the elimination of risks to the environment,
- to provide rapid and reliable data on the status of ambient radiation for the purposes of assessing the consequences of a potential operating trouble or to lay the foundations for interventions concerning the surrounding population.

Environmental radiation protection monitoring is provided by a two tiered system: it consists of one on-line monitoring remote measurement system and an off-line system based on sampling. Samples are processed and measured in the laboratory.

INTRODUCTION OF THE IN-PLANT ENVIRONMENTAL RADIATION PROTECTION MONITORING SYSTEM

Remote measurement systems of environmental monitoring

The parts of the installed discharge and environmental radiation protection monitoring system include the following:

- dose rate measuring probes within the plant site of the power plant,
- A network of “A” and “B” type remote measurement stations and “G” type dose rate measurement stations,
- a meteorological measurement system.

The monitoring system for radiological state of the plant area

The dose rate measuring probes within the plant site of the nuclear power plant continuously monitor the level of ambient gamma radiation, indicating instantly when dose rates are high due to some operating trouble or a nuclear accident.

The meteorological measurement system

A total of 18 measured or derived data, respectively are provided by 11 detectors/sensors in the meteorological garden beside the power plant at both ground level (2 m), and at the 20, 50 and 120 m level of a 120 m high meteorological measuring tower for the purposes of migration calculations.

Environmental remote measurement network consisting of “A”, “B” and “G” type stations

Type “A” and “B” stations conduct the following remote measurements:

- measurement of aerosol and elemental iodine activity concentration by total beta count. Pending on the route of the air drawn through the instrument the elemental iodine filter and elemental iodine measurement can be by-passed and in such cases binding and measurement of elementary iodine takes place in conjunction with the organic iodine compounds (at default setting all three filters and measurements are functional),
- measurement of the activity concentration for four iodine isotopes (^{131}I, ^{132}I, ^{133}I, ^{135}I) in organic (+elemental) form by evaluating the multiple channel gamma spectrum recorded using a scintillation detector,
- measuring the dose rate of environmental gamma-radiation.

Continuous aerosol, elementary and organic iodine samples are taken at these stations with a volume rate of flow of 30-50 m^3/h in order to supply samples to laboratory testing.

The laboratory conducts fall-out sampling operations at the remote measurement stations using stainless steel sampling vessels containing carriers and replaced on a monthly basis and in the neighbourhood of the stations soil and grass samples are also taken on a semi-annual basis. The monthly dose of environmental gamma radiation is measured by a thermoluminescent dosimeter (TLD), which is then used to determined the average monthly dose rate (in order to make it comparable to the results obtained with the dose rate measurement gauges). Type “B” stations differ from type “A” stations only in their being the reference stations because of their location they are least affected by radioactive discharges from the power plant.

On type G metering stations the dose rate of the environmental gamma radiation is also measured by a dose rate measuring probe.

Under standard conditions the remote measurement network described above is only supplemented with a so called type “C” station conducting only TL dosimetry. If necessary, these stations can also be used to take fall-out samples.

Test methods of environmental samples

Filter samples of the iodine remote measuring device (aerosol, elemental iodine, organic iodine filter)

The filter samples of the iodine remote measuring system described above and operated on the remote measurement stations are fit for gamma-spectrography testing in laboratory, and to determine the activity concentration from the total absorbed aerosol, and the various forms of iodine isotopes.

Filter samples from the high volume air sampling unit (aerosol, elemental iodine, organic iodine filter)

Continuous sampling of aerosol, elementary and organic iodine takes place at the remote measurement stations with a volume rate of flow of 30-50 m^3/h in order to provide samples for laboratory testing (aerosol and iodine filters are replaced on a weekly and monthly basis, respectively).

Air borne HT, HTO samples

The sampling unit is an adsorption column filled with two molecular sieves. One of the columns is used to bind HTO, the other to bind HT after catalytic oxidation of the HT to HTO on a platinum-palladium catalyst).

Air borne CO_2, C_nH_m samples

The sampling unit is a device equipped with two NaOH bubble aeration columns. One of the columns is used to bind carbon dioxide (CO_2), the other for binding carbon dioxide and hydrocarbons ($C_nH_m + CO_2$) after catalytic oxidation of C_nH_m to CO_2 on a platinum catalyst).

Fall-out samples

A stainless steel vessel with parallel walls and a surface area of 0.14 m^2 is used for sampling on each station.

Soil samples

Soil sampling takes place in every half year in the neighbourhood of the type “A” and “B” stations, from soil surfaces which are not cultivated if possible.

Grass samples

Grass samples are taken twice a year during the Spring and Autumn vegetation periods from the neighbourhood of the type “A” and “B” stations.

Dosimetry using TLD

Measurement of monthly doses of environmental gamma radiation takes place by TLD meters installed on each environmental monitoring station.

Groundwater samples

Monitoring the radioactive contamination of groundwater is effectuated by automatic water sampling devices, wells equipped with automatic water level gauges, as well as by a number of wells with manual sampling opportunities.

Other samples from surface waters

Samples are taken once a quarter from the four fish ponds assigned for sampling (Kondor Lake, Fish Nursery, Fisher Lake and Vörösmalmi Lake), from the four specified locations of the rainwater collecting belt ditch, as well as from the two settling ponds in the sludge area all at once. Samples are taken on a monthly basis from the inlet section of the Fadd ditch and once a year from the Danube at two locations (north and south of the hot water canal mouth, respectively).

Mud samples from the Danube

In every half year, samples are taken from the Danube on three dedicated sections (the profile at the Paks coach station, the mouth of the hot water canal and south of the mouth, respectively).

Other mud samples

Sampling is made from the same fishing ponds dedicated for water sampling as well, from the belt ditch, the Fadd canal, chemical settling ponds on a semi-annual basis and before transportation from the faecal sludge desiccation site.

1.11 Please provide the reasons why you did not take into account operating states exceeding the normal operating conditions when dose rate calculations were made for the territory of Hungary [such as complex sequences (TAK1), severe accidents (TAK2)]. Pursuant to Section 2. c) of Annex No 6 in Government Decree No 14/2005. (XII. 25.) (hereinafter referred to as: Government Decree.) on environmental impact assessment and universal environmental use licensing procedure accidents, potential failures eventually causing exposure of the environment and the resulting impact factors need to be assessed when the proposed activity is described, furthermore according to Section 3 Annex No 7 to the Government Decree the direct impact areas must be defined for each impact factor and for each stage of the proposed activity as set forth in paragraph (2) Article 6 therein, as well as pursuant to the impact area concerned in the event of a potential failure or accident. For all these reasons the operating state exceeding the design base (default) and the accidental situation shall also be investigated during the design phase.

In response to the request by the Inspectorate, the population dose rates for the national territory of Hungary calculated from the appropriately conservative baseline data concerning TAK 1-2 (DEC 1-2) operating states, provided by the Russian party are described hereinafter. It is noted furthermore that the benchmark data and the meteorological parameters herein are identical with the data described earlier in the international chapter of the Environmental Impact Study, thus the dose rates can be evaluated in conjunction with the former particulars and under the same conditions.

MODELS USED

For the purposes of simulation, migration simulation and dose calculation models based on various approaches were used. The software programmes applied are validated and have references from the nuclear power industry, a part of them is currently in service at the Paks Nuclear Power Plant as an operative tool.

The model takes into account advection, vertical and horizontal diffusion, settlement, chemical reactions and releases for the purposes of describing migration patterns in the atmospheric transport formulas:

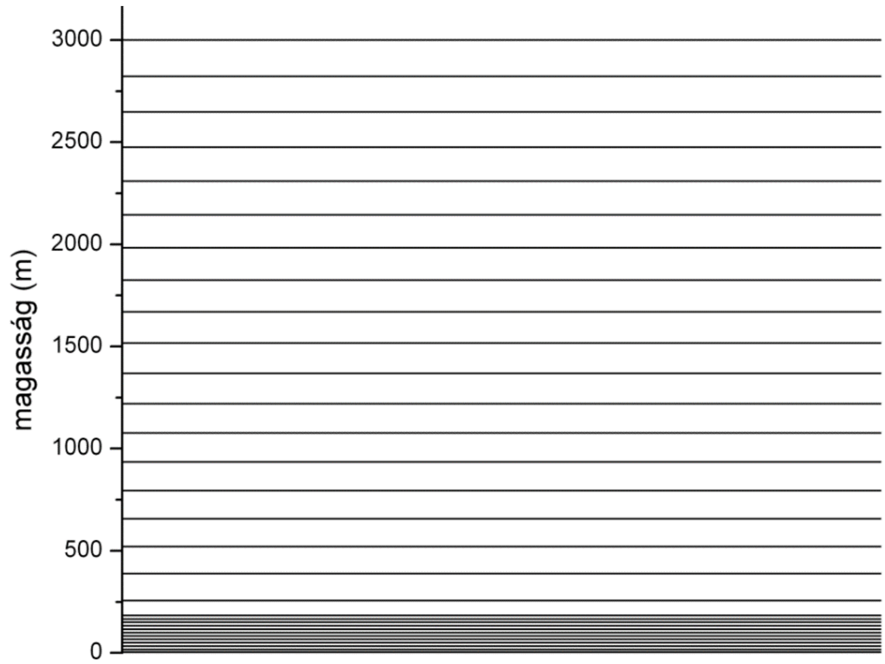
$$\frac{\partial \bar{c}}{\partial t} = -\bar{\boldsymbol{V}}\nabla\bar{c} + \nabla\boldsymbol{K}\nabla\bar{c} - (k_d + k_w)\bar{c} + E + R$$

where

$\bar{c}$	average concentration for the material type concerned [mass unit/m^3],
$\bar{\boldsymbol{V}} = (\bar{u}, \bar{v}, \bar{w})$	average three dimensional wind field [m/s],
k_d	dry settlement coefficient [1/s],
k_w	wet settlement coefficient [1/s],
$\boldsymbol{K} = (K_x, K_y, K_z)$	vector of turbulent diffusion coefficients, with its components being the horizontal and vertical diffusion coefficient [m^2/s],
E	emission levels of the material type concerned [mass unit/volume]
R	speed of the concentration changes as a result of the chemical reactions [mass unit/(m^{3}s)].

The model is quasi three dimensional, as most models used in current practice. The tested section of the atmosphere is broken down in the model into layers in vertical direction, and concentration changes in these layers are described by separate two dimensional models one by one, while vertical transport across layers is calculated using the appropriate physical models. In order to allow for a more accurate description of vertical mixing 32 height levels are differentiated.

Up to a height of 200 metres calculated from the ground and between 200 and 3 000 metres altitude 12 and an additional 20 levels are placed, respectively, so that differential pressure be equal between individual layers assuming a hydrostatic atmospheric condition (197 and 1514 Pa, respectively). This has been achieved by embedding the two pressure coordinate systems into each other.



magasság - height

Figure 1-2: Vertical stratification of the model (height)

The selection of the time scale and grid resolution are of essential importance for the accuracy of the solution, beside it may result numeric errors, convergence and stability problems arising from the finite element resolution. In the case of diffusion calculations a stable solution is provided, when the following correlation exists among K turbulent diffusion constant, Δt time scale and Δx grid resolution:

$$\frac{2K \cdot \Delta t}{\Delta x^2} \leq 1$$

A stable solution for advection calculations exists when the following correlation exists among $\mathbf{V}$ velocity vector size, a Δt time scale and Δx grid resolution:

$$\frac{|\mathbf{V}| \cdot \Delta t}{\Delta x} \leq 1$$

It can be seen that at a given diffusion constant and wind speed the stability of the solution can be secured by increasing grid resolution and decreasing the time scale steps. However, when rough grid resolution is used, the discharge will be averaged on a larger area which blurs the steep gradient and causes high numeric diffusion rates. As a consequence, maximum concentration in the plume will be under estimated and the width of the plume over estimated. By reducing the time scale steps – and with low grid resolution – the time required for calculation will be increased substantially. All these factors need to be taken into account for the purposes of selecting some kind of a compromised time scale and grid resolution. The model developed by us computes concentration and settlement of contaminants originating from a single point source in an area covering entire Central Europe with a 0.15 × 0.1 degrees (~10 km × ~10 km) spatial resolution grid and 10 seconds time scale steps.

The construction of the Euler model used

The programme code consists of several components.

The *main program* reads data, calls various functions and organises them in cycles and finally displays the results.

The *first subordinated module* provides the horizontal and vertical boundary conditions. At the edge of the range' no-flux' boundary condition was used, in other words it was assumed that no material flow exists at the boundary. A special routine carries out calculations for vertical and horizontal diffusion and the determination of altitudes. A separate function calculates the Monin–Obukhov-length (L) and the vertical turbulent diffusion coefficient (K_z) required for these operations. Separate computation of the different material transports (advection, diffusion) and of the chemical reactions and settlement is allowed by the operator slicing, a method discussed later on.

The horizontal diffusion coefficient was taken in the model a constant factor. Vertical turbulent diffusion is calculated based on the K-theory and taken into account with the elevation dependent K_z diffusion coefficient. In order to reduce the running time of the model calculation of the K_z value was made using a stochastic random method. Vertical distribution of each type of material (profile) was provided with the turbulent diffusion equation:

$$\frac{\partial c}{\partial t} = \frac{\partial}{\partial z}\left(K_z(z) \frac{\partial c}{\partial z} \right)$$

The vertical turbulent diffusion coefficient was parametered using the similarity theory by Monin–Obukhov in the following manner:

$$K_z(z) = \frac{\kappa u_* z}{\Psi\left(\frac{z}{L}\right)} \left(1 - \frac{z}{H_z}\right)^2$$

According to this the turbulent diffusion coefficient can be written up at any given z level as a function of the altitude of the mixing layer (H_z) the friction speed (u^*), the stability coefficient (Ψ), the Kármán-constant (κ) and the Monin–Obukhov-length (L).

When calculating dry settlement rates a constant settlement coefficient was taken into account. Wet settlement rates were calculated when relative humidity was above the 80 % level. Additionally, it was assumed that any settlement can be made only from the first, near ground layer.

After reading in of the data, specification of the elevations, and providing the initial and boundary conditions, the programme would calculated advection in each level for each of the time steps, and then determines vertical mixing for each of the air columns, the turbulent diffusion coefficient and the necessary Monin–Obukhov length. Finally the settlement rate is defined from the near ground (or, on other words the close to surface) layer. In the next time step the process described above is repeated again.

Numeric solution

Three dimensional models with acceptable accuracy require a huge computational potential and sophisticated numeric solution techniques. The method of operator slicing was used in the TREX-Euler model to solve the equations, in other words the members of the partial differential equations were resolved separately, one by one. Spatial transport members were discreeted using a finite differential scheme. Only the advection member (the impact of advection) was taken into account in the first step and c^{adv} concentration was defined this way (the new concentration distribution formed as a result of advection) from the old c^{old} concentration value as follows:

$$c^{adv} = c^{old} + A^{adv}\Delta t$$

Following this using the c^{adv} concentration obtained above the c^{diff} concentration formed as a result of diffusion processes was determined (separately calculating vertical and horizontal diffusion):

$$c^{diff} = c^{adv} + A^{diff}\Delta t$$

Finally the impact of the chemical reaction and the impact of dry and wet settlement was calculated from the concentration defined in the previous step on the basis of the following equation:

$$c^{chem} = c^{diff} + A^{chem}\Delta t$$

This way, the cnew concentration obtained in step three contained the impact of all the three factors after any specified Δt time period. In these equations A^{adv} is the advection operator, A^{diff} the diffusion operator, while A^{chem} stands for the operator describing chemical reactions and settlement. Various methods were used to resolve these equations.

An effective method of resolution for partial differential equations is the so called “method of lines” technique. The essence of the method is the temporal integration of the set of differential equations generated after spatial discreeting of the transport members with the use of the appropriate initial and boundary conditions. Spatial discreeting of advection can be achieved with the use of the so called “second upwind” method, and for calculating the vertical diffusion the “first upwind” method. First and second order upwind methods are schemes providing stability to the resolution of the advection and diffusion equations. No spatial derivative is involved in the case of chemical reactions, dry and wet settlement, only the temporal integration has to be completed in this case. Temporal integration of the discreeted members was achieved by the explicit Euler-scheme.

The TREX Euler model was used to calculate activity concentration of each isotope, integrated activity concentration levels, and doses as well for the Central European region.

Meteorological databases used

<u>Average meteorological parameters for conservative estimates</u>

In order to obtain conservative figures in the estimates the climate parameters typical for the area with the average and most characteristic values were taken into account. The dominant wind direction at the area is north-western, but an estimate independent from the direction was carried out for the purposes of the conservative assessment. However, the frequency parameter of wind directions per 10 degrees each offers information about the probability they occur within the area. The wind speed levels were set as the average of the measurement findings carried out on the 20 and 120 metres elevations of the Paks metering tower between 2002 and 2011. They provided an average wind speed of 2.52 m/s and 5.47 m/s in a height of 20 and 120 metres, respectively. No temperature data were available from the measurements of the tower, therefore the climatic average temperature was taken into account which is specified for the area under investigation as 10.7 °C. Assuming dry adiabatic temperature stratification the temperature at the 925 hPa pressure level is 4.7 °C, and at 850 hPa is –3.3 °C. The geopotential height of the 925 hPa pressure level and of the 850 hPa pressure level was taken as 700 metres and 1500 metres, respectively. The height of the boundary layer was set to the lowest level typical for the hours during the day (300 m), which is the most adverse condition in terms of contaminant migration. Overcast of 4 oktas (50 % overcast), a sensible heat flow of 100 W/m^2, and a roughness parameter of 0.25 m were set.

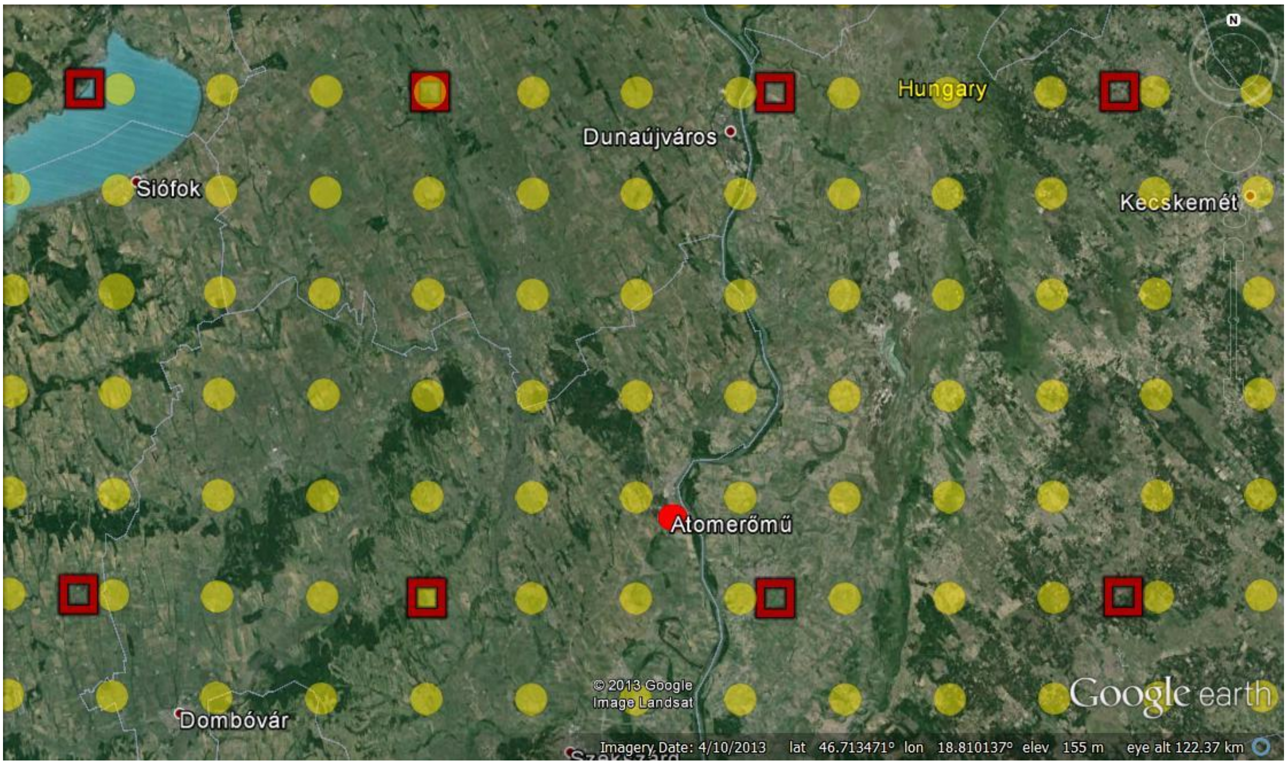
Beside this typical meteorological situation adverse weather conditions were also taken into account for some of the simulation runs. In this scenario wind speed at 20 m was taken as 1 m/s, and 2 m/s in the altitude of 120 m, the boundary layer height to be 100 m, and vertical temperature stratification as isotherm, calculated with strong surface emanation (stable air stratification).

<u>Simulation with real a meteorological database</u>

Model simulations were completed for a whole year taking hourly discharges into account using a real meteorological database.

Partly point measurement data, partly numeric forecast model outputs were used for the simulation runs.

For the purposes of accomplishing migration simulations with the help of the Euler model the archives of the numeric weather forecast model of the Global Forecast System (GFS) was used. For the purposes of simulation the meteorological fields were interpolated in three hours time scale to 90 × 96 grid points (a total of 8 640 grid points), with a spatial resolution of 0.1 × 0.15 degrees (approximately 10 km × 10 km). The meteorological parameters specified by the GFS numeric forecasting model at the vertical levels into the vertical levels of the migration model (all in all to 34 levels).



Note: red rectangles represent the grid points of the GFS model. The yellow circles show the grid resolution used for the Euler-type simulation model. The values of the meteorological parameters were defined for these points by interpolation.
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Figure 1-3: Comparison of the GFS numeric forecasting model and the grid points of the Euler model

Radioactive discharge particulars

For default data in this case such a severe accident situation was taken as the initial state the probability of occurrence of which is less than 10^{-6} 1/reactor year.

The characteristic features of the TAK1 (DEC1) complex sequence exceeding the design operating state include the following: It is a process beyond the control of the expected operating events and design operating troubles which may only occur as a consequence of multiple failures independent from each other and which may entail consequences more severe than the processes included within the design base and may cause zone damage not including melt down.

The characteristic features of the TAK2 (DEC2) severe accident include: An accidental state accompanied by the severe damage of the reactor zone and even melt down, a state of accident which may entail consequences more severe than the processes included within the design base and operating troubles beyond the design state.

Discharges may originate from two sources, a 100 m high ventilation stack and through the wall of the reactor building (35 m). The Supplier of the reactors provided the estimated release particulars of each accident scenario, these are summarised below.

Isotope	Ventilation stack (100 m)			Lower release (35 m)		
	1 day	10 days	30 days	1 day	10 days	30 days
	activity (Bq)					
Elemental iodine						
I-131	1.1E+08	5.9E+08	8.7E+08	2.3E+11	2.4E+11	2.4E+11
I-132	3.4E+07	3.4E+07	3.4E+07	2.5E+11	2.5E+11	2.5E+11
I-133	1.2E+08	2.0E+08	2.0E+08	3.4E+11	3.4E+11	3.4E+11
I-134	2.3E+07	2.3E+07	2.3E+07	2.7E+11	2.7E+11	2.7E+11
I-135	5.3E+07	5.6E+07	5.6E+07	2.3E+11	2.3E+11	2.3E+11
Organic iodine						
I-131	2.5E+09	1.7E+10	2.8E+10	1.8E+09	1.2E+10	2.0E+10
I-132	4.0E+08	4.0E+08	4.0E+08	2.8E+08	2.8E+08	2.8E+08
I-133	2.6E+09	4.7E+09	4.7E+09	1.8E+09	3.3E+09	3.3E+09
I-134	1.4E+08	1.4E+08	1.4E+08	1.0E+08	1.0E+08	1.0E+08
I-135	9.5E+08	1.0E+09	1.0E+09	6.7E+08	7.3E+08	7.3E+08
Noble gases						
Kr-85m	4.9E+11	5.0E+11	5.0E+11	3.6E+10	3.6E+10	3.6E+10
Kr-87	3.5E+11	3.5E+11	3.5E+11	8.5E+10	8.5E+10	8.5E+10
Kr-88	1.1E+12	1.1E+12	1.1E+12	1.2E+11	1.2E+11	1.2E+11
Xe-133	3.2E+13	1.9E+14	2.6E+14	8.2E+11	2.0E+12	2.4E+12
Xe-135	8.1E+11	9.8E+11	9.8E+11	3.6E+10	3.7E+10	3.7E+10
Xe-138	1.1E+11	1.1E+11	1.1E+11	1.9E+11	1.9E+11	1.9E+11
Aerosols						
Cs-134	6.2E+05	6.2E+05	6.2E+05	1.4E+08	1.4E+08	1.4E+08
Cs-137	3.2E+05	3.2E+05	3.2E+05	7.2E+07	7.2E+07	7.2E+07

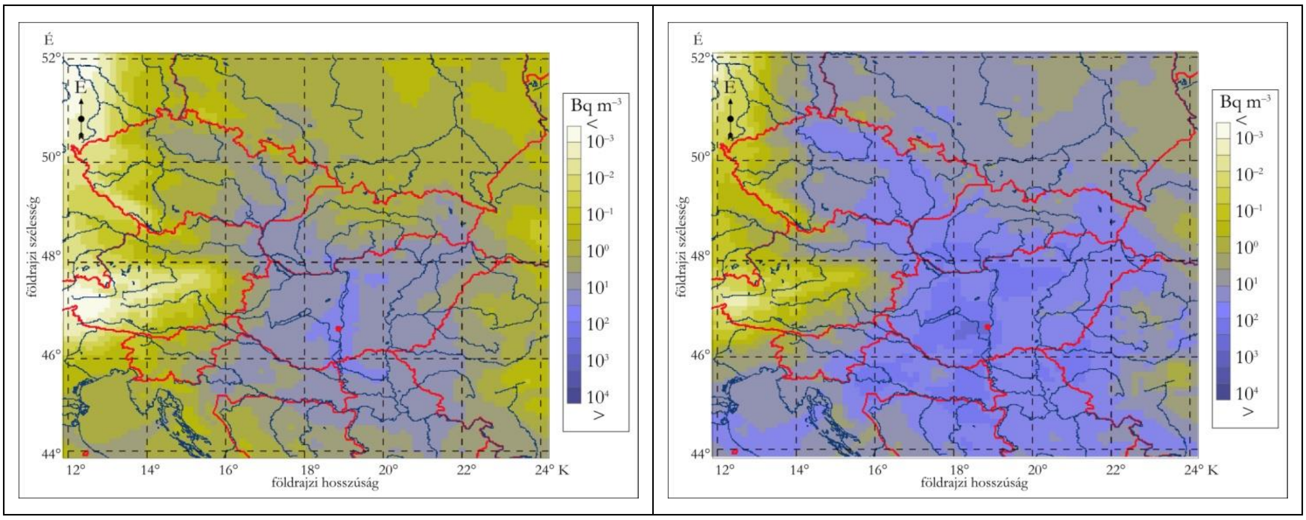
Table 1-4: TAK1 (DEC1) complex sequence discharge data

Isotope	Lower release (35 m)			Ventilation stack (100m)	
	0 – 1 day	1 – 7 days	7-30 days	1 – 7 days	7 – 30 days
	activity (Bq)				
Noble gases					
Kr-85m	3.9E+13	4.3E+11	-	3.6E+13	-
Kr-87	1.1E+13	-	-		-
Kr-88	6.2E+13	1.3E+11	-	1.1E+13	-
Xe-133	2.4E+15	1.1E+15	2.0E+14	5.7E+16	2.0E+16
Xe-135	6.2E+14	4.7E+13	-	2.9E+15	-
Xe-138	7.8E+11	-	-	-	-
Elemental iodine					
I-131	9.4E+12	4.1E+11		3.5E+11	
I-132	7.9E+11	5.2E+09		2.8E+09	
I-133	1.3E+13	3.1E+11		2.9E+11	
I-134	2.6E+11	-		-	
I-135	5.1E+12	7.8E+10		7.7E+10	
Organic iodine					
I-131	1.8E+12	8.4E+11	4.7E+11	4.5E+12	4.7E+12
I-132	3.7E+11	3.1E+10	-	1.6E+11	-
I-133	2.4E+12	2.9E+11	5.9E+08	1.8E+12	5.9E+09
I-134	3.0E+10	-	-	-	-
I-135	8.9E+11	2.4E+10	-	1.8E+11	-
Aerosol					
I-131	4.5E+13	6.8E+12	-	6.2E+11	-
I-132	3.5E+13	7.9E+10	-	5.3E+09	-
I-133	7.5E+13	5.7E+12	-	5.6E+11	-
I-134	5.8E+12	-	-	-	-
I-135	4.5E+13	9.2E+11	-	9.2E+10	-
Cs-134	1.1E+13	1.6E+12	2.5E+11	1.5E+11	2.5E+10
Cs-137	5.2E+12	8.1E+11	1.6E+11	7.3E+10	1.6E+10

Table 1-5: TAK2 (DEC2) severe accident discharge data

Activity concentration values

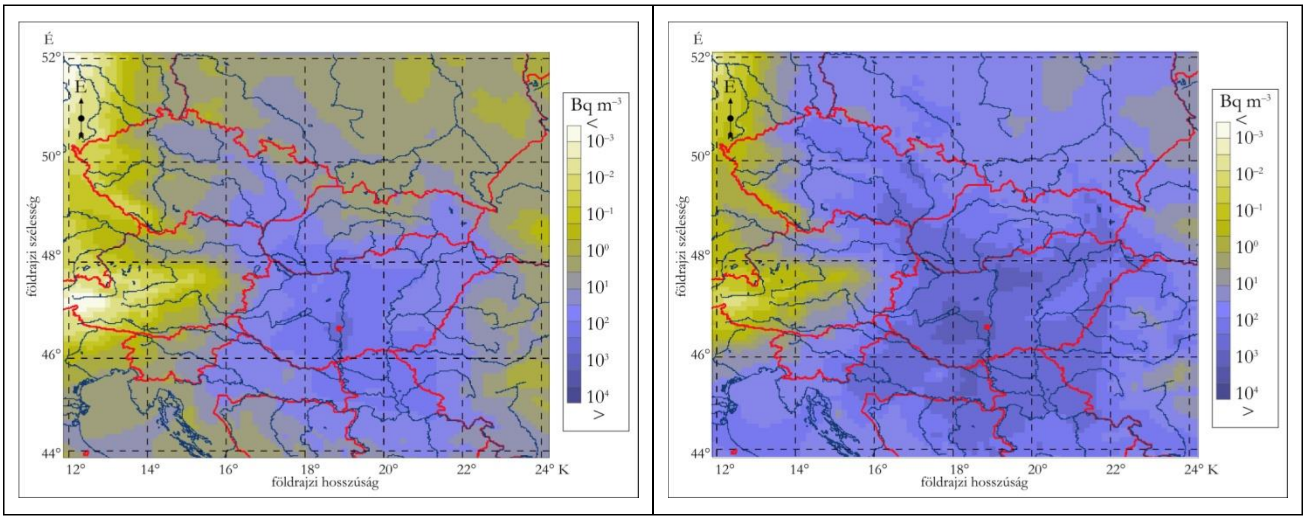
In order to determine the population doses the activity concentration levels of radioactive isotopes at the location concerned are needed. Thus the first step in the simulation run was to calculate expected average and maximum levels of activity concentrations in the case of incidents beyond the design base for the cases of TAK1 (DEC1) and TAK2 (DEC2) discharges both in terms of early and late discharges. (The average activity concentration will be the average value of the activity concentration simulated for the year concerned in any given grid point. The maximum activity concentration will be the largest value of the activity concentration simulated for the year concerned in any given grid point.) Following this the early and late inhalation dose levels expected for both adults and children were defined in the case of both types of incidents. (The term early means activity concentrations or doses calculated in the case of TAK1 (DEC1) 7 (0-7 days) days, in the case of TAK2 (DEC2) 10 (0-10 days) days. The term late concerns activity concentrations or doses calculated on the basis of 30 (0-30 days) day long discharges.) As an initial condition, discharges from day 1 to 10, and from day 0 to 7 were considered for the purposes of early dose calculations in the case of TAK1 (DEC1) complex sequences and TAK2 (DEC2) severe accidents, respectively. Discharges for a period of 30 days and from day 7 to day 30 were taken into account as initial conditions for late dose calculations in the case of TAK1 (DEC1) complex sequences and TAK2 (DEC2) severe accidents, respectively.



a,) early b,) late

földrajzi szélesség - latitude
földrajzi hosszúság - longitude

Figure 1-4: Early and late activity concentration fields in the case of TAK1 (DEC1) complex sequences



a,) early b,) late

földrajzi szélesség - latitude
földrajzi hosszúság - longitude

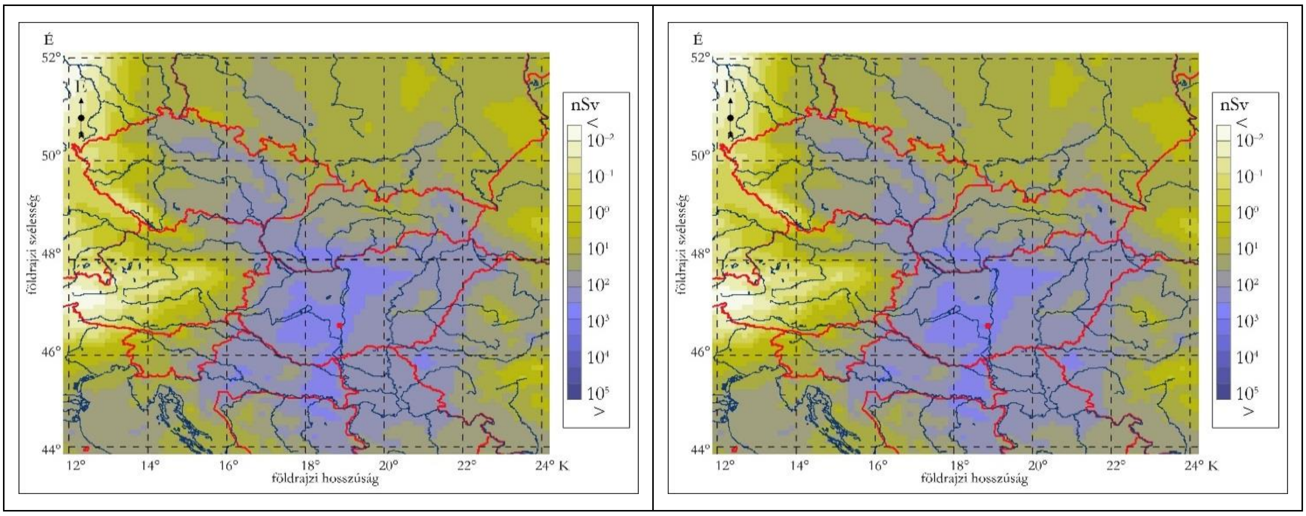
Figure 1-5: Early and late activity concentration fields in the case of TAK2 (DEC2) severe accident

Inhalation doses and effective doses integrated for 50 years

When calculating the radiation protection consequences of incidents beyond the design base the inhalation dose was provided because other dose rates are less than this be orders of magnitude and their role played in the assessment was negligible. (For instance, the specification of ingested doses was not justified for the purposes of the protective measures ordered in the event of occurrence of such incidents to the exposed population – such as banning the consumption of certain food items). In our case inhalation dose levels are so low which do not trigger any precautions for the population.

Beside inhalation doses effective dose estimates integrated for a 50 years period were also provided. In this case it must be stressed that dose levels without measures to protect the population may be misleading because of the high level of conservatism and the specification of sources beyond planning possibilities.

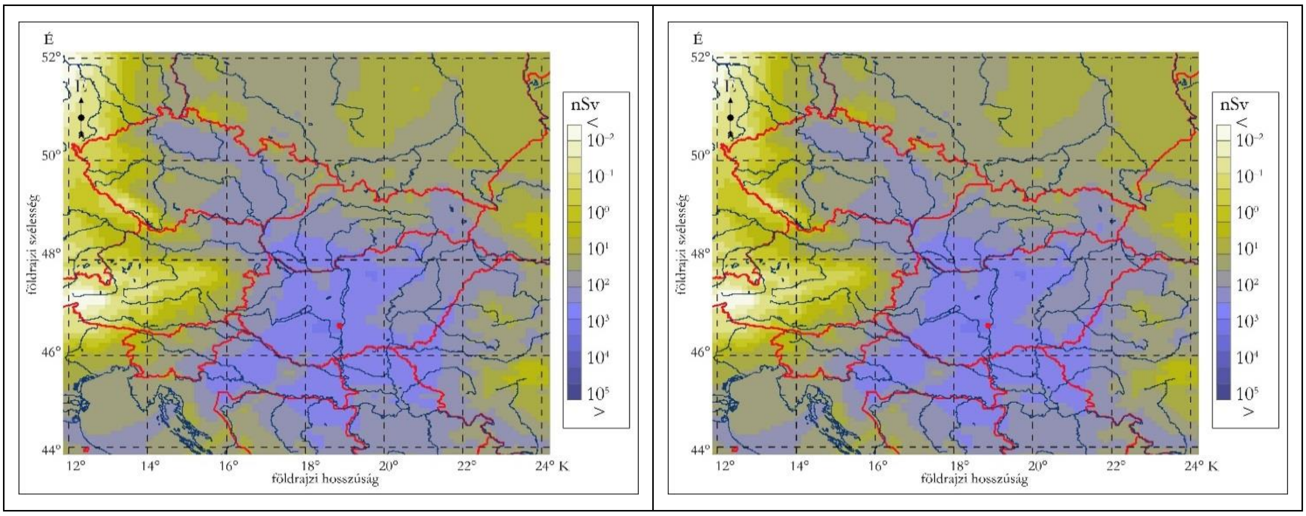
Dose levels for adults and children expected in incidents beyond the design base are shown on the following figures in the case of TAK1 (DEC1) and TAK2 (DEC2) discharges.



a,) early b,) late

földrajzi szélesség - latitude
földrajzi hosszúság - longitude

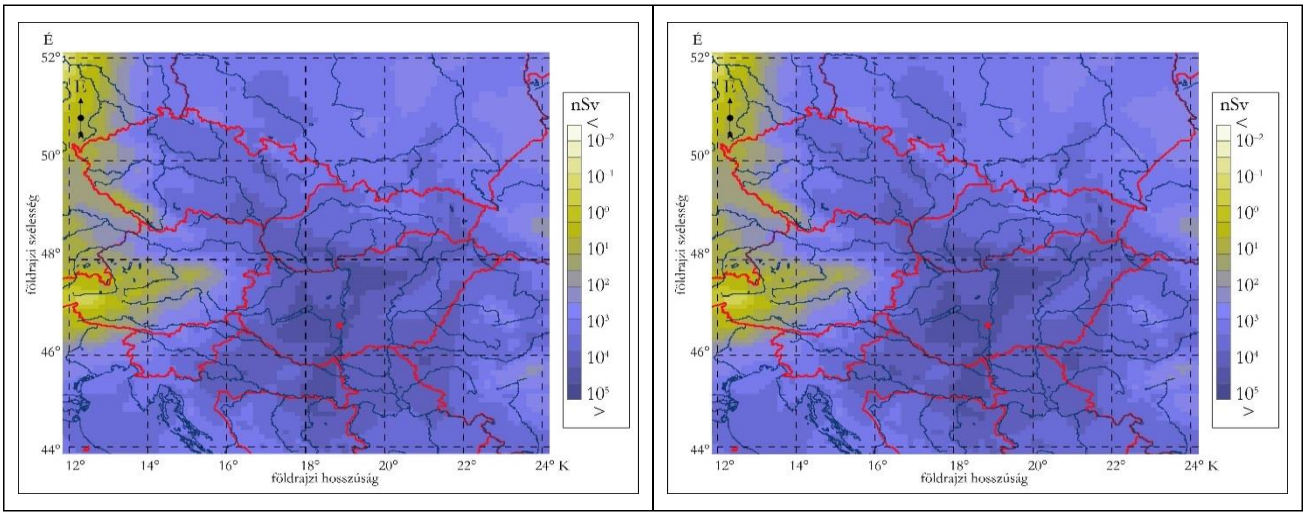
Figure 1-6: Early and late inhalation doses for adults in the event of TAK1 (DEC1) complex sequence discharge



a,) early b,) late

földrajzi szélesség - latitude
földrajzi hosszúság - longitude

Figure 1-7: Early and late inhalation doses for children in the event of TAK1 (DEC1) complex sequence discharge

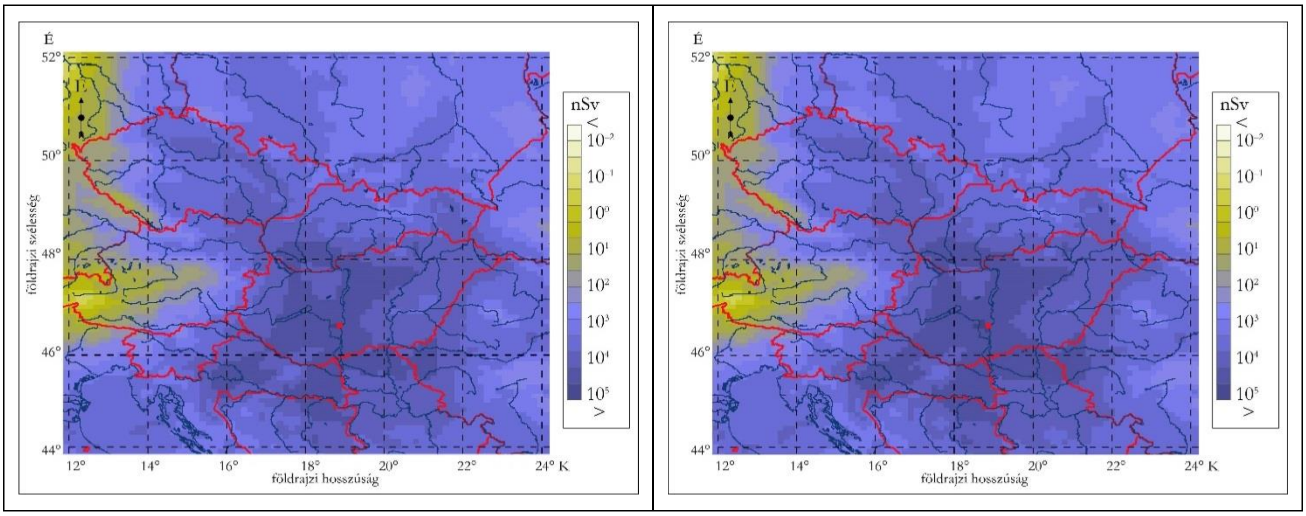


a,) early

b,) late

földrajzi szélesség - latitude
földrajzi hosszúság - longitude

Figure 1-8: Early and late inhalation doses for adults in the event of TAK2 (DEC2) severe accidental release



a.) early

b.) late

földrajzi szélesség - latitude
földrajzi hosszúság - longitude

Figure 1-9: Early and late inhalation doses for children in the event of TAK2 (DEC2) severe accidental release

Settlement	**Model coordinates**		**Inhalation dose nSv**		**Integrated effective dose nSv**
	Width	Length	TAK1 (early)	TAK1 (late)	for 50 years
Nagydorog	18.65	46.6	2.776E+02	2.813E+02	1.13E+04
Paks	18.80	46.6	2.624E+02	2.667E+02	1.07E+04
Kalocsa	18.95	46.5	2.137E+02	2.174E+02	8.70E+03
Dunaújváros	18.95	47.0	9.652E+01	9.853E+01	3.94E+03

Table 1-6: Annual inhalation and integrated dose rates (adults) originating from TAK1 (DEC1) complex sequence discharges in selected settlements in the environment of the proposed units on the basis of the model grid point level situated the closest to the settlement concerned

Settlement	**Model coordinates**		**Inhalation dose nSv**		**Integrated effective dose nSv**
	Width	Length	TAK1 (early)	TAK1 (late)	for 50 years
Nagykanizsa	17.00	46.7	4.064E+01	4.142E+01	1.66E+03
Győr	17.60	47.7	1.032E+02	1.048E+02	4.19E+03
Pécs	18.20	46.1	1.021E+02	1.037E+02	4.15E+03
Budapest	19.10	47.5	1.973E+02	1.999E+02	8.00E+03
Miskolc	20.75	48.1	1.117E+02	1.133E+02	4.53E+03
Szeged	21.20	46.3	7.820E+01	7.933E+01	3.17E+03
Debrecen	21.65	47.5	3.665E+01	3.722E+01	1.49E+03

Table 1-7: Annual inhalation and integrated dose rates (adults) originating from TAK1 (DEC1) complex sequence discharges in selected settlements in the environment of the proposed units on the basis of the model grid point level situated the closest to the settlement concerned

Settlement	**Model coordinates**		**Inhalation dose nSv**		**Integrated effective dose nSv**
	Width	Length	for 50 years	TAK1 (late)	for 50 years
Nagydorog	18.65	46.6	4.642E+02	4.705E+02	1.88E+04
Paks	18.80	46.6	4.389E+02	4.461E+02	1.78E+04
Kalocsa	18.95	46.5	3.574E+02	3.638E+02	1.46E+04
Dunaújváros	18.95	47.0	1.614E+02	1.649E+02	6.60E+03

Table 1-8: Annual inhalation and integrated dose rates (children) originating from TAK1 (DEC1) complex sequence discharges in selected settlements in the environment of the proposed units on the basis of the model grid point level situated the closest to the settlement concerned

Settlement	**Model coordinates**		**Inhalation dose nSv**		**Integrated effective dose nSv**
	Width	Length	TAK1 (early)	TAK1 (late)	for 50 years
Nagykanizsa	17.00	46.7	6.797E+01	6.930E+01	2.77E+03
Győr	17.60	47.7	1.725E+02	1.753E+02	7.01E+03
Pécs	18.20	46.1	1.707E+02	1.736E+02	6.94E+03
Budapest	19.10	47.5	3.300E+02	3.345E+02	1.34E+04
Miskolc	20.75	48.1	1.869E+02	1.896E+02	7.58E+03
Szeged	21.20	46.3	1.308E+02	1.327E+02	5.31E+03
Debrecen	21.65	47.5	6.129E+01	6.228E+01	2.49E+03

Table 1-9: Annual inhalation and integrated dose rates (children) originating from TAK1 (DEC1) complex sequence discharges in selected settlements in the environment of the proposed units on the basis of the model grid point level situated the closest to the settlement concerned

Settlement	**Model coordinates**		**Inhalation dose nSv**		**Integrated effective dose nSv**
	Width	Length	TAK2 (early)	TAK2 (late)	for 50 years
Nagydorog	18.65	46.6	2.523E+04	2.684E+04	5.37E+06
Paks	18.80	46.6	2.386E+04	2.558E+04	5.12E+06
Kalocsa	18.95	46.5	1.943E+04	2.084E+04	4.17E+06
Dunaújváros	18.95	47.0	8.783E+03	9.486E+03	1.90E+06

Table 1-10: Annual inhalation and integrated dose rates (adults) originating from TAK2 (DEC2) severe accidental releases in selected settlements in the environment of the proposed units on the basis of the model grid point level situated the closest to the settlement concerned

Settlement	**Model coordinates**		**Inhalation dose nSv**		**Integrated effective dose nSv**
	Width	Length	for 50 years	TAK2 (late)	for 50 years
Nagykanizsa	17.00	46.7	3.692E+03	4.055E+03	8.11E+05
Győr	17.60	47.7	9.382E+03	1.004E+04	2.01E+06
Pécs	18.20	46.1	9.267E+03	9.997E+03	2.00E+06
Budapest	19.10	47.5	1.796E+04	1.911E+04	3.82E+06
Miskolc	20.75	48.1	1.015E+04	1.079E+04	2.16E+06
Szeged	21.20	46.3	7.106E+03	7.535E+03	1.51E+06
Debrecen	21.65	47.5	3.333E+03	3.571E+03	7.14E+05

Table 1-11: Annual inhalation and integrated dose rates (adults) originating from TAK2 (DEC2) severe accidental releases in selected settlements in the environment of the proposed units on the basis of the model grid point level situated the closest to the settlement concerned

Settlement	**Model coordinates**		**Inhalation dose nSv**		**Integrated effective dose nSv**
	Width	Length	TAK2 (early)	TAK2 (late)	for 50 years
Nagydorog	18.65	46.6	3.491E+04	3.734E+04	7.47E+06
Paks	18.80	46.6	3.302E+04	3.559E+04	7.12E+06
Kalocsa	18.95	46.5	2.689E+04	2.899E+04	5.80E+06
Dunaújváros	18.95	47.0	1.215E+04	1.323E+04	2.65E+06

Table 1-12: Annual inhalation and integrated dose rates (children) originating from TAK2 (DEC2) severe accidental releases in selected settlements in the environment of the proposed units on the basis of the model grid point level situated the closest to the settlement concerned

Settlement	**Model coordinates**		**Inhalation dose nSv**		**Integrated effective dose nSv**
	Width	Length	TAK2 (early)	TAK2 (late)	for 50 years
Nagykanizsa	17.00	46.7	5.109E+03	5.664E+03	1.13E+06
Győr	17.60	47.7	1.298E+04	1.398E+04	2.80E+06
Pécs	18.20	46.1	1.282E+04	1.393E+04	2.79E+06
Budapest	19.10	47.5	2.485E+04	2.657E+04	5.31E+06
Miskolc	20.75	48.1	1.404E+04	1.503E+04	3.01E+06
Szeged	21.20	46.3	9.832E+03	1.049E+04	2.10E+06
Debrecen	21.65	47.5	4.611E+03	4.974E+03	9.95E+05

Table 1-13: Annual inhalation and integrated dose rates (children) originating from TAK2 (DEC2) severe accidental releases in selected settlements in the environment of the proposed units on the basis of the model grid point level situated the closest to the settlement concerned

Evaluation

The Nuclear Safety Code (NSC – Government Decree No 118/2011. (VII. 11.)) does not provide any dose limit values for operating states characterised by the extension of the design base in the case of the establishment of new nuclear power plant units (complex sequences – TAK 1 (DEC1), severe accidents – TAK 2 (DEC2)) either for the reference population or for the persons staying within the plant site but outside the controlled zone of the nuclear power plant. Since the dose limit for population doses according to the NSC in the case of TA4 (DBC4) design operating troubles within the scope of the design base with a frequency rate of not more than 10^{-5} 1/year is 5 mSv/incident. Since this level is half of the minimum level associated with precautions measures for the population – associated with close up – pursuant to Ministerial Decree No 16/2000. EüM (10 mSv/incident), the conclusion can be drawn that any radiation exposure (impact) triggering precautionary measures for the population cannot be allowed in operating states within the design base. It follows logically from the above that such a restriction cannot be enforced in TAK1-2 operating states (DEC 1-2) exceeding the conditions of the design base, in other words the relieving the population from the radiation exposure and impact must be ensured by other means – interventions, population precautionary measures. The associated radiation protection principles are laid down in Ministerial Decree No 16/2000. EüM and are implemented by the National Nuclear Accident Prevention System (NNAPS) regulated by Government Decree No 167/2010. It can be concluded therefore that just because the lack of planning options such initial conditions must be taken into account in TAK 1-2 (DEC 1-2) operating states which are to be selected on an arbitrary basis. The same applies to radiation protection requirements since due to the state beyond plannability sometimes strongly conservative approaches ate used and the final results of radiation exposures calculated on this basis might be misleading. All these considerations are worth mentioning in order to allow for the radiation protection evaluation of the operating states beyond the normal operation made in the light of the limitations of the calculation method.

Based on the 5.4 and 7.4 mSv integrated effective dose levels for 50 years there is no legal and professional ground for the qualification of the impact area, since either the legislator, nor the designer are in the position to define limit values for operating states beyond the design base (just because it is a state which cannot be designed for). However, these dose exposures are still within an insignificant range from the perspective of radiation protection when compared to the natural background (which represents a dose exposure of 120-150 mSv for the population, integrated also for 50 years period). With respect to the evaluation of the impacts from complete effective doses it is also important to note that you should know such impacts can be effectively mitigated by for instance ordering and maintaining precautionary measures for restrictions on food consumption as long as the activity concentration levels of food items exceed the limits according to Regulation 2218/89/EURATOM.

Based on all these it is recommended for the purposes of assessing the impacts of operating states exceeding the design base state and of accidental situations to take into account the provisions laid down in Section 3a.2.4.700. of the NSC, and the guidance included in Ministerial Decree No 16/2000. (VI. 8.) EüM. According to these, the following should be demonstrated for the incident resulting in the TAK1 operating state and with a view to the requirements laid down in Section 3a.2.2.7000 for the incident resulting in TAK2 operating state:

a) no urgent precautionary measures need to be taken beyond the 800 m distance measured from the nuclear power plant;
b) no transient measures are needed beyond a distance of 3 kilometres from the nuclear reactor, in other words no temporary resettlement of the surrounding population is needed;
c) no late precautionary measures need to be taken beyond the 800 m distance measured from the nuclear power plant, in other words no final resettlement of the surrounding population is needed;
d) no need for long term restrictions on food consumption.

The establishment license from the Nuclear Safety Directorate in the Hungarian Atomic Energy Authority is granted only when the design of the power plant ensures meeting of these requirements.

Ministerial Decree No 16/2000 EüM assigns intervention levels of 10 mSv/2days, or 50 mSv/1 week associated with urgent precautionary measures which are higher than the dose levels estimated herein.

It follows from the requirements laid down in the two pieces of legislation referred to above that the dose levels specified in the study do not require the application of any urgent precautionary principle in the course of the TAK 1-2 events beyond the 800 metres distance specified in the NSC, thus the estimated impact area cannot be more than the circle around the reactor with the 800 metres radius.

It is therefore suggested that the 800 metres radius circle around the reactor site be considered as the impact area.

1.12 The direct impact areas must be provided for each impact factor and in accordance with the stages of the activity (as set forth in paragraph (2) Article 6), as well as according to the impact area of an eventual operating failure or accident.

Based on the response given to Section 1.11 of the call for submitting missing information the answer to this issue is that impacts of operating states beyond the design base and of accident situations will have no modification effect on the impact area originally determined in the EIS documentation.

1.13 The necessary domestic dose calculations must be carried out for largest expected environmental radioactive discharges (for instance severe accident, TAK2 category), and the demarcation of the radiological impact area, the expected radiohygienic impacts need to be assessed and the appropriate chapters of the Environmental Impact Study supplemented accordingly.

Based on the response given to Section 1.11 of the call for submitting missing information the requirements formulated in this point have already been met. The impacts of operating states beyond the design base and of accident situations will have no modification effect on the impact area originally determined in the EIS documentation, thus the part of the Environmental Impact Study dealing with impact areas is not affected by this supplementary information.

1.14 Please analyse the impact of the accidental situations resulting in maximum radioactive discharges for the operation of the Paks Nuclear Power Plant and of the ISSNF. Demonstrate the expected radiological exposure and radiohygienic impacts of the incident.

The management of the impacts from an accidental situation will be accomplished in line with the current accident mitigation practices (a part of which is the accident prevention activity of the ISSNF). Accordingly, it is not expedient to separate the accidental impacts of the new units to be established from the current units and the ISSNF. The nuclear accident relief functions of the six operational units will be accomplished by the joint Accident Relief Organisation (ARO) on the basis of the legislation which is currently in place. In summary, handling the impacts of a potential accidental situation formulated in the official requirement will be covered by the scope of responsibility of the Accident Relief Organisation serving all six units and the ISSNF, and it will take place in accordance with the rules or procedure in place therein.

A separate study will be prepared at a later stage of the licensing procedure to assess the radiological impacts of the two new units to be established within the common site on the existing four units and the ISSNF. The EIS contains all data available from the designer in the current design phase. The detailed data will be generated during the currently ongoing design operations and will be available at a later stage, thus they may be provided in the course of the establishment licensing procedure constituting a part of the nuclear licensing process. During the establishment licensing procedure the acting authority is the Hungarian Atomic Energy Authority, but Government Decree No 112/2011. (VII.4) also defines that specialist expert authorities contributing the official procedures of the Hungarian Atomic Energy Authority, and in this sense the South-Transdanubian Environmental and Nature Conservation Inspectorate is the acting specialist expert authority and the body making statements in professional expert issues.

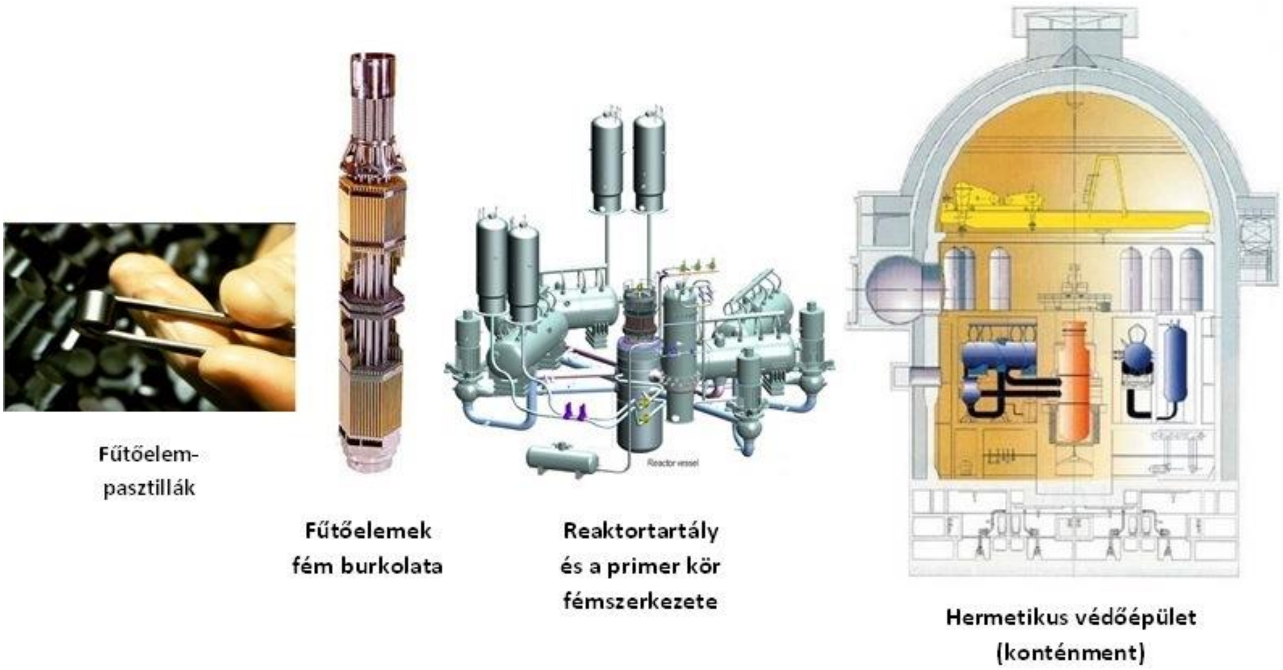
1.15 Please explain in details the proposed measures, technologies, the designed failure management systems and their operation designed for mitigating the environmental damages and environmental exposures listed in the Environmental Impact Study.

Prevention of any operating troubles with a great degree of certainty is an objective of technical safety engineering in the establishment process of any nuclear power plant. It is also intended to be achieved that potential consequences of all kind of operating troubles considered for the facility beforehand be kept within the required limits and extent and that the probability of severe accidents involving significant consequences remained sufficiently low. In order to ensure this the fundamental principle determining the safety philosophy of the nuclear power plant is the application of the in-depth tiered system of protection.

According to the principle of defence in depth the systems in the power plant units must ensure that:

- functional parameters of the power plant remained within the normal operating limits,
- violation of the normal operating limits could be detected promptly and the self-sustaining chain reaction stopped automatically,
- in the course of the potential operating troubles the application of accurate management instructions and the integrated safety systems ensure shut down of the chain reaction and appropriate cooling of the fuel assemblies so that fuel elements be not damages and no radioactive discharges exceeding the maximum permitted level occurred,
- in the event a severe functional failure resulted in the occurrence of such circumstances which lead to the damage or the fuel elements nevertheless, appropriate management instructions applicable to the cases of severe accidents thus occurring should be in place to mitigate the consequences, in other words to avoid high level radioactive discharge,
- should all these measures fail, accident relief measures in place at the nuclear power plant ensure the prevention of substantial radiation related health impairment of the population in line with the nationwide accident relief operations.

Nuclear fission material is shut off from the environment by four physical barriers built on each other: high stability ceramic material structure of the fuel element capsules; the metal armouring of the rod shaped fuel elements; metal structure of the reactor vessel and the primary circuit; furthermore, the wall of the hermetically sealed protective building (containment) represent these barriers.



fűtőelem pasztillák - Fuel element capsules
fűtőelemek fém burkolata - metal casing of fuel assemblies
raktortartály és a primer kör fémszerkezete - reactor vessel and primary circuit in metal structure
hermetikus védőépület (konténment) - hermetically sealed protective building (containment)

Figure 1-10: Successive physical barriers of a nuclear power plant

In line with the in depth defence principle safe operation of the power plant is furthermore ensured by process technology protection, safety, and localisations systems in addition to the standard plant operation systems. Safety systems may be actively or passively operated.

ACTIVE SAFETY SYSTEMS

The new units will have several active systems needing electric power supply to handle operating, functional troubles. Most of these systems have four parallel branches which are physically separated and operate independently, but one is sufficient to provide the protective function in question. The key active safety systems of MIR-1200 will be as follows:

- The high pressure failure management cooling system feeds boric acidic cooling water into the primary circuit in the case of operating troubles involving the loss of cooling medium.
- The low pressure failure management cooling system is activated when operating troubles start with the break of large diameter pipes in the primary circuit.
- The failure management emergency boron system delivers high boric acid concentration cooling medium into the expansion tank in case of primary-secondary through-flows, and into the reactor to secure the sub-critical state when the safety protection system fails.
- The spray (sprinkler) system sprays cold water into the air space of the containment through nebuliser nozzles, facilitating the condensation of the steam in the containment, cooling of the air space and reducing its pressure.
- Low and high boric acid concentration water reservoir system providing boric acid replenishment in all operating state of the reactor.
- The system dedicated to remove residual heat is connected to the primary circuit and prevents overheating of the thermal medium in the primary circuit in case of operating troubles involving shut down.
- The primary circuit over pressure protection system releases steam from the pressure vessel to the aeration tank when pressure level in the primary circuit happened to increased above the permitted level for whatever reason.
- The failure management gas removal system removes the mixture of gas and steam from the primary circuit cooling medium (reactor, pressure vessel, as well as stem generating collectors). Additionally it is also involved in reducing pressure release in the primary circuit in the case of design rate and beyond design base operating troubles.
- The failure management feed water system provides make up water to steam generators in design states when standard and auxiliary feed water systems are not available or fail.
- The secondary circuit pressure release system protects against excessive increase of pressure in the secondary circuit by releasing fresh steam from steam pipelines.
- The main steam line isolation system provides isolation of the steam generators in situations with operating troubles when there is a need to quick and reliable localisation of the steam generators on the secondary side.

In the event of operating troubles the active safety systems are supplied with electric power by diesel aggregates, four of which are available on each unit.

PASSIVE SAFETY SYSTEMS

Beside the active safety systems a number of passive safety systems are also used by the new units. Their common property is that no human intervention or external energy source is needed and their function is accomplished by simple physical processes.

Long term cooling of the reactor and the primary circuit is ensured in cases of breakdown situations without the need for operator intervention. Cooling of the active zone is provided from four independent pressure storage reservoirs (hydraulic accumulators) where an appropriate volume and concentration boric acid solution is stored. The function of the hydraulic accumulators is to keep the active zone submerged under water in the initial period of operating troubles implying high level of losses from the primary thermal carrier, until active systems step in. Cooling water is delivered from these pressure storage reservoirs into the reactor by a high pressure nitrogen cushion in the gas space above the water level.

Additional passive safety systems include the passive heat removal systems providing long term accidental cooling to the primary circuit and the containment, the description of which is found in the next section.

MANAGING SEVERE ACCIDENTS

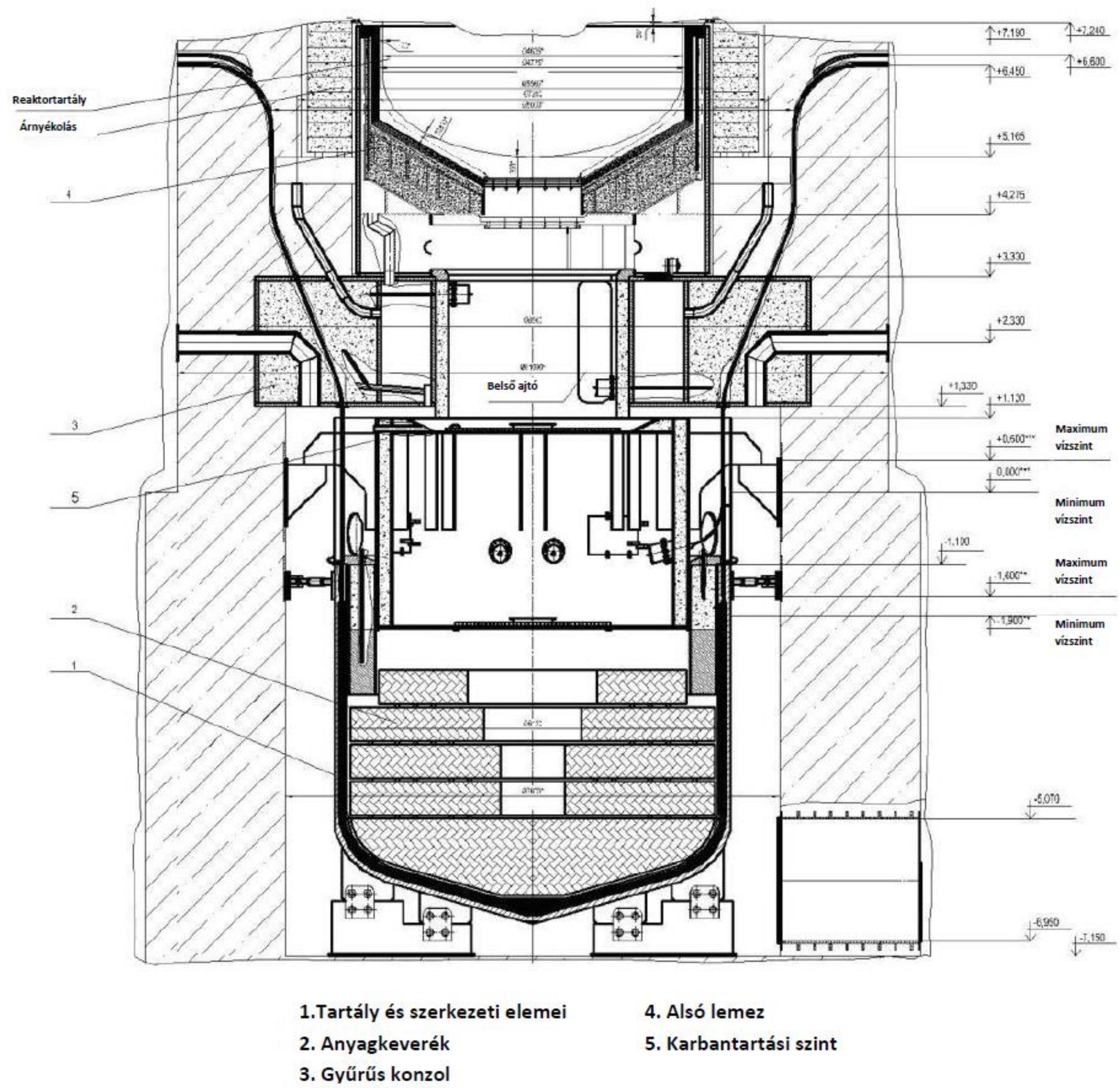
Third generation reactors are designed in a manner that they have appropriate tools available for the purposes of managing severe accidents.

Two such passive systems are available to remove residual heat which is put into the foreground in the case of severe accidents. One removes heat from the steam generator, the other from the containment. They consist of four parallel branches each with flow provided by natural circulations. Passive cooling of steam generators may be necessary when active cooling systems fail. If the active spraying (sprinkler) system designed to cool the air space within the containment does not operate, passive heat removal systems make sure that the inner pressure of the protective building did not reach the level which would risk the integrity of the construction. Passive systems are able to prevent core damage for a period of 72 hours without any external intervention and their proper functioning is substantiated by trials conducted on a high number of experimental equipment.

Following an eventual core injury the integrity of the containment may be put to risk by hydrogen released as a result of the reaction between zirconium and water vapour. In the new units to be constructed at Paks the passive autocatalytic recombinators placed in the upper part of the inner containment prevent the accumulation of an explosive state.

In order to mitigate the consequences of the most severe accident situation, core melt down a so-called melt trap was designed. This is a special vessel placed in the bottom of the reactor cavity under the reactor vessel (Figure 2) and should the reactor vessel be damaged following the meltdown of the core, the melted core will get into this.

The vessel contains ceramics with aluminium and iron oxide contents which is fit for being blended with the core melt. As a result of the mixing the material properties of the melt will be altered, the melt is diluted and the residual heat in any unit of volume is reduced. Neutron absorbing gadolinium is also added to the ceramics, thus enhancing subcriticality of the melt. The steel vessel of the melt trap is cooled by water from the outside. Using this so called dry trap solution it can be prevented that the melt could enter into interaction with the concrete on the foundation slab. With the use of the melt trap hydrogen generation and escape of radioactive fission products from the core debris can be reduced.



reaktortartály - Reactor vessel
árnyékolás - Shielding
belső ajtó Inner door
maximum vízszint - Maximum water level
minimum vízszint - Minimum water level
maximum vízszint - Maximum water level
minimum vízszint - Minimum water level

1. Tartály és szerkezeti elemek - 1. Vessel and structural elements
2. Anyagkeverék - 2. Material mixture
3. Gyűrűs konzol - 3. Annular console
4. Alsó lemez - 4. Base plate
5. Karbantartási szint - 5. Maintenance level

Figure 1-11: Cross section of the meltdown trap in the core (Source: Atomstroyexport)

Hermetic protective building (containment)

In the new blocks both the reactor vessel and the primary circuit are situated in a double hulled protective construction (containment). The containment provides the final, fourth physical barrier and the failure management safety systems are also installed here. Equipment is protected from external hazards by the external construction with a diameter of approximately 50 which is called the secondary containment. The inner – so called primary – containment is cylindrical floor area building with 44 metres of inner diameter, covered by the hemisphere from above. The height of the cylindrical part is 44.6 m. The thickness of the wall in the cylindrical part is 1.2 m while the upper spherical dome is 1 m thick. A 6 mm thick steel armouring covers the pre-stressed concrete walls from the inside, which prevents any leakage.

The inner containment seals the primary circuit containing the radioactive substances hermetically from the environment. Air space between the external and the inner wall is continuously ventilated and air is exhausted through filters. Doors leading to the containment are operated like a lock and close hermetically.

Protection against external hazards

During the design process a special emphasis was put on securing protection against external hazards. Thanks to the solutions applied this type of reactor is appropriately protected from the most important hazards of human origin in addition to the natural calamities as follows:

- The power plant was designed in a manner that it withstands any earthquake the maximum free surface horizontal acceleration rate of which does not exceed a level of 0.25 g.
- Upon the design of the safety equipment of the nuclear power plant a shock wave following a potential external explosion was also taken into consideration.
- The double hulled containment was designed in a manner that it could withstand the crash of a large passenger carrier aircraft.
- Snow pressure generated by a snow cover of several metres thick can be resisted by the building.
- Safety equipment to withstand extreme ambient temperature, high wind speed and tornado.

1.16 Please provide (by using reference data, if necessary) the estimated specific activity of the shut down reactors at the time of abandonment or decommissioning, isotope composition, material balance and contamination level for the buildings and main technology systems.

Pursuant to Government Decree No 118/2011. (VII. 11.) on the nuclear safety requirements of nuclear facilities and the related activities of authorities a preliminary decommissioning plan has to be developed in the design phase of any nuclear facility. This should cover – among others – considerations related to the environmental aspects of decommissioning, in particular the management of radioactive waste and radioactive discharges, as well as the estimates on expected doses for both the persons concerned and the general public.

The same decree provides for the preparation of the so called Preliminary safety report, in which the following details must be described with respect to the management of radioactive waste:

- Determination of sources of discharges
- Liquid waste treatment systems
- The basis for design
- System description
- Discharge levels
- Gaseous waste treatment systems
- The basis for design
- System description
- Discharge levels
- Solid waste treatment systems
- The basis for design
- System description
- Waste management concept of waste generated during the management and clean up of operating troubles, severe accidents and very severe accidents
- Estimates of the quantity and quality of waste generated
- Presentation of the comprehensive waste management concept
- The system monitoring and sampling radioactivity in process technology systems and environmental discharges
- The basis for design
- System description
- Environmental monitoring and sampling system
- The system monitoring and sampling radioactivity in process technology systems
- Its evaluation

The preparation of both documents is part of the establishment licensing procedure to be conducted by the HAEA (and, as a specialist expert authority, by the environmental protection authority), the permit can only be issued when holding them. However, the Environmental Impact Assessment required by Government Decree No 314/2005. (XII. 25.)

precedes the establishment licensing procedure in terms of time, therefore in this stage the data otherwise necessary for the establishment licensing procedure are not or only partially available, and are determined in the course of such procedure, such as the estimated specific activity of the reactors, isotope composition, material balance and contamination level for the buildings and main technology systems at the time of decommissioning. In spite of this the material balance and main radioactive waste sources as well as the contamination level for the buildings can be estimated with a good approximation, which are described below.

More than 50% of the radioactive waste generated in the course of the decommissioning process will originate from the structural elements and biological protection around the reactor vessel. The approximate volume of concrete protective structure is 1900 m^3 (4408 t), while the amount of incorporated steel is 500 tons. Estimated isotope composition and specific activity [Bq/g] of the activated concrete structures is shown on the following table.

Isotope	**Holding time (year)**				
	1	**5**	**25**	**50**	**100**
^{3}H	2.90E+07	2.30E+07	7.40E+06	2.00E+06	7.70E+04
^{14}C	7.10E+01	7.10E+01	7.10E+01	7.10E+01	7.10E+01
^{36}Cl	1.10E+02	1.10E+02	1.10E+02	1.10E+02	1.10E+02
^{41}Ca	6.00E+00	6.00E+00	6.00E+00	6.00E+00	6.00E+00
^{46}Sc	1.60E+02	9.10E+04	6.60E-30	-	-
^{55}Fe	4.60E+04	8.50E+03	9.60E+01	1.40E-01	4.00E-07
^{60}Co	5.00E+03	3.00E+03	2.10E+02	7.90E+00	1.10E-02
^{59}Ni	5.20E-01	5.20E-01	5.20E-01	5.20E-01	5.20E-01
^{63}Ni	4.80E+01	4.80E+01	4.00E+01	3.40E+01	2.40E+01
^{85}Kr	4.60E+01	3.50E+01	9.70E+00	1.90E+00	7.70E-02
^{94}Nb	7.00E-05	7.00E-05	7.00E-05	7.00E-05	7.00E-05
^{134}Cs	2.90E+02	7.60E+01	8.60E-02	1.80E-05	7.90E-13
^{151}Sm	4.10E+01	4.10E+01	3.50E+01	2.80E+01	1.60E+01
^{152}Eu	9.50E+03	7.70E+03	2.50E+03	6.50E+02	4.30E+01
^{154}Eu	1.20E+03	8.40E+02	1.40E+02	2.10E+01	3.50E-01

Table 1-14: Activated concrete structures with the activity concentration of their dominant isotopes (Bq/g)

Another significant source of radioactive waste is the reactor vessel and core components. According to the preliminary estimates the specific activity of the reactor vessel will be 1.1×10^{10} Bq/kg, the mass is 323 tons, while the estimated specific activity of the inner reactor components will be 5.5×10^{10} Bq/kg, total mass approximately ~183,7 tons.

For the purposes of predicting the estimated activity concentration of the other conditioned radioactive waste generated during the decommissioning process the following assumptions can be made:

- surface contamination of equipment in the main water circuit 400 000 Bq/cm^2,
- surface contamination of thermal carrier treatment systems in the primary circuit, escape water collecting systems, liquid radioactive waste storage and processing systems is also estimated to be 400 000 Bq/cm^2,
- surface contamination of other primary circuit systems is 40 000 Bq/cm^2.

Activity of the characteristic isotopes of waste treated and conditioned with the various waste management technologies is presented in the following table.

Isotope	^{3}H	^{14}C	^{60}Co	^{59}Ni	^{63}Ni	^{137}Cs	^{90}Sr	^{152}Eu	^{154}Eu
Activity [Bq]	2.59E+15	7.40E+08	1.11E+14	3.70E+11	7.40E+11	7.77E+13	2.33E+13	1.11E+11	1.11E+10

Activity of the characteristic isotopes of conditioned radioactive waste

Estimated amount of radioactive waste generated during decommissioning and requiring final disposal with respect to one unit is shown on the table below.

Waste	Waste category	Volume [m^3]
Metal scrap from melting	high activity	85
Metal chippings from decommissioning and decontamination of sludge equipment	intermediate activity	10
Structural elements of the reactor building	low and intermediate activity	560
Structural elements of the turbine building	low activity	40
Structural components of various equipment	low and intermediate activity	100
Refractory material	low and intermediate activity	1340
Total	low and intermediate activity	2050
	high activity	85

Figure 1-15:: Estimated amount of radioactive waste generated during decommissioning and requiring final disposal for each unit [1]

1.17 Please describe the decommissioning strategies considered, the radiation protection properties of decommissioning and the proposed radiation protection monitoring arrangements, the expected radioactive discharges and the quantitative characteristics of the radioactive waste generated

During the preparation of the environmental impact study the following decommissioning strategies were considered:

- instant decommissioning,
- delayed decommissioning,
- mixed decommissioning (instant decommissioning of the primary circuit and delayed decommissioning of the primary circuit).

TRANSIENT PERIOD

All three decommissioning strategies start with the final shut down of the unit. Each of the three strategies reckon with a transient period between final shutdown and the commencement of decommissioning. The main purpose of the decommissioning activity during the transient period is to remove and cool down spent fuel, to remove all functional waste and hazardous materials and to reduce the number of auxiliary systems present to a level, which still can support safe decommissioning operations.

The main phases of the transient period and their respective characteristic features are as follows:

- unit 1 shut down, unit 2 operated at output level (2080-2085):
    - unit 1 spent fuel in the holding basin,
    - unit 1 spent fuel cooling systems in operation,
    - operation of joint systems of unit 1 and unit 2.
- both unit 1 and unit 2 are shut down (2085-2090):
    - spent fuel removed from unit 1,
    - shut down of unit 1 systems, preparation for the next decommissioning phase,
    - unit 2 spent fuel in the holding basin,
    - unit 2 spent fuel cooling systems in operation,
- both unit 1 and unit 2 are shut down (2090-2093):
    - spent fuel removed from unit 1 and 2,
    - shut down of unit 2 systems, preparation for the next decommissioning phase.

At the end of the transient period the final stage of the systems corresponds to the stat required fro the purposes of the next decommissioning phase, just as desired by the decommissioning option concerned.

Completion of the transient period can be characterised as follows:

- spent fuel elements had been removed from the facility,
- primary circuit systems have been drained and decontaminated,
- functional radioactive waste was processed and disposed of,
- systems out of service are shut down in a safe technical state,
- the next phase of decommissioning prepared.

INSTANT DECOMMISSIONING

In the case of the instant decommissioning version dismantling of the facility takes place in a single phase, immediately after the transient period:

- by preparation of actual implementation of the decommissioning operations,
- by dismantling of the less or not at all contaminated auxiliary systems,
- by dismantling of the primary circuit systems and management of the waste generated this way,
- by decommissioning of the reactors,
- by decontamination, radiation protection monitoring and demolition of the building structures,
- rehabilitation of the site.

Preparation of instant decommissioning

Prior to licensing, as part of the decommissioning preparations, the following steps need to be taken: designing the decommissioning processes; radiation protection and hazardous material assessment for the purposes of design and licensing; information dissemination to the public; development of the management model for decommissioning in the case decommissioning is carried out by the operator staff, and selection of Subcontractors, provided the other model is chosen.

In order to complete the main decommissioning operations the necessary equipment need to be procured, such as: equipment needed for decommissioning within the site; equipment for the decontamination of personnel and tools; equipment for radiation protection and health preservation.

In order to ensure transport of the decommissioning materials a designated transport route need to be specified. Work stations need to be established to monitor and decontaminate the transport containers for radiation protection before they would leave the controlled zones of the units.

Decontamination and decommissioning

The main operations related to the decontamination and decommissioning of facilities containing radioactive substances are as follows: decontamination of the process technology systems and selected areas in buildings before decommissioning (chemical and electrochemical), procurement and preparation of equipment/operations needed for manual or remotely controlled decommissioning.

Decommissioning is made gradually, starting with the systems with lower radiation levels and using the manual decommissioning operations; remotely controlled decommissioning will be applied for systems where dose rates are not reduced to the level needed for the application of manual decommissioning, even in the course of the decontamination efforts preceding decommissioning; remotely controlled systems will be applied for the decommissioning of the reactor.

All necessary measures must be taken during the decontamination efforts and decommissioning operations listed above in order to ensure safe local conditions (local ventilation, protective covers and hoods to minimise dispersal of aerosol, shielding, etc.) and to protect personnel (various types of protective clothing) in accordance with the prevailing radiation situation.

In the last stage of decommissioning the auxiliary systems such as ventilation, electric power supply systems, systems providing the technology media, lifting equipment, etc., must be dismantled.

Decontamination of architectural constructions

Technology components, pipe crossings, sinks, built in special sewer and channel pipelines, hermetically sealing doors, etc. in the premises will be removed after full decommissioning of the primary circuit and auxiliary systems. Structural materials of constructions and embedded technological components will be removed with the help of core drilling, concrete cutting and other technologies, operations and equipment. The result of this is a state where all premises are empty and free from any system components. This is the initial state for activities conducted on the architectural components, such as decontamination of the building surfaces using chemical or mechanical methods, pending on the type and radiological parameters of the building. The last activity is the radiological monitoring of the decontaminated surfaces to document that transfer and acceptance conditions for the building have been met.

Waste management

Treatment and conditioning of radioactive and inactive waste originating from the decommissioning will take place using the technology presented in Chapter 19.9.1 of the EIS. Decommissioning of the treatment plants of radioactive waste will take place after all decommissioning waste was duly processed. Equipment processing common non radioactive waste will be dismantled after all waste originating from the last common source of waste (which is the demolition of the buildings) have been processed.

Rehabilitation of the site

Standard industrial operations of decommissioning process technology systems and demolition of building constructions will be applied in the following cases: decommissioning of systems installed in the buildings outside of the controlled zone, decommissioning of active buildings after decontamination and radiological checks, and the demolition of buildings outside the controlled area.

After backfilling the area is covered by a layer of topsoil and landscaped. The final activity is the completing radiological monitoring of the site, development of a documentation for the authority which presents the final state achieved.

As part of the decommissioning project all necessary supporting activities and services must be provided, in other words preparation and conversion of the work places, project management, contacts with the public (PR), supporting services, health protection and security services.

DELAYED DECOMMISSIONING

In the case the decommissioning option is exercised, decommissioning takes place in three phases following the transient period:

Phase I: Preparation of the safeguarded preservation of the primary circuit:

- zoning of the buildings,
- re-definition of the controlled zone, reduction of entry points, etc.;
- modification of the systems necessary for safeguarded preservation of the primary circuit;
- modification of the building construction structures and systems in order to ensure long term safety for safeguarded preservation of the primary circuit.

Phase II: Safeguarded preservation of the primary circuit for a period of 50 years

Phase III: Decommissioning/demolition of primary circuit process technology and buildings:

- preparation of decommissioning;
- decommissioning of low activity or inactive auxiliary systems;
- decommissioning primary circuit systems;
- reactor decommissioning;
- decontamination and radiological checks of architectural structures;
- demolition of architectural structures,
- rehabilitation of the site.

Radioactive and inactive materials generated in the first phase are treated in the systems used for the management of the plant operation waste, in the second phase waste generated is collected and is treated only in the third phase.

Phase I of decommissioning

Zoning within the buildings

The operations used during the operation of the facility are also used to a slight decontamination of the external surfaces of process technology systems and the selected building structures, to minimise aerosol formation in the period of safeguarded preservation of the primary circuit. Controlled zones in each of the buildings are modified to minimise their sizes.

Modification of systems needed for safeguarded preservation of the primary circuit

During the safeguarded preservation of the primary circuit the selected auxiliary systems operate only for scheduled surveillance and maintenance periods: electric power supply system, ventilation, radiological monitoring, special sewer system, radiation gates, lifting equipment, physical safety engineering systems. Other systems not used during the period of safeguarded preservation of the primary circuit which will be still needed at the time of final decommissioning, are preserved.

Modification of the building construction structures and systems for the purposes of long term safety

Long term safety of systems and structures is a key issue in the case of delayed decommissioning. When safeguarded preservation of the primary circuit takes place, all active buildings are safely shut down, and measures must be taken to secure long term stability. This must be made before the start of the safeguarded preservation period in such an extent that no major overhaul should be required during the safeguarded preservation period.

Phase II of decommissioning

Operation during safeguarded preservation

Waste generated during safeguarded preservation of the primary circuit are collected and stored in the premises of the reactors under safeguarded preservation. Expected types of waste in this period include protective clothing, waste from maintenance of systems and structures; condensate.

Waste collected will be processed in Phase III of decommissioning.

Preparation of decommissioning during safeguarded preservation of the primary circuit

After safeguarded preservation of the primary circuit final decommissioning follows. The scope of activities in principle is the same as in the case of instant decommissioning.

Phase III of decommissioning

No decontamination before decommissioning will be necessary. Decommissioning and chopping of primary circuit components into pieces can be carried out on site as a result of decayed activity of the isotopes. In general, the technology, operations are a lot more straightforward and the radiation exposure of the personnel is substantially lower.

Decommissioning technology, decontamination of building surfaces, waste management and site rehabilitation are practically the same as in the case of instant decommissioning.

Radiological properties of decommissioning, radiation protection monitoring

As a potential source of radiation, equipment, structural elements, surfaces, construction structure components contaminated in the course of operation of the facility must be taken into account during decommissioning. Therefore, potential risk of radiation may be represented for the personnel working there by the works which may occur in relation to these components (radiation survey, decontamination, decommissioning , demolition, waste management etc.).

A common feature of activities with associated radiation hazard to be completed during decommissioning is – assuming the application of wet decontamination processes of the equipment and the use of appropriate exhaust and personal protective equipment in the decommissioning and demolition processes – that external radiation exposure is the dominant source, any incorporation may only be considered during the treatment of the decontamination waste.

In the decommissioning period the main purpose of the periodical radiological measurements is to follow up the changes in the radiation conditions throughout the progress of the decommissioning processes – for instance decontamination, dismantling of equipment, demolition of contaminated building structures, treatment and disposal of radioactive waste.

The concept of environmental radiation protection covers the monitoring of discharges and the environment in the case of decommissioning as well.

During decommissioning the sources of atmospheric releases include the following processes:

- treatment of liquid media in technology systems;
- decontamination of contaminated surfaces;
- decommissioning related to contaminated surfaces and materials, cutting, demolition, chopping operations.

Decreasing the particles generated and aerosol discharge can be implemented by dust separator, filtering equipment and using wet processes.

With the control of the liquid discharges and atmospheric releases in the manner referred to above it can be secured that current release limits be complied with.

Rules pertaining to monitoring of discharges and the environment are laid down in Ministerial Decree No 15/2001. (VI.6.). Under this Decree a nuclear power plant must have Emission Monitoring Regulations (EMR), and Environmental Monitoring Regulations (EnMR) concerning its operation. The regulations referred to above contain the following elements:

- rules of procedure for monitoring;
- methods of control;
- measurement methods;
- rules of procedure for recording and archives of measurement results;
- sample, data and information supply to authority;
- measures for non-scheduled operation incidents.

For the purposes of discharge and environmental monitoring of decommissioning the regulations referred to above should be taken into account, modified to the extent justified by the properties of the decommissioning operations. In general it can be stated that the methodology and set of means of operational discharge and environmental monitoring basically can and should also be used for the purposes of decommissioning (as long as the decommissioning processes allow to do so).

For the purposes of adapting the monitoring systems to the needs of decommissioning the following considerations may be taken into account:

- For the purposes of discharges through the ventilation stack the data of the continuous aerosol (beta, alpha) measuring unit are necessary. Measurement cycles will be best modified with a view to the experiences drawn from the measured data. For the purposes of investigating any other component – that is, isotope specific measurements – the samples of the laboratory sampling unit must be used. No noble gas measurement is justified. During the decommissioning process the properties of the sampling and measurements need to be adapted as a function of the measurement results obtained and the progress of the working operations.
- Upon commencement of decommissioning environmental monitoring should be continued in an unaltered format. As a function of the experiences of the measurements and the evaluation of the measured data decrease of the test directions, decrease in the measurement cycles, rationalisation and decrease of the metering points are expected to be possible by the progress of the decommissioning operations. However, the scope of the environmental elements tested is recommended to be retained in order to have full scale information available on the environmental impacts of the decommissioning process.

2 AMBIENT NOISE AND VIBRATION CONTROL

2.1 Benchline measurements for noise and vibration exposures

2.1.1 The general/overall view of the measurement points shall be provided in such a scale where noise sources can be verified and critical points are clearly discernible.

The measurement sites/points for benchline status of ambient noise levels were provided on the Master plans and Lay-out plans for the settlements concerned including the township of Paks. Maps in the size of A0 and A3 format scaled M=1:3000 are attached as an annex hereto.

2.1.2 Benchline measurements for traffic noise at the critical points must be repeatedly completed with a view to the following considerations;

2.1.2.1 The measuring microphone should be placed pursuant to Section 5.3 of the Hungarian standard No MSZ ISO 1996-2:1995 referred to in Sections 3.1.1 and 3.2.1 of Annex No 3 to Ministerial Decree No 25/2004. (XII. 20.) KvVM (hereinafter referred to as; 25/2004. KvVM Decree) laying down the detailed rules for the preparation of strategic noise maps and of actions plans.

On the 1:3000 scale maps illustrating the placement of the measuring points used during the baseline measurements of ambient noise level the tip of the arrow indicating the measurement point defines the direction of the measuring microphone of the noise measurement instrument used for noise measurements.

ZMP10

The measurement point No ZMP10 in the township of Paks, the noise measurement instrument was placed at the location marked by the asterisk during the assessment of the ambient noise benchline level.

Figure 2-1: Measurement point No ZMP10 in Paks township

The main road No 6 running underneath the embankment (to which the microphone was directed) can be seen on the following picture:

Figure 2-2: The main road No 6 running underneath the embankment, the railway and the Danube river

ZMP9

Measurement point No ZMP9 within the area of Paks township, the measurement microphone is directed towards the Main Road No 6 during the assessment of the ambient noise benchline level.

Figure 2-3: The position of the measurement microphone at measurement point No ZMP9 during the assessment of the ambient noise benchline level.

ZMP5

Measurement point No ZMP5 Paks-Csámpa, the measurement microphone is directed towards the Main Road No 6 during the assessment of the ambient noise benchline level.

Figure 2-4: The position of the measurement microphone at measurement point No ZMP5 during the assessment of the ambient noise benchline level.

ZMP14

Measurement point No ZMP14 Dunaszentgyörgy, the measurement microphone is directed towards the Main Road No 6 during the assessment of the ambient noise benchline level.

Figure 2-5: The position of the measurement microphone at measurement point No ZMP14 during the assessment of the ambient noise benchline level.

ZMP12

Measurement point No ZMP12 Paks Kölesdi Road, the measurement microphone is directed towards the Kölesdi Road during the assessment of the ambient noise benchline level.

Figure 2-6: The position of the measurement microphone at measurement point No ZMP12 during the assessment of the ambient noise benchline level.

ZMP13

Measurement point No ZMP13 Paks Kölesdi Road, the measurement microphone is directed towards the Main Road No 6 during the assessment of the ambient noise benchline level.

Figure 2-7: The position of the measurement microphone at measurement point No ZMP13 during the assessment of the ambient noise benchline level.

2.1.2.2 Measurements should be assigned to the critical points (at the most adversely situated properties).

During the assessment of the ambient noise benchline level the benchline status measurements were carried out at the most adversely situated properties, in front of the façade of those properties to be protected (in accordance with the respective applicable decrees) which are the closest to the Paks Nuclear Power Plant along the transport routes.

2.1.2.3 Provided sampled measurements are intended to be carried out please consider the provisions laid down in item b) Section 3.4 Annex No 3 to Ministerial Decree No 25/2004. KvVM for the purposes of selecting the duration of the measurement sessions.

No sampled work is intended to be carried out.

2.1.2.4 Traffic counts shall be taken in accordance with the acoustic vehicle categories defined in Table No 2 in Annex No 2 to Ministerial Decree No 25/2004. KvVM when traffic counts are taken and measurement results evaluated as part of the traffic noise assessment.

Benchline measurements of traffic noise have been carried out in accordance with Section 4.2. in Annex No 2 to Ministerial Decree No 25/2004. KvVM. The vehicle categories defined in the decree were used. A training course was held on the use of noise measurement sheets before the commencement of the measurement series and all experts participating in the measurements were trained on the kinds of transport vehicles representing transport categories 1. 2 and 3.

2.1.2.5 Please conduct traffic noise evaluations pursuant to AKMI data from the year 2012

At the time the measurements were evaluated (December 2012 - January 2013), no ÁKMI data from the year 2012 were available.

2.1.2.6 Disturbing noises encountered during measurements such as barking dogs or harvesting combines cannot be measured towards the traffic noise.

After the second series of measurements which was intended to assess traffic noises, harvesting machines were operated in the adjacent cropland beside the public road in Section 4 of the phased measurement at measurement point No ZMP7 (from 18:00 to 19:00 o'clock), the noise of which could not be excluded. The noise of the combine harvester was taken into account as a background noise, it can be seen from the completed calculations that the difference between the L_{Aeq} noise pressure level values measured during the individual measurement phases does not exceed 2 (two) dB. The noise measuring instrument is of an integrating type which excludes the short term noise impacts occurring during a long measurement period (3600 sec) (for instance: dog barking). The ratio of the long integration period and the short term noise effect differ considerably.

2.1.3 It has to be justified why the measurement results on the measuring sheet differ from the measurement results included in the documentation prepared on the benchline assessment (hereinafter referred to as: Benchline documentation).

The instantaneous value was recorded erroneously in the field entitled "Noise pressure level L_{Aeq} [dB (A)]" on the measurement sheets. The instantaneous value is the dB value displayed on the measurement device at the end of the measuring session, appearing when the measurement is stopped automatically. Such a value does not provide the measurement result for the entire measurement period because it is stored in the memory of the measuring device.

2.1.4 Please state whether or not the noise pulses could be detected by subjective observation during the benchline assessment at the measurement points where pulse correction was applied.

It was determined on the basis of both the subjective observations and the diagrams where pulse correction has to be conducted. The pulse correction was accomplished on these points.

2.1.5 In the event noise pulses could be detected by subjective observation, the determination of the pulse correction must be made in accordance with Annex No M.1.2 of the Hungarian standard No MSZ 18150-1 entitled assessment and entitled of ambient noise (hereinafter referred to as: Standard MSZ 18150-1) and when the measurement results are discussed, the results providing the basis for pulse correction must be provided.

The relevant conditions were met during the pulse correction procedure, the pulse correction was accomplished in compliance with the standard requirements. The results providing the basis for pulse correction pursuant to Hungarian standard MSZ 18150-1:1998 Annex M1 ΔL_{Amax}, LA_{Smax}, LA_{Imax}, $LA_{Smaxaverage}$, $LA_{Imaxaverage}$, K_{imp} are found in the Noise and vibration benchline documentation for each measurement point.

With respect to the evaluation of the measurement point No ZMP22 the method of calculation is presented below.

At least ten L_{AImax} values were determined with the help of the noise measurement software (BZ5503 version 4.3.2.123) manually and the value of $L_{AImax\ average}$ was derived from the figures thus obtained.

$L_{AImax\ average}$ =(65.5+63.9+63.2+65.4+63.8+63.4+63.5+63.7+63.8+64.8)/10=64.1 [dB]

The value of $L_{ASmax\ average}$ is calculated by the software programme integrated into the noise measuring device (BZ5503 version 4.3.2.123) automatically in each case.

$L_{ASmax\ average}$=56.8 [dB]

Measurement	Start Time	Stop Time	Elapsed Time	LAeq [dB]	LAImax [dB]	Bandwidth	Serial Number	LAF95,0 [dB]
Total	2014.01.23. 13:46:02	2014.01.23. 14:01:02	00:15:00	59,2	65,5	1/3-octave	2685339	57,8
Logged	2014.01.23. 13:46:11	2014.01.23. 13:46:12	00:00:01	61,7	65,5			59,3

No marker features available. Requires license BZ-5503-A

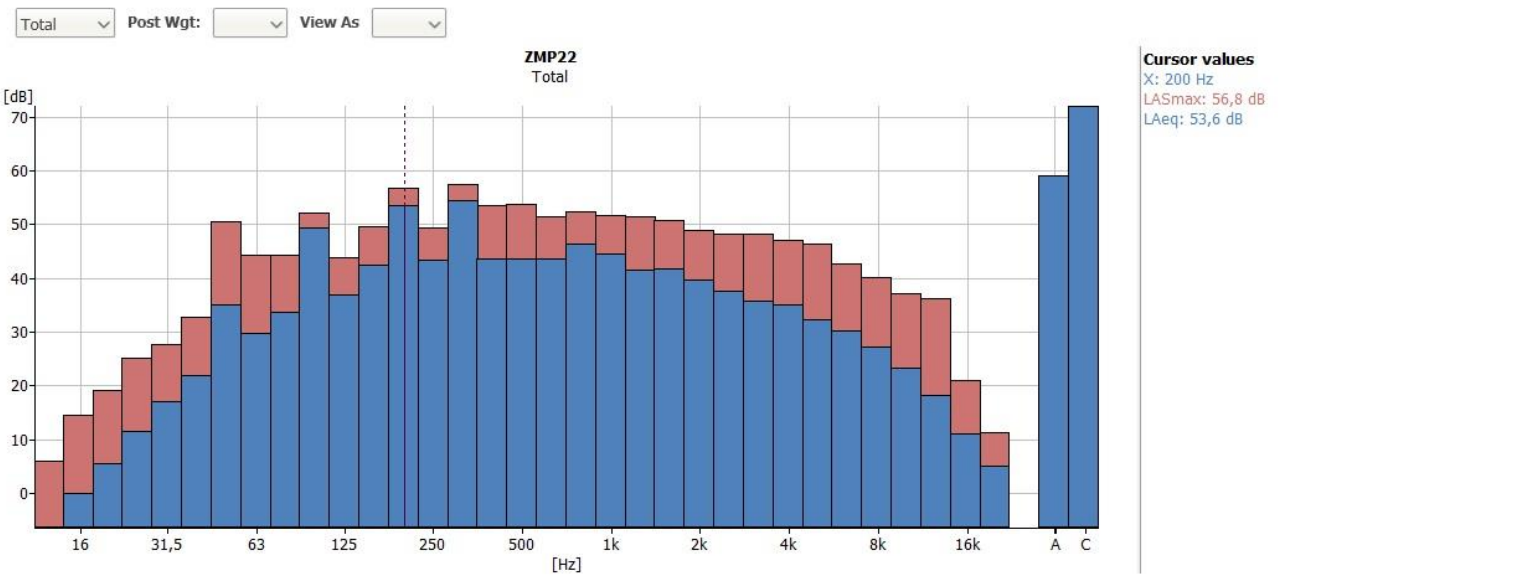


Figure 2-8: First L_{AImax},value and $L_{ASmax\ average}$ value at the measurement point ZMP22 (cursor position)

Measurement	Start Time	Stop Time	Elapsed Time	LAeq [dB]	LAImax [dB]	Bandwidth	Serial Number	LAF95,0 [dB]
Total	2014.01.23. 13:46:02	2014.01.23. 14:01:02	00:15:00	59,2	65,5	1/3-octave	2685339	57,8
Logged	2014.01.23. 13:47:47	2014.01.23. 13:47:48	00:00:01	60,8	63,9			59,8

No marker features available. Requires license BZ-5503-A

Total | Post Wgt: | View As

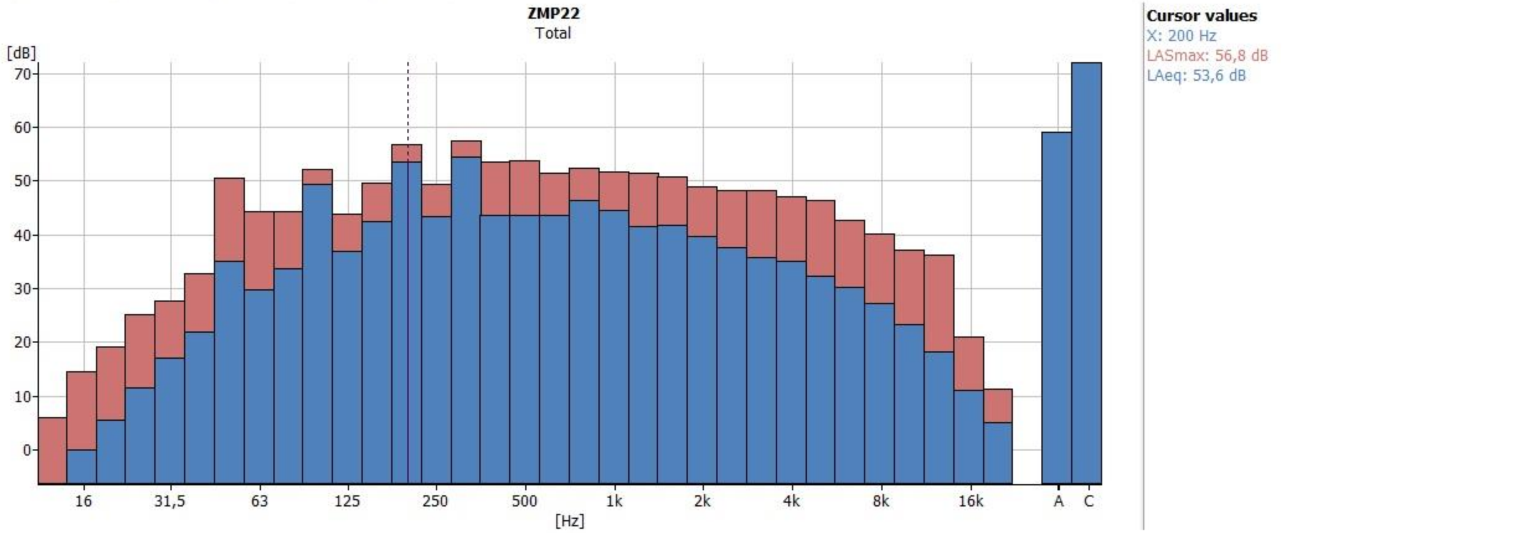


Figure 2-9: The second L_{AImax}, value and $L_{ASmax\ average}$ value at the measurement point ZMP22 (cursor position)

2.1.6 Disturbing noises of the measurement not part of the assessment (dog barking, donkey, pheasant, rooster, cyclist, cricket) need to be disregarded during the evaluation of the measurement results.

Noises caused by dog barking, donkey, pheasant, rooster, cyclist, cricket are the characteristic ingredients of the background noise of the measurement points concerned, which turn up in the specified season of the year regularly and they define the extent of the background noise, therefore they can not be cut out, otherwise a default state typical for the measurement point in question would be changed.

2.1.7 Having regard to the very high background noise measured at some of the measurement points (for instance ZMP22 — ZMP25), please provide the methodology for measuring the background noise, which noises the background noise contains.

Noise assessment of plant equipment was made at the measurement points No ZMP22, ZMP23. ZMP24, ZMP25, and the background noise was determined in accordance with paragraph three Section 4.1.8 of the Hungarian standard No MSZ 18150-1:1998. The background noise is the accompanying noise of the equipment installed at the test points.

2.1.8 Please take into account Section 4.5.2 of the Hungarian standard No MSZ 18150-1 when L_{AM} is defined.

Values were corrected as follows.

Plant noise was measured at point No **ZMP1**. The nature of the noise was continuous and permanent during both daytime and night-time.

Daytime					Night-time				
L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$	L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$
[dB]					[dB]				
51.1	-3.72	2.4	48.7	NH*	53.9	-5.87	1.3	52.6	NH*

**can not be determined independently from the background noise*

L_{AM}	L_{Aeq}	K_{imp}	ΔL_{Amax}	L_{ASmax}	L_{AImax}	L_{AM}	L_{Aeq}	K_{imp}	ΔL_{Amax}	L_{ASmax}	L_{AImax}
[dB]						[dB]					
X	51.1	X	X	X	X	X	53.9	X	X	X	X

Table 2-1: Correction calculations daytime/nighttime – ZMP1

Plant noise was measured at point No **ZMP2**. The nature of the noise was continuous and permanent during both daytime and night-time

Daytime					Night-time				
L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$	L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$
[dB]					[dB]				
47.2	-0.94	7.1	40.1	46.3	47.0	-4.9	1.7	45.3	NH*

*can not be determined independently from the background noise

L_{AM}	L_{Aeq}	K_{imp}	ΔL_{Amax}	L_{ASmax}	L_{AImax}	L_{AM}	L_{Aeq}	K_{imp}	ΔL_{Amax}	L_{ASmax}	L_{AImax}
[dB]						[dB]					
46.3	46.3	x	x	x	x	x	47	x	x	x	x

Table 2-2: Correction calculations daytime/nighttime – ZMP2

Plant noise was measured at point No **ZMP3**. The nature of the noise was continuous and permanent during both daytime and night-time.

Daytime					Night-time				
L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$	$L_{Aeq\ measured}$	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$
[dB]					[dB]				
47.9	-0.85	7.5	40.4	47	47.3	-4.69	1.8	(45.5)	NH*

*can not be determined independently from the background noise

L_{AM}	L_{Aeq}	K_{imp}	ΔL_{Amax}	L_{ASmax}	L_{AImax}	L_{AM}	L_{Aeq}	K_{imp}	ΔL_{Amax}	L_{ASmax}	L_{AImax}
[dB]						[dB]					
47.0	47.0	x	x	x	x	x	47.3	x	x	x	x

Table 2-3: Correction calculations daytime/nighttime – ZMP3

Plant noise was measured at point No **ZMP4**. The nature of the noise was continuous both during the day and the night.

Daytime					Night-time				
L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$	$L_{Aeq\ measured}$	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$
[dB]					[dB]				
46.1	-0.19	13.7	32.4	45.9	44.4	-2.49	3.6	40.8	41.9

*can not be determined independently from the background noise

L_{AM}	L_{Aeq}	K_{imp}	ΔL_{Amax}	L_{ASmax}	L_{AImax}	L_{AM}	L_{Aeq}	K_{imp}	ΔL_{Amax}	L_{ASmax}	L_{AImax}
[dB]						[dB]					
45.9	45.9	x	x	x	x	41.9	41.9	x	x	x	x

Table 2-4: Correction calculations daytime/nighttime – ZMP4

Plant noise was measured in the second measurement at point No **ZMP4**. The nature of the noise was continuous both during the day and the night.

Daytime					Night-time				
L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$	L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$
[dB]					[dB]				
41.1	-0.99	6.9	34.2	40.1	39.7	-1.75	4.8	34.9	38.0

L_{AM}	L_{Aeq}	K_{imp}	ΔL_{Amax}	L_{ASmax}	L_{AImax}	L_{AM}	L_{Aeq}	K_{imp}	ΔL_{Amax}	L_{ASmax}	L_{AImax}
[dB]						[dB]					
40.1	40.1	x	x	x	x	38.0	38.0	x	x	x	x

Table 2-5: Correction calculations daytime/nighttime – ZMP4 – second measurement

Plant noise was measured at point No **ZMP6**. The nature of the noise was continuous both during the day and the night.

Daytime					Night-time				
L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$	L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$
[dB]					[dB]				
44.3	-1.02	6.8	37.5	43.3	39.8	-0.3	11.8	28	39.5

L_{AM}	L_{Aeq}	K_{imp}	ΔL_{Amax}	L_{ASmax}	L_{AImax}	L_{AM}	L_{Aeq}	K_{imp}	ΔL_{Amax}	L_{ASmax}	L_{AImax}
[dB]						[dB]					
43.3	43.3	x	x	x	x	39.5	39.5	x	x	x	x

Table 2-6: Correction calculations daytime/nighttime – ZMP6

Plant noise was measured at point No **ZMP22**. The nature of the noise was continuous and pulsed during the day.

Daytime				
L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	L_{Aeq} calculated
[dB]				
59.2	-3.86	2.3	56.9	NH *

*can not be determined independently from the background noise

L_{AM}	L_{Aeq}	K_{imp}	ΔL_{Amax}	L_{ASmax} average	L_{AImax} average
[dB]					
x	59.2	4.87	7.3	56.8	64.1

Table 2-7: Correction calculations, daytime – ZMP22 —supplementary measurement

Plant noise was measured at point No **ZMP23**. The nature of the noise was continuous and permanent during the day.

Daytime				
L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	L_{Aeq} calculated
[dB]				
67.9	-6.17	1.2	66.7	NH *

*can not be determined independently from the background noise

L_{AM}	L_{Aeq}	K_{imp}	ΔL_{Amax}	L_{ASmax}	L_{AImax}
[dB]					
x	67.9	x	x	x	x

Table 2-8: Correction calculations, daytime – ZMP23 —supplementary measurement

Plant noise was measured at point No **ZMP24**. The nature of the noise was continuous and permanent during the day.

Daytime				
L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	L_{Aeq} calculated
[dB]				
80.3	-4.89	1.7	78.6	NH *

*can not be determined independently from the background noise

L_{AM}	L_{Aeq}	K_{imp}	ΔL_{Amax}	L_{ASmax}	L_{AImax}
[dB]					
x	80.3	x	x	x	x

Table 2-9: Correction calculations, daytime – ZMP24 —supplementary measurement

Plant noise was measured at point No **ZMP25**. The nature of the noise was continuous and permanent during the day.

Daytime				
L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	L_{Aeq} calculated
[dB]				
72.3	-5.59	1.4	70.9	NH *

*can not be determined independently from the background noise

L_{AM}	L_{Aeq}	K_{imp}	ΔL_{Amax}	L_{ASmax}	L_{AImax}
[dB]					
x	72.3	x	x	x	x

Table 2-10: Correction calculations, daytime – ZMP25 —supplementary measurement

Other type of ambient noise was measured at point No **ZMP7**. The nature of the noise was continuous both during the day and the night.

Daytime					**Night-time**				
L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$	L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$
[dB]					[dB]				
45.5	-0.45	10.1	35.4	45.1	40.8	-0.44	10.2	30.6	40.4

L_{AM}	L_{Aeq}	K_{imp}	ΔL_{Amax}	L_{ASmax}	L_{AImax}	L_{AM}	L_{Aeq}	K_{imp}	ΔL_{Amax}	L_{ASmax}	L_{AImax}
[dB]						[dB]					
45.1	45.1	X	X	X	X	40.4	40.4	X	X	X	X

Table 2-11: Correction calculations daytime/nighttime – ZMP7

Other type of ambient noise was measured at point No **ZMP8**. The nature of the noise was continuous both during the day and the night.

Daytime					**Night-time**				
L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$	L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$
[dB]					[dB]				
47.5	-0.71	8.2	39.3	46.8	45.1	-0.38	10.8	34.3	44.7

L_{AM}	L_{Aeq}	K_{imp}	ΔL_{Amax}	L_{ASmax}	L_{AImax}	L_{AM}	L_{Aeq}	K_{imp}	ΔL_{Amax}	L_{ASmax}	L_{AImax}
[dB]						[dB]					
46.8	46.8	X	X	X	X	44.7	44.7	X	X	X	X

Table 2-12: Correction calculations daytime/nighttime – ZMP8

Other type of ambient noise was measured at point No **ZMP15**. The nature of the noise was continuous both during the day and the night.

Daytime					**Night-time**				
L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$	L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$
[dB]					[dB]				
35.9	-0.89	7.3	28.6	35.0	47.9	-1.22	6.1	41.8	46.7

L_{AM}	L_{Aeq}	K_{imp}	ΔL_{Amax}	L_{ASmax}	L_{AImax}	L_{AM}	L_{Aeq}	K_{imp}	ΔL_{Amax}	L_{ASmax}	L_{AImax}
[dB]						[dB]					
35.0	35.01	X	X	X	X	46.7	46.7	X	X	X	X

Table 2-13: Correction calculations daytime/nighttime – ZMP15

Other type of ambient noise was measured at point No **ZMP16**. The nature of the noise was continuous both during the day and the night.

Daytime					**Night-time**				
L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$	L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$
[dB]					[dB]				
48.6	-0.092	16.8	31.8	48.5	39.2	-3.12	2.9	36.3	39.2

L_{AM}	L_{Aeq}	K_{imp}	ΔL_{Amax}	L_{ASmax}	L_{AImax}	L_{AM}	L_{Aeq}	K_{imp}	ΔL_{Amax}	L_{ASmax}	L_{AImax}
[dB]						[dB]					
48.5	48.5	X	X	X	X	39.2	39.2	X	X	X	X

Table 2-14: Correction calculations daytime/nighttime – ZMP16

Other type of ambient noise was measured at point No **ZMP17**. The nature of the noise was continuous and pulsed both during the day and the night.

Daytime					Night-time				
L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$	L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$
[dB]					[dB]				
63	-0.001	34.8	28.2	63	42.0	-0.15	14.8	27.2	41.9

L_{AM}	L_{Aeq}	K_{imp}	ΔL_{Amax}	L_{ASmax} average	L_{AImax} average	L_{AM}	L_{Aeq}	K_{imp}	ΔL_{Amax}	$L_{ASmax\ average}$	L_{AImax} average
[dB]						[dB]					
63.0	63.0	-0.33	-0.5	78.5	78.0	45.4	41.9	3.5	5.25	57.6	62.9

Table 2-15: Correction calculations daytime/nighttime – ZMP17

Other type of ambient noise was measured at point No **ZMP18**. The nature of the noise was continuous both during the day and the night.

Daytime					Night-time				
L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$	$L_{Aeq\ measured}$	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$
[dB]					[dB]				
40.1	-0.584	9	31.1	39.5	38.9	-4.33	2	(36.9)	NH*

*can not be determined independently from the background noise

L_{AM}	L_{Aeq}	K_{imp}	ΔL_{Amax}	L_{ASmax}	L_{AImax}	L_{AM}	L_{Aeq}	K_{imp}	ΔL_{Amax}	L_{ASmax}	L_{AImax}
[dB]						[dB]					
39.5	39.5	x	x	x	x	38.9	38.9	x	x	x	x

Table 2-16: Correction calculations daytime/nighttime – ZMP18

Other type of ambient noise was measured at point No **ZMP21**. The nature of the noise was continuous during the day and pulsed at night.

Daytime					Night-time				
L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$	$L_{Aeq\ measured}$	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$
[dB]					[dB]				
63.3	-0.01	27.6	35.7	63.3	54.6	-0.03	21.6	33.0	54.6

L_{AM}	L_{Aeq}	K_{imp}	ΔL_{Amax}	L_{ASmax}	L_{AImax}	L_{AM}	L_{Aeq}	K_{imp}	ΔL_{Amax}	L_{ASmax} average	L_{AImax} average
[dB]						[dB]					
63.3	63.29	x	x	x	x	54.6	54.6	0.15	0.23	67.3	67.5

Table 2-17: Correction calculations daytime/nighttime – ZMP21 —supplementary measurement

Traffic noise was measured at point No **ZMP5**. The nature of the noise was continuous both during the day and the night.

Daytime					Night-time				
L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$	L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$
[dB]					[dB]				
69.0	0.00	31.1	37.9	69.0	65.7	-0.01	28.4	37.3	65.7
68.7	0.00	31.7	37	68.7	63.8	0.00	30.2	33.6	63.8
68.7	-0.01	28.7	40	68.7					

$L_{AMkö}$	K_f	$L_{Aeqkö}$	$L_{AMkö}$	K_f	$L_{Aeqkö}$
[dB]			[dB]		
70	0.76	68.8	63	1.6	61.8

Table 2-18: Correction calculations daytime/nighttime – ZMP5

Ambient traffic noise was measured in the second measurement at point No **ZMP5**. The nature of the noise was continuous both during the day and the night.

Daytime					Night-time				
L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$	L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$
[dB]					[dB]				
68.7	-0.01	27.9	40.8	68.7	65.5	-0.02	24.6	40.9	65.5
70.8	0.00	34.4	36.4	70.8	61.6	-0.01	26	35.6	61.6
71.7	0.00	36.4	35.3	71.7					

$L_{AMkö}$	K_f	$L_{Aeqkö}$	$L_{AMkö}$	K_f	$L_{Aeqkö}$
[dB]			[dB]		
73	2.28	70.57	66	5.16	60.96

Table 2-19: Correction calculations daytime/nighttime – ZMP5– second measurement

Ambient traffic noise was measured in the second measurement at point No **ZMP7**. The nature of the noise was continuous both during the day and the night.

Daytime					Night-time				
L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$	L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$
[dB]					[dB]				
54.3	-0.02	23.5	30.8	54.3	53.5	-0.05	19.6	33.9	53.5
51.5	-0.03	21.6	29.9	51.5	46.8	-0.05	19.2	27.6	46.7
53	-0.06	19.0	34	52.9					

$L_{AMkö}$	K_f	$L_{Aeqkö}$	$L_{AMkö}$	K_f	$L_{Aeqkö}$
[dB]			[dB]		
53	-	53.05	48	-	48.28

Table 2-20: Correction calculations daytime/nighttime – ZMP7 – second measurement

Traffic noise was measured at point No **ZMP9**. The nature of the noise was continuous both during the day and the night.

Daytime					Night-time				
L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$	L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$
[dB]					[dB]				
63.1	-0.03	22.1	41	63.1	53.0	-0.013	25.4	27.6	53.0
61.8	-0.03	21.2	40.6	61.8	51.5	-0.03	21.6	29.9	51.5
61.6	-0.04	20.5	41.1	61.6	56.8	-0.033	21.2	35.6	56.8
63.2	-0.01	27.4	35.8	63.2					

$L_{AMkö}$	K_f	$L_{Aeqkö}$	$L_{AMkö}$	K_f	$L_{Aeqkö}$
[dB]			[dB]		
67	4.65	62.5	63	11.3	51.3

Table 2-21: Correction calculations daytime/nighttime – ZMP9

Ambient traffic noise was measured in the second measurement at point No **ZMP9**. The nature of the noise was continuous both during the day and the night.

Daytime					Night-time				
L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	L_{Aeq} calculated	L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	L_{Aeq} calculated
[dB]					[dB]				
62.4	0.00	31.8	30.6	62.4	51.2	-0.049	19.5	31.7	51.2
61	0.00	32.1	28.9	61.0	48.4	-0.035	20.9	27.5	48.4
59.4	0.00	30.0	29.4	59.4	51.0	-0.015	24.7	26.3	51.0

$L_{AMkö}$	K_f	$L_{Aeqkö}$	$L_{AMkö}$	K_f	$L_{Aeqkö}$
[dB]			[dB]		
65	3.84	61.10	59	12.07	47.34

Table 2-22: Correction calculations daytime/nighttime – ZMP9 – 2.mérés

Traffic noise was measured at point No **ZMP10**. The nature of the noise was continuous both during the day and the night.

Daytime					Night-time				
L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$	L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$
[dB]					[dB]				
61	-0.045	19.9	41.1	61.0	57.6	-0.053	19.2	38.4	57.5
60.4	-0.004	30.3	30.1	60.4	51.1	-0.012	25.5	25.6	51.1

$L_{AMkö}$	K_f	$L_{Aeqkö}$	$L_{AMkö}$	K_f	$L_{Aeqkö}$
[dB]			[dB]		
62	2.83	58.9	57	4.56	52.4

Table 2-23: Correction calculations daytime/nighttime – ZMP10

Traffic noise was measured at point No **ZMP11**. The nature of the noise was continuous both during the day and the night.

Daytime					Night-time				
L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$	L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$
[dB]					[dB]				
68.1	-0.007	28.2	39.9	68.1	66.3	-0.013	25.1	41.2	66.3
67	-0.005	29.5	37.5	67.0	60.2	-0.05	19.1	41.1	60.1
63.9	-0.018	23.8	40.1	63.9					

$L_{AMkö}$	K_f	$L_{Aeqkö}$	$L_{AMkö}$	K_f	$L_{Aeqkö}$
[dB]			[dB]		
68	0.88	66.7	65	3.36	61.2

Table 2-24: Correction calculations daytime/nighttime – ZMP11

Ambient traffic noise was measured in the second measurement at point No **ZMP11**. The nature of the noise was continuous both during the day and the night.

Daytime					Night-time				
L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$	L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$
[dB]					[dB]				
69.6	-0.003	31.9	37.7	69.6	66.0	-0.002	32.7	33.3	66.0
67.5	-0.001	35.9	31.6	67.5	62.1	-0.01	25.4	36.7	62.1
66.9	-0.003	31	35.9	66.9					

$L_{AMkö}$	K_f	$L_{Aeqkö}$	$L_{AMkö}$	K_f	$L_{Aeqkö}$
[dB]			[dB]		
73	4.54	68.16	65	3.98	61.47

Table 2-25: Correction calculations daytime/nighttime – ZMP11 – second measurement

Traffic noise was measured at point No **ZMP12**. The nature of the noise was continuous both during the day and the night.

Daytime					Night-time				
L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$	L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$
[dB]					[dB]				
69.6	-0.004	30.2	39.4	69.6	66.3	0.00	29.4	36.9	66.3
68.5	-0.003	31.9	36.6	68.5	57.4	0.00	31.1	26.3	57.4
63.1	-0.003	31.3	31.8	63.1					

$L_{AMkö}$	K_f	$L_{Aeqkö}$	$L_{AMkö}$	K_f	$L_{Aeqkö}$
[dB]			[dB]		
68	-	67.8	61	-	60.8

Table 2-26: Correction calculations daytime/nighttime – ZMP12

Traffic noise was measured at point No **ZMP13**. The nature of the noise was continuous both during the day and the night.

Daytime					Night-time				
L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$	L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$
[dB]					[dB]				
64.2	-0.024	22.5	41.7	64.2	61.7	-0.03	21.9	39.8	61.7
65.1	-0.021	23.2	41.9	65.1	56.1	-0.01	27.2	28.9	56.1
59.5	-0.026	22.3	37.2	59.5					

$L_{AMkö}$	K_f	$L_{Aeqkö}$	$L_{AMkö}$	K_f	$L_{Aeqkö}$
[dB]			[dB]		
64	-	63.5	57	-	56.7

Table 2-27: Correction calculations daytime/nighttime – ZMP13

Traffic noise was measured at point No **ZMP14**. The nature of the noise was continuous both during the day and the night.

Daytime					Night-time				
L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$	L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$
[dB]					[dB]				
70	-0.002	33.1	36.9	70.0	70.1	0.00	33.9	36.2	70.1
70.2	-0.004	30	40.2	70.2	62.1	0.00	33.8	28.3	62.1
68.5	-0.003	32.3	36.2	68.5					

$L_{AMkö}$	K_f	$L_{Aeqkö}$	$L_{AMkö}$	K_f	$L_{Aeqkö}$
[dB]			[dB]		
72	2.0	69.6	68	3.72	64.7

Table 2-28: Correction calculations daytime/nighttime – ZMP14

Traffic noise was measured at point No **ZMP19**. The nature of the noise was continuous both during the day and the night.

Daytime					Night-time				
L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$	L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$
[dB]					[dB]				
65.1	-0.014	24.8	40.3	65.1	62.9	-0.02	23.9	39	62.9
64.4	-0.015	24.7	39.7	64.4	55.1	-0.02	24.1	31	55.1
62	-0.011	26	36	62					

$L_{AMkö}$	K_f	$L_{Aeqkö}$	$L_{AMkö}$	K_f	$L_{Aeqkö}$
[dB]			[dB]		
64	-	64.0	58	-	57.5

Table 2-29: Correction calculations daytime/nighttime – ZMP19

Traffic noise was measured at point No **ZMP20**. The nature of the noise was continuous both during the day and the night.

Full 24 hours					**Daytime 16 hours**				
L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$	L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$
[dB]					[dB]				
61.5	-0.002	34.6	26.9	61.5	62.76	-6.83	1.01	(61.75)	NH

$L_{AMkö}$	K_f	$L_{Aeqkö}$	$L_{AMkö}$	K_f	$L_{Aeqkö}$
[dB]			[dB]		
63	1.22	61.5	64	1.22	62.76

Night-time 8 hours				
L_{Aeq} measured	K_a	ΔL_A	L_{Aa}	$L_{Aeq\ calculated}$
[dB]				
57	-6.61	1.07	(55.97)	NH

$L_{AMkö}$	K_f	$L_{Aeqkö}$
[dB]		
66	9.09	57.04

Table 2-30: Correction calculations daytime/nighttime – ZMP20

2.1.9 Please state was there any buzzing sound heard during the measurement session at the transformer yard. If yes, please consider the possibility of correction with the narrow band component.

Based on the subjective observation of the person conducting the noise measurement session no buzzing sound was experienced at the transformer yard during the benchline assessment.

2.1.10 Please state what does the LA_{95} value included in paragraph 1 page 126 of the Baseline documentation refer to.

In spite of the substantial differences between the daytime and night-time valued measured the 95% frequency level for this area – being approximately 30 dB – is typical for the surrounding of the metering point.

2.1.11 Based on the photographic evidence included in the documentation prepared on the baseline assessment the measurement points for environmental vibration were not set in accordance with Section 2.2 of the Hungarian standard entitled Measurement of vibrations. Assessment of environmental vibrations involving an impact on humans No MSZ 18163-2:1998 (hereinafter referred to as: Hungarian standard MSZ 18163-2:1998), therefore the baseline studies of vibrations originating from traffic need to be carried out in a manner defined by the aforementioned standard.

Assessment of the baseline vibration exposure was carried out in line with the contents of paragraph five Section 4.3.5 of the document entitled Lévai Project Technical specifications (version 2.0) dated on 1 August 2011. In the paragraph mentioned above the Lévai Project document states as follows: “Vibration levels must be estimated within the vibration impact area of the establishment and measurements need to be carried out in a reasonable number to determined baseline levels. Detailed assessment of the vibration exposure to the buildings to be protected is not necessary.” No facility to be protected exists within a 100 metres surrounding of the plant site dedicated for the establishment of the new units, the closest building to be protected is further up than 1 km (Paks-Csámpa). Therefore, the impact of the direct vibration exposure of the new nuclear power plant units on the buildings to be protected is irrelevant.

Vibration exposure measurement points for baseline assessment were designated in a manner which involved typical ground objects which are assumed to remain on the same place in a stationary position for decades, thus ensuring the repeatability of the measurement series.

The vibration exposure measurement points were identified at locations the closer to the front of the buildings to be protected to better, and the vibration exposure levels determined on these points of measurement complied with the vibration exposure limit value specified in Annex No 5 to the Joint Ministerial Decree No 27/2008. (XII.3.) KvVM-EüM. The ground in the neighbourhood of the nuclear power plant is loess based sedimental rock in which the propagation of vibrations is limited.

2.2 In the noise and vibration control chapter of the Environmental Impact Study

When the impact study was drawn up, noise exposure was determined using the SoundPlan 7.2 software. (See EIS Chapter 15 Noise and vibration).

As the initial parameter, international standard No ISO 9613-2: 1996, Hungarian standard No MSZ 07-2904:1990 and instruction No ÚT 2.1-302 were applied.

A 25 metres grid span was taken for the purposes of drawing up the raster grid, and the grid was laid in a height of 1.5 m above ground level. Layout map sheets were digitalised by scanners, cut to fit each other and matched with points having known EOV coordinates. Georeferenced ortophotos were also used as raster graphic images. A shape file with 0.25 m contour line intervals was also available which was used as initial data for noise calculations in the noise modelling programme, creating a digital relief map from the contour lines.

Traffic intensity for the road sections assessed was determined from the traffic count figures of the database named Cross Section Traffic of National Public Roads 2012, which was the most recent reference available at the time of modelling.

Additional data taken into account for the purposes of calculations included the following: vehicle rate of travel on various road sections and per vehicle category, relief, route layout, correction pending on the roughness of pavement, width of traffic lanes, two-way traffic.

Increments on traffic noise exposure was provided for the period during the construction phase causing the highest exposure and for the service period. For the construction phase, one motorboat with 6 towed barges progressing at 9 km/h on the Danube and one 580 metres long train progressing at 60 km/h on the railway starting from the investment project site on the existing railway branch line towards Előszállás were considered on a daily basis. Noise exposure originating from the activities was determined by calculation on the grid maps and on the individual points to be protected beside the noise sources. Detailed data, modelling particulars and their outcome are all included in the impact study.

Recuperation hydrostation

At the outlet point of the hot water canal to the Danube either a recuperation hydropower plant or an energy dissipation/dissipating device is situated. Their impact is identical, therefore their impact area is also the same.

2.2.1 Please specify the exact location of the assessment points in the baseline state model (city, street, house number, topographical number).

Those grid points of the several hundred thousand points calculated in the modelling phase which were illustrated individually, were indicated on the master plans layout plans of Paks and the settlements concerned. The A0 and A3 format maps scaled to Scale 1:3000 are contained in the Annex.

As a supplement, an additional modelling point was identified north of the noise measurement point ZMP10, for which grid calculations were made earlier on but which was not indicated as an individual point. Indicating the results calculated for this point referred to above (Paks, Dunaföldvári út 4.) might be important because the road and the railway are close to it and this modelling point and its surrounding is critical in terms of noise exposure due to the proximity of Main Road No 6.

The findings at the individual point identified as an addition (12k=5h=6v) were indicated in the tables below, in conjunction with the results modelled at point ZMP10 for the reasons of comparison.

Code	To be protected	limit value (dB) daytime/night-time	baseline exposure (dB) daytime/night-time	exposure with increment (dB) daytime/night-time	noise exposure change (dB) daytime/night-time
3.k	Paks_residential building_2 (ZMP10)	65/55	63.9/57.1	65.4/57.1	1.5
12.k	Paks Dunaföldvári út 4.	65/55	70.9/64.1	72.3/64.1	1.4

Table 2-31: Noise exposure from road traffic in the construction phase

Code	To be protected	daytime limit value (dB)	noise exposure (dB)
4.v	Paks residential building_1 (ZMP10)	60	38.2
6.v	Paks Dunaföldvári út 4.	60	41.4

Table 2-32: Noise exposure from railway traffic in the construction phase

Code	To be protected	limit value	noise exposure (dB)
1.h	Paks residential building_1 (ZMP10)	-	44.6
5.h	Paks Dunaföldvári út 4.	-	39.3

Table 2-33: Noise exposure from water traffic in the construction phase

Code	To be protected	limit value (dB) daytime/night-time	baseline exposure (dB) daytime/night-time	exposure with increment (dB) daytime/night-time	noise exposure change (dB) daytime/night-time
3.k	Paks_residential building_2 (ZMP10)	65/55	63.9/57.1	64/57.1	0.1/-
12.k	Paks Dunaföldvári út 4.	65/55	70.9/64.1	71/64.1	0.1/-

Table 2-34: Noise exposure from road traffic in the service period

Noise exposure from establishment and operation of Paks II at the assessment point of Paks Dunaföldvári út 4. is not significant and no impact area could be defined.

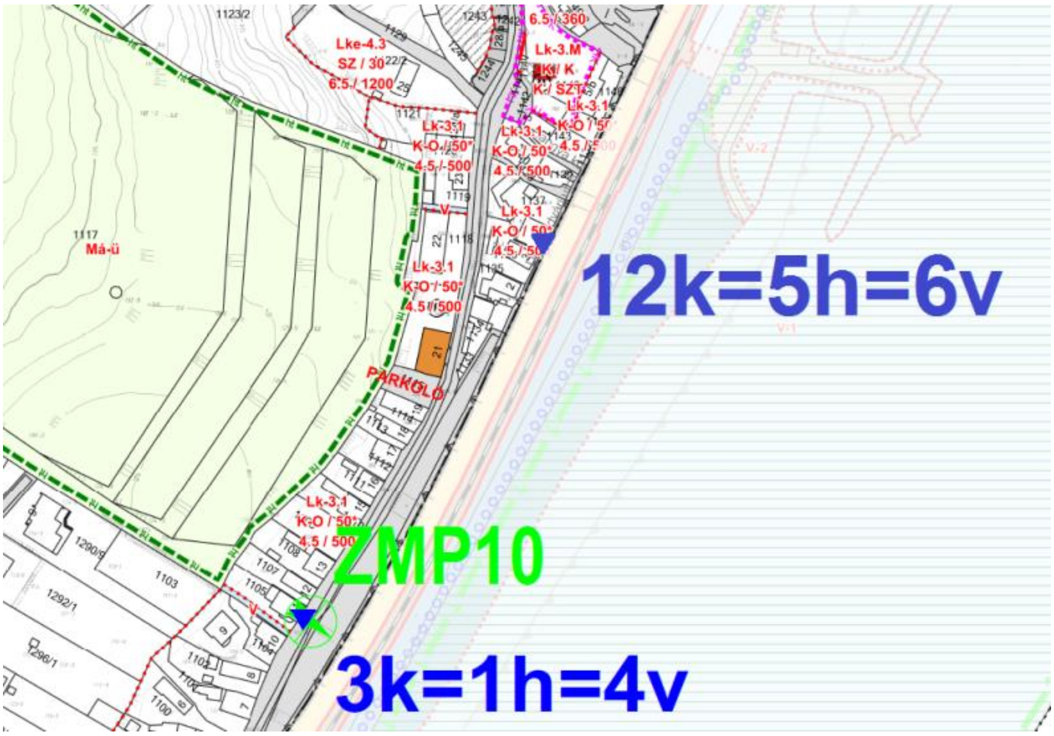


Figure 2-10: Additional modelling point north of the measurement point marked ZMP10

The summary table of the locations of points indicated during modelling as individual points is as follows:

Modelling point	City	Topographical number	Street and house number
1u=3h	Dunaszentbenedek	581/2	Zöldfa u. 3.
2u=5k	Paks - Csámpa	0292/2/a	-
3u=6k	Paks - Csámpa	0191/23/a	-
4u	Paks	4585	Tolnai utca 137.
5u	Paks - Birító	0269/36	Iskola utca 22.
1k	Dunaföldvár	3729	Paksi út 100.
2k=3v	Dunakömlőd	8104	-
3k=1h=4v	Paks	1105	-
12k=5h=6v	Paks	1137	Dunaföldvári út 4.
4k=2h=5v	Paks	158	-
7k	Paks - Csámpa	10047/1	-
8k	Dunaszentgyörgy		Rákóczi u. 1. front facing Main Road No 6
9k	Fácánkert	312	Béke u. 21.
10k	Tengelic	01355	Vadászmajor
11k	Paks - Gyapa	12511	Rét u. 2.
4h	Uszód	59	Béke u. 10.
1v	Dunaföldvár	3484/1	Baross dűlő 43.
2v	Bölcske	0360/12/2	Szentandráspuszta

Legend:

k= road traffic assessment point
h= transport by inland water navigation assessment point
v= railway transport assessment point
u= point investigated for the purposes of construction/operation within the plant site and transmission line construction/operation

Table 2-35: The location of modelling points

2.2.2 Extra traffic expected to occur during the implementation phase need to be determined with a view to the number of rounds the amount given in each of the transportation periods (cement, gravel, concrete, earth etc.) on the means of transport considered is intended to be transported. Please define possible routes of transport between the material extraction sites and the site of the investment project.

Increments of the road traffic were determined with a view to the needs of temporary stockpiling and scheduled transport of the earth excavated in the course of the earth works (ground levelling, foundations). Earth will be removed during the grading of the ground and the two years long foundation period. For the purposes of specifying the extra traffic loads heavy duty vehicles with a load bearing capacity of approximately10 tons were considered. The maximum extra traffic increment in day time hours was defined on this basis.

Transport of gravel is scheduled to be delivered on waterways. Delivery of the required volume of gravel in an amount of approximately ~450 000 tons across the two years foundation construction period per unit means the arrival of one tow-dumb barge per day as a maximum when calculated with a load bearing capacity of approximately ~10 000 tons per barge.

Cement transport is scheduled on railway. The amount of cement necessary for the erection of the two new nuclear power plant units is the train consisting of 40 cars referred to above, which can be transported by a single train assuming a load bearing capacity of approximately ~40 tons per freight-wagon.

The concrete needed for the foundation works will be produced at the mixer plant on site, therefore it has no implications on transport.

Adaptation to the noise model

The most intensive road traffic takes place during the earth works (grading), generated primarily by the transport of the excavated earth volumes, therefore the road model simulation was made for this operation. Vehicles on the public roads run in even intervals during the daylight hours. Alternatives of road vehicle traffic with equal probability include the following options: Highway M6 to the south, Highway M6 to the north, Main Road No 6 to both north and south. Correspondingly, It follows from the above that the amount of vehicles specified were considered for the entire exposed section of both Main Road No 6 and Highway M6 (25 km each to north and south, respectively), assuming that each vehicle run both ways. Railway and boat transport takes place in the period of foundation construction, therefore the modelling for railroad and waterway was prepared for this period.

Grading period	Freight transport	Vehicle category No III	130 rounds
	Passenger transport	Vehicle category No II	84 rounds
	Passenger car	Vehicle category No I	350 rounds
Foundation period	Boat shipment	One motor towboat, 6 towed barges	
	Railway shipment	One locomotive, 40 freight wagons	

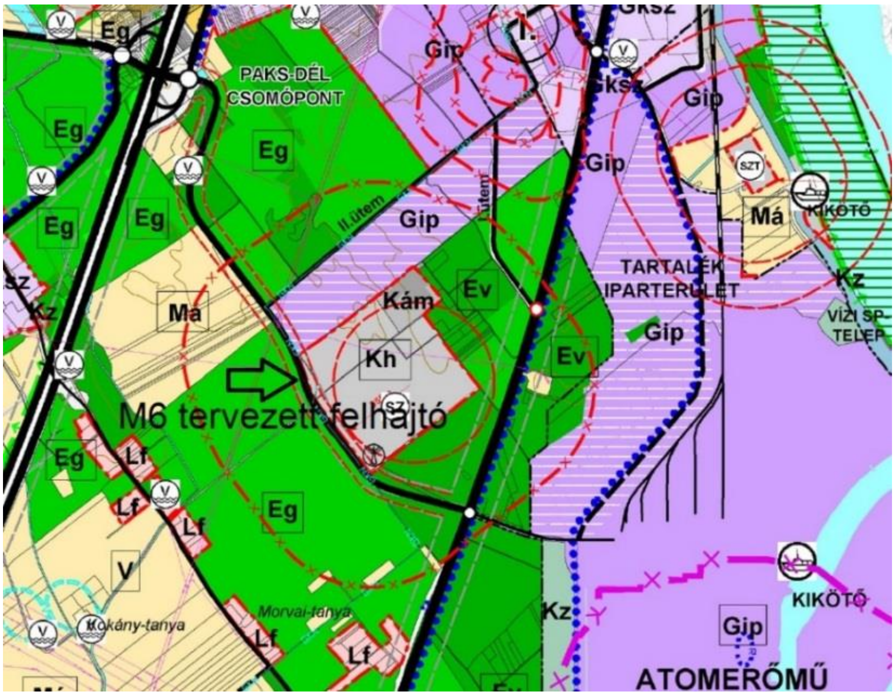
Table 2-36: Transport traffic

For the purposes of noise control the 130 vehicles are distributed across the 16 hours period considered for daytime, and since they run both to and from, such traffic must be multiplied by two. (Input data request for the noise modelling programme will then be calculated as: 130/16*2= 16.25. For instance, the baseline daytime traffic along the road section encoded 4941 in vehicle category III is 15 per hour during daytime, which is incremented by the extra traffic caused by the power plant construction as 15+16=31.)

2.2.3 Please describe which way Highway M6 is intended to be accessed. If the route affects built up areas, road noise modelling must be completed for those road sections as well.

The exact location of material extraction sites at this stage of the design is not yet known, therefore the approaching route from the prospective material extraction sites towards Highway M6 and Main Road No 6 can not be determined. Having regard to the volume of materials to be procured and diversification of the procurement sources however, lower noise levels can be assumed in the surrounding areas of the material extraction sites during the period of maximum freight traffic and transport (because of lower level of heavy duty traffic) than in the environment of the new nuclear power plant site.

According to the settlement arrangement plan of the city of Paks approach of Highway M6 is proposed on the route seen on the illustration below. This road has not been built yet, no information is available for the proposed road with respect to noise model simulation. The proposed routing of the road avoids all residential areas to be protected.



Paks dél csomópont - Paks south junction
Kikötő - Port
Tartalék iparterület - Reserve industrial site
Vízi sporttelep - Water sports complex
M6 tervezett felhajtó - M6 proposed approach lane
Atomerőmű – Nuclear Power Plant

Figure 2-11: Settlement arrangement plan for the city of Paks (2014) – excerpt with the proposed approach road to M6

2.2.4 Please state whether or not the Owner intends to carry out transportation of freight on any other road within the 25 kilometres district of the site in addition to those constituting the subject matter for the assessment.

Transportation is envisaged on the routes included in the Environmental Impact Study, no alternative routes are currently known.

2.2.5 Please specify the distance from the noise source in which the Lp acoustical pressure level values included in Table 15.5.3.-I of the Noise and vibration chapter of the Environmental Impact Study were determined, and provide the method of determination used for the purposes of Lw acoustical power level.

The acoustical pressure levels are to be understood in a distance of 1 metre from the device at a height of 1.5 m. The acoustical power levels were determined according to the following formula:

$$L_w = L_p + 10 \log (A)$$

The acoustical power levels were calculated using the Soundplan 7.2. noise modelling programme (the special case calculated with separate support by Excel) having specified the distance from the device, the overall dimensions (width, length, height) and position of the noise source.

2.2.6 Please provide measurement results of background noise for both daytime and night-time periods.

For the purposes of demarcation of the impact area of the construction and operation of Paks II plant and associated transmission lines:

Reference level	determination of background exposure	background exposure	
		night-time (dB)	daytime (dB)
ZMP5	L_{A95} 95%-os A-	36.6-37.1	40.9-48.8
ZMP6	L_{A95} 95%-os A-acoustical pressure level	27.2-30.5	38.2
ZMP16	L_{A95} 95%-os A-acoustical pressure level	36.7	31.8
ZMP18	L_{A95} 95%-os A-acoustical pressure level	37.3	31.9
ZMP20	L_{A95} 95%-os A-acoustical pressure level	32.5	45

Table 2-37: Background exposure levels - Paks II erection and operation

At the ZMP20 point the L_{A95} 95 % A-acoustical pressure level value built on the 24 hours long earlier measurement result available was separated to daytime and night-time measurement with the use of the noise metering instrument software. The values thus obtained did not make any change to the demarcation line of the impact area and the isolines to be considered in the demarcation of the impact area do not concern any facility to be protected. The impact area of Paks II (in the case of establishment, operation, joint operation, operating troubles) to the north was determined in accordance with item e) Article 6 of Government Decree No 284/2007.(X.29.).

For the purposes of assessing the impacts of waterways and railways during erection:

Reference level	determination of background exposure	background exposure	
		night-time (dB)	daytime (dB)
ZMP9	$L_{AM, traffic}$	63-59	65-67
ZMP10	$L_{AM, traffic}$	57	62
ZMP16	$L_{Aeq, measured}$	39.2	48.6
ZMP18	$L_{Aeq, measured}$	38.9	40.1
ZMP11	$L_{AM, traffic}$	65	68

Table 2-38: Background exposure levels – waterways and railway

Due to lack of limit values the impact area of the waterway cannot be determined (shipment on boats), while the impact area on railway cannot be detected pursuant to the relevant decree (railway transport).

2.2.7 Please provide the data used for the purposes of determination of noise exposure of Paks Nuclear Power Plant currently in service, measurement results, and the distances between the metering instrument and the source of the noise. Please state whether or not any other dominant sources of noise in addition to the points tested can be found within the site area of the nuclear power plant.

Data used for the purposes of determination of noise exposure of Paks Nuclear Power Plant currently in service are as follows:

- The assessments, studies and reports conducted and delivered by the MVM Lévai Project could be used as baseline references for the purposes of measurements carried out on site.
  - ✓ Environmental Impact Study on the Lifetime Extension Project for the Paks Nuclear Power Plant (ETV-ERŐTERV Rt., 000000K00004ERE/A, February 2006).
  - ✓ Chapters of the preliminary consultation documentation dealing with noise and vibration control (Pöyry Erőterv Zrt. 6F111121/0002/O, 31 January 2012)
    - Chapter 03 Current state of the environment
    - Chapter 04 Environmental impacts of construction works
    - Chapter 05 Environmental impacts of operation
    - Chapter 06 Joint environmental impact
    - Chapter 07 Impact of operating troubles and accidents
    - Chapter 08 Abandonment
    - Chapter 09 Impact areas
- Structural Settlement Plans and Arrangement Plans of certain settlements.

Measurement points and their respective locations used for the purposes of determining noise exposures of the Paks Nuclear Power Plant

The noise measurement points were assigned on the northern, western and south-eastern sides of the proposed installation site, on three locations at the site boundary (ZMP1, ZMP2, ZMP3) and one locations within the Ecopark area (ZMP4) as follows:

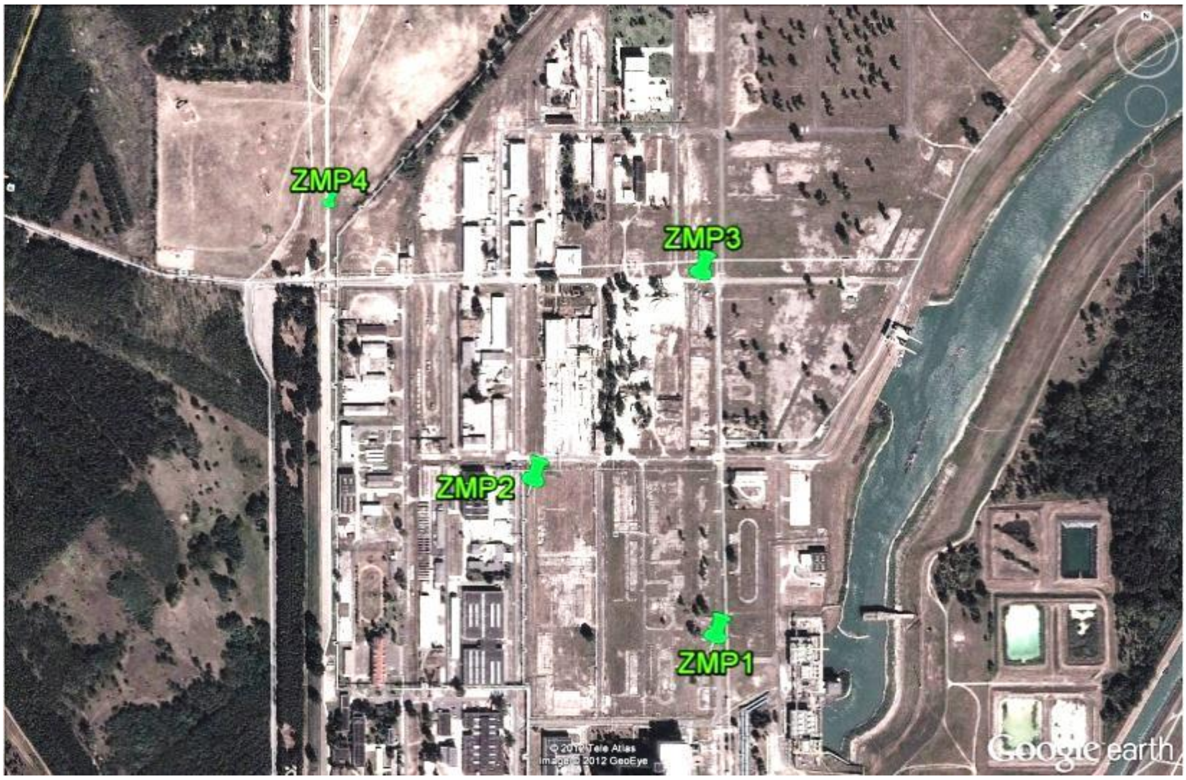


Figure 2-12: Noise control points ZMP1-ZMP4

Code of the measurement point	GPS coordinates		EOV coordinates	
ZMP1	46° 34.654'É	18° 51.267'K	N137038	E635205
ZMP2	46° 34.785'É	18° 51.047'K	N137281	E634924
ZMP3	46° 34.958'É	18° 51.249'K	N137601	E635181
ZMP4	46° 35.022'É	18° 50.801'K	N137721	E634612

Table 2-39: Coordinates of the noise measurement points ZMP1-ZMP4 used for the determination of noise exposure originating from the Paks Nuclear Power Plant

As an addition, four measurement points were localised within the power plant area, one point at the Danube mouth of the hot water canal (ZMP25), one point at the constant-level device/regulator overfall weir (ZMP24), at two points at the main transformers of the plant units (ZMP22, ZMP23) as follows:

Atomerőmű – Nuclear Power Plant

Figure 2-13: Noise control points ZMP22-ZMP25

Code of the measurement point	GPS coordinates		EOV coordinates	
ZMP22	46° 34.427'É	18° 51.282'K	N136617	E635222
ZMP23	46° 34.265'É	18° 51.299'K	N136317	E635243
ZMP24	46° 34.483'É	18° 51.568'K	N136720	E635588
ZMP25	46° 34.979'É	18° 52.294'K	N137637	E636517

Table 2-40: Coordinates of the noise measurement points ZMP22-ZMP25 used for the determination of noise exposure originating from the Paks Nuclear Power Plant

The locations of the designated measurement points are zoned as Gip “Economic, industrial zone” pursuant to the Arrangement Plan and the Settlement Structural Plan.

Port – Kikötő
Atomerőmű – Nuclear Power Plant
Horgásztavak – Fishing Ponds
Duna folyam – Danube river

Figure 2-14: Settlement Structural Plan in the noighbourhood of measurement points ZMP1-ZMP4, — ZMP22-ZMP25

2.2.8 Please state whether or not operator of Paks II will be the same entity which is the operator of the current Paks Nuclear Power Plant in order to allow the establishment of the noise control impact area and noise emission limit values.

No information is available on the identity of the operator, thus it cannot be provided at this stage. The license holder of the current licensing procedure will be MVM Paks II. Zrt.

3 AIR CONTROL

3.1 Please present extra traffic expected during the implementation phase in conjunction with the noise and vibration control chapter, and define the impact of transportation activities in the light of the data during the period of establishment, taking into account the potential routes of transport between the material extraction sites and the site of the investment project.

Calculations included in the air control chapter of the EIS are in line with the calculations of the noise control chapter, having regard to the fact that their baseline figures are the same.

The exact location of material extraction sites at this stage of the design is not yet known, therefore the approaching route from the prospective material extraction sites towards Highway M6 and Main Road No 6 can not be determined.

3.2 Please specify the access roads used for the purposes of transportation on Highway M6 and Main Road No 6 and provide the air pollution implications of current and expected transport related impacts on these road sections.

Approach to Highway M6 is effectuated through the road connecting the Paks south exit and the northern reception of Paks Nuclear Power Plant, which crosses Main Road No 6. This road is included in the Settlement Structure Plan of Paks city. The road referred to above is a currently undeveloped access road opening towards the east from the roundabout situated on the eastern side of the Paks south exit lane, which runs initially to the south from the roundabout and then turns to the south-east in front of the communal landfill, before crossing Main Road No 6, and reaching the northern entrance gate of Paks Nuclear Power Plant. This route does not affect any residential area to be protected.

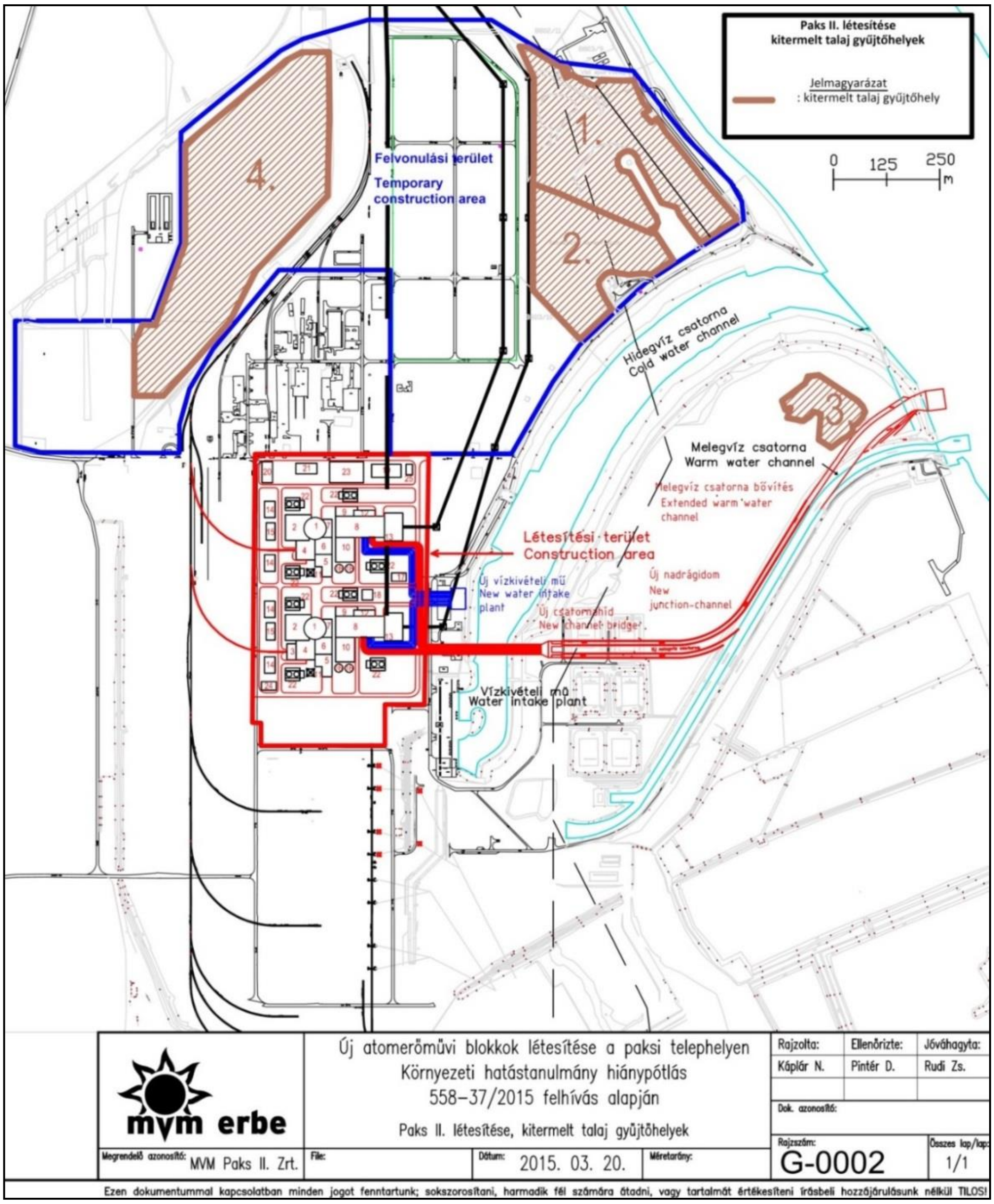
3.3 Please investigate whether or not the Owner intends to carry out transportation of freight on any other road within the 25 kilometres district of the site in addition to those used during the construction phase and if there is any substantial change expected compared to the current traffic intensity, please demonstrate the relevant applicable alterations in air quality.

The existing potential of Highway M6 and Main Road No 6 provide an appropriate level of capacity during the maximum intensity of freight traffic expected and may also be alternatives to each other when the appropriate axle loads are taken into account. Future development of the access roads will be implemented in conjunction with and with a view to the capacities of the current access roads leading to the erection and operation areas of the new nuclear power plant as well as with the expected increase in the traffic. Consequently, transport on other alternative routes will not be necessary.

4 WASTE MANAGEMENT

4.1 Please indicated the collecting sites of waste generated during the erection works (in particular, extracted earth material).

The location of the dumping ground sites proposed for stockpiling earthen material extracted during the erection works of Paks II is shown on the figure below.



Erection of new nuclear power plant units at the Paks site Environmental Impact Study Submission of missing information based on the order Ref. No- 558-37/2015. Erection of Paks II Collection sites for excavated soil. Legend: collection site for excavated soil. – Új atomerőművi blokk létesítése a paksi telephelyen. környezeti hatástanulmány hiánypótlás az 558 -37/2015 felhívás alapján. Paks II létesítése, kitermelt talaj gyűjtőhelyek Jelmagyarázat: kitermelt talaj gyűjtőhely-

Legend:

1 Construction debris deposit
2 Area to the south from construction debris deposit
3 Deeper area found in the eastern part of the island
4 Reserve dumping ground on the north-western part of the mobilisation area

Figure 4-1: Location of the dumping grounds proposed for stockpiling earthen material extracted during the erection works of Paks II at the nuclear power plant site

4.2 Please demonstrate by calculations that the area dedicated for the purposes of temporary storage of the earth excavated was sufficient to dump the volumes generated by each of the stages.

The waste generated in the largest volume during the construction works of the Paks II units is the earthen material extracted from the construction site the estimated quantitative figures of which are shown on the table below.

Operations in the construction works of Paks II	Volume [m^3]
Construction of the reactor units	820 000
Installation of the condenser cooling water system	570 000

Table 4-1: Estimated amount of earth extracted from the construction site during the implementation works of Paks II

Key parameters of the proposed collection sites for dumping earth extracted during the construction of Paks II are presented on the table below.

	Denomination and location of the collection site	Area [m^2]	Maximum height of backfill [m]	Full capacity [m^3]
1.	Construction debris deposit	120 000	5.5 + 2 = 7	660.000 + 240.000 = 900.000
2.	Area to the south from construction debris deposit	60 000	2	120.000
3.	Deeper area found in the eastern part of the island	18 000	5,5	99.000
4.	Reserve dumping ground on the north-western part of the mobilisation area	180 000	2	360.000

Table 4-2: Construction of Paks II, dimensions of the collection sites for excavated soil

According to our calculations an amount of 410,000 m^3 excavated earth volume is produced during the construction works of *Paks II Nuclear Power Plant Unit 1*. This quantity or a part of it can be deposited on a permanent basis at the construction debris dumping site situated on the north-eastern part of the mobilisation area by backfilling the current ground level – an average of 91 metres above Baltic sea level – up to the elevation of the surrounding areas. The area was filled up earlier on with the soil excavated and construction debris generated during the erection of Paks Nuclear Power Plant. Theoretical capacity of the site is 120.000 m^2 x 5.5 m = 660.000 m^3. (We talk about a theoretical capacity, since the part of the area next to the Danube and in particular the northern section of it may be suitable for wildlife and animals to migrate there in response to the disturbances associated with the construction works by themselves and to colonise the area again upon completion of the construction works from these habitats.)

The amount of soil extracted during the establishment of the *condenser cooling water* system is 570,000 m^3, a part of which can be dumped permanently by backfilling the deeper ground on the eastern part of the Island. The cubic capacity of the area is 18,000 m^2 x 5.5 m = 99,000 m^3.

The amount extracted in addition to this volume is 570,000 m^3 – 99,000 m^3 = 471,000 m^3, of which the amount which can be transferred to the construction debris dumping ground accounts for 660,000 m^3 - 410,000 m^3 = 250,000 m^3. With this soil quantity the backfilling level reaches ground zero of the site.

The remaining amount of 471,000 m^3 - 250,000 m^3 = 221,000 m^3 earth need to be dumped on a preliminary manner within the erection site. Calculating with a stockpiling height of 2.00 m it will require a volume of 221,000 m^3 / 2.00 m = 110,500 m^2. Therefore, disposal is possible on the ground of the construction debris landfill (120.000 m^2) which was previously backfilled up 96.5 mBf, increasing this elevation further by 2 m.

Upon the construction of Unit 1 of the nuclear power plant will be filled back around the foundation bodies, the volume of this according to the preliminary calculations will be approximately ~33.000 m^3. Also, a part of the soil excavated during the construction of the cooling water pipeline route and hot water drainage will be filled back, and according to the preliminary calculations it will be approximately ~66.000 m^3.

The final disposal site of the earth removed is currently unknown.

According to our calculations an amount of 410,000 m^3 excavated earth volume is produced during the construction works of *Paks II Nuclear Power Plant Unit 2*, which needs temporary storage and disposal (except the backfill volume). The place requirement of this amount calculated with a 2.00 m thick filling is 410,000 m^3 / 2.00 m = 210,000 m^2. This area is also available in the north-eastern corner of the mobilisation area on the ground of the construction debris dumping ground which will have been filled up to the elevation of the surrounding terrain by this time (120.000 m^2), and on the area to the south from there (60.000 m^2). A reserve soil collection site was also designated in the north-western part of the mobilisation area. The entire surface of the reserve soil collection area is 180,000 m^2, of which 30,000 m^2 will be used for the purposes of construction of Unit 2 as the calculations suggest, when a backfill of 2 m height is considered.

An amount of temporary stored earth 410,000 m^3 – 33,000 m^3 = 377,000 m^3 need to be removed from the site before the investment project with the establishment of Unit 2 is completed.

The final disposal site of the earth removed is currently unknown.

A maximum height of 2 metres was determined for the stockpiles for the purposes of dimensioning the collection sites of excavated earth, any higher heaps are not expedient in the light of the characteristic features of the area.

5 LANDSCAPE AND NATURE CONSERVATION

5.1 Landscape conservation

5.1.1 Computer aided architectural design of the recovery plant and auxiliary facilities to be installed in the proposed new hot water canal should be prepared.

5.1.2 Computer aided architectural design of the recovery plant and auxiliary facilities to be installed in the existing hot water canal should be prepared.

5.1.3 The consolidated computer aided architectural design should feature the recovery plant and auxiliary facilities to be installed in the existing and new hot water canal, respectively. The view of the architectural design should be from the direction of the Danube.

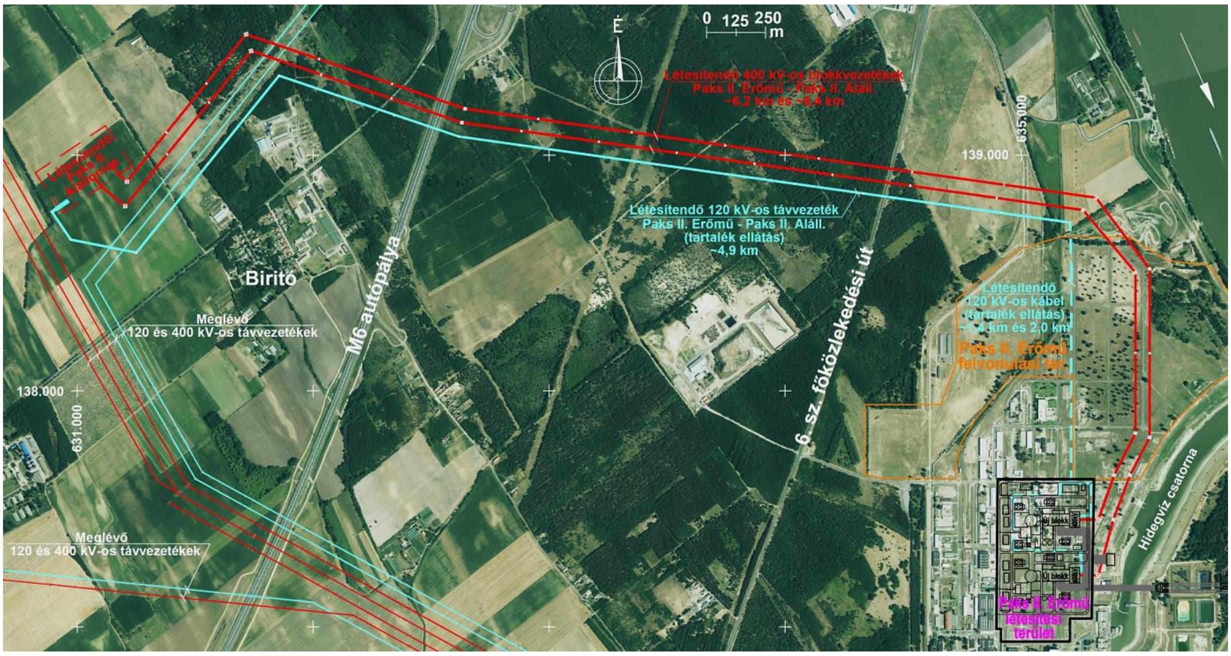
As a partial performance of Section 6 in this order to submit missing information MVM Paks II. Zrt. stated on 24 March 2015 that the recovery plant designed in the new hot water canal will not be subject to this current environmental permit licensing procedure. The establishment of this facility will take place under a separate project at a later stage, when an independent environmental impact study will be prepared and submitted with a view to obtaining the environmental permit. Correspondingly, sections 5.1.1, 5.1.2 and 5.1.3 are not relevant with respect to the submission of missing information.

5.2 Nature conservation

5.2.1 Please present the protection arrangements of the proposed middle and high voltage level electrical transmission lines against electric shock of and hitting by birds.

A condition precedent of the erection of the new nuclear power plant units is that electric power produced in the nuclear power plant be fed onto the national electricity system with the help of a suitable network of transmission lines. Furthermore, the provision of back up power necessary for the safe operation of the nuclear power plant is also required through a transmission line network independent from the one referred to above. In order to meet these condition precedents connection lines need to be installed from the new nuclear power plant to the Paks II Substation which is also to be set up as a new facility and is a designated connection point.

In order to send out the electric output of 2x1200 MW generated, a 400 kV voltage level unit line needs to be established for each of the units, while backup power supply can be ensured at the voltage level of 120 kV. Having regard to the more than 6 kilometre long distance of the line route and the technical and business considerations, these lines are air conductors, corresponding to the practices prevailing in the domestic sector of the industry. Because of the lack of space within the nuclear power plant site and in order to support the implementation works of erection the section within the power plant site of the 120 kV backup power supply line runs under the ground on buried cables. The 120 kV ground cable does not represent any risk to birds. The route of the high voltage power line to be installed in relation to the new nuclear power plant units is shown on the following figure.



Létesítendő 400 kV-os blokkvezetékek Paks II Erőmű – Paks II Alállomás, kb. 6,2 km és 8,4 km - 400 kV voltage level unit transmission lines to be installed, Paks II Power Plant – Paks II Substation, approximately 6.2 km and 8.4 km
Létesítendő Paks II alállomás - Paks II Substation to be erected
Létesítendő 120 kV-os távvezeték Paks II Erőmű – Paks II Alállomás (tartalék ellátás), kb. 4,9 km - 120 kV voltage level transmission line to be installed, Paks II Power Plant – Paks II Substation (backup power supply), approximately 4.9 km
Meglévő 400 kV és 120 kV-os távvezetékek - Existing 120 kV and 400 kV transmission lines
Létesítendő 120 kV-os távvezeték Paks II Erőmű – Paks II Alállomás (tartalék ellátás), kb. 1,4 km + 2,0 km - 120 kV voltage level cable to be installed (backup power supply), approximately 1.4 km + 2.0 km
Paks II Erőmű felvonulási terület - Paks II Power Plant mobilisaton area
M6 autópálya 6-osfőközlekedési út - Highway M6 Main road No 6
Meglévő 400 kV és 120 kV-os távvezetékek - Existing 120 kV and 400 kV transmission lines
Paks II Erőmű létesítési terület - Paks II Power Plant construction site
Hidegvíz csatorna - Cold water canal

Figure 5-1: The high voltage power lines to be installed in relation to the new nuclear power plant units

The aerial conductors to be installed have an impact on their immediate environment and one of such impact factor is the endangering of birds. Power transmission lines represent a risk to birds because when they settle onto the line carrier poles for the purposes of resting or preying, they may be exposed to electrical shock or may hit the wires which are difficult for them to detect during flying. With respect to the high voltage power lines to be established in the current project the main danger which may occur is hitting the power line wire, the risk of electrical shock is less intensive because live points are at a larger distance from grounded structures. Of the transmission lines considered the aerial conductor with the voltage level of 120 kV represents any risk of electrical shock for birds. Electrocuted and wire hit birds may suffer severe injuries or may perish, therefore they need protection against these threatening impacts.

The protection of birds against the impacts of existing high voltage power transmission lines is secured by the company operating the core network of the electricity grid, MAVIR ZRt. in collaboration with the environmental authorities and organisations. In the case of high voltage power transmission lines to be established under a new project the measures ensuring protection of the birds are put in place with a view to the actual site of installation during the works preparing for the building licensing procedure and during the design of the working drawings in cooperation with the authorities and organisation.

During the installation of a network of conductors the following measures are taken or will be taken in the course of the implementation phase in order to protect birds:

The application of a wire corridor

The transmission lines to be installed between the new nuclear power plant units and Paks II Substation will be placed in a wire corridor on the shortest possible route, this way the surface of the wires within the flight route of the birds is minimised. Additionally, multiple conductor wires appear simultaneously in the field of visions of the birds which happen to approach the line route, thus it will be easier for birds to perceive the power line than in the case of wires associated with a single transmission power line, in particular when the application and protecting effect of bird deflectors are considered. 400 kV unit power lines are designed in double braided wire structures, which also improves visibility of the wires. (The aerial conductor on the right hand side of the picture has a voltage level of 400 kV).

Figure 5-2: High voltage power transmission line designed in a wire corridor, implemented section

Impact of the neighbouring forested areas:

Approximately 70% of the length of the transmission line routes outside of the power plant site cross forested areas, which naturally prevents or impedes accidental clashes of birds with the power line wires. The forested area beside the cleared forest glade naturally protects the birds from approaching the power line route up to the height of the trees in the forest. Additionally, the adjacent forest areas provide appropriate nesting, preying and resting places and grounds to the birds, thus reducing the need to perch on power poles.

Arrangement of wires on the poles

On the power-line poles/towers of the 120 and 400 kV lines to be installed a relatively large distance (at 120 kV: minimum 0.9 m; 400 kV: minimum 2.7 m) is established between the live points and the grounded supporting structure because of the wire arrangement and safety spacing requirements laid down in the relevant standard. The wing span of the largest bird species in this country does not exceed 240 cm, consequently no electric shock may occur on 400 kV aerial conductors. The risk of electric shock to birds is therefore relatively low, especially when the safe design of the artificial nesting places on the poles is also taken into account.

Figure 5-3: Line carrier pylons and anchor masts for 400 kV aerial conductor

Use of bird friendly equipment

In line with domestic practices, the poles and mast where artificial nesting boxes (hatching crates) are installed will be determined with the involvement of the environmental authority and the stakeholder organisations in the course of the preparations for the working drawings of the long distance transmission line. The installation of the artificial nesting places is effectuated with a view to the safety of the birds in line with the already established practices, thus they may contribute to the increased rate of reproduction of the birds. Birds may nest on line carrier poles of high voltage power transmission lines naturally, as can be seen on the next photo.

Figure 5-4: Nesting box installed on power line pylon and natural nest

Use of bird deflectors

With the use of bird deflectors mounted on the power line wire the attention of the birds is called to the source of hazard. These reflecting or fluorescent surface devices are adapted specifically to the vision of birds which they can detect even in backlighting, therefore these bird deflector devices assist birds to spot the wires and avoid crashes. Selection and application of bird deflectors and specification of the locations of application will be made with the involvement of the stakeholder organisations with a view to the actual site of installation.

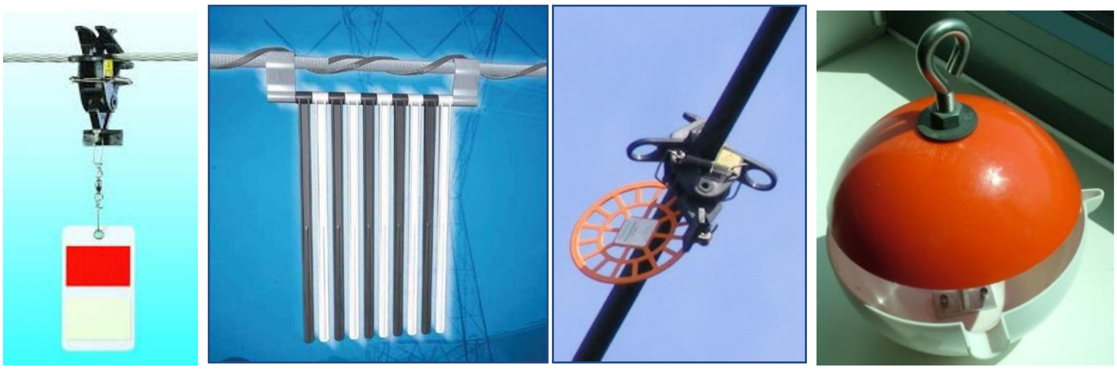


Figure 5-5: Bird protecting deflector devices installed on power line wires (Fire-fly, flag, disc, ball)

In the past years the company operating high voltage power transmission lines, MAVIR ZRt. and the national parks as well as the Hungarian Association of Ornithology formed a close collaboration in order to promote landscape and nature conservation efforts. A distinguished field of this cooperation is the protection of birds. For this purpose programmes like free sky, artificial nest or conservation program for the lanner (*Falco cherrug*) were started. During the installation of the new high voltage power lines – which is indispensable for the erection of the new nuclear power plant units – the protection of the birds can be ensured by the advancement of the experiences and practices of the past years.

5.2.2 Please complete the Natura 2000 impact assessment by investigating and estimating the impacts of the increased heat load caused in the Danube by Paks II discharges on the indicator fish species.

Each of the Natura 2000 fish species found in the Danube section beside Paks Nuclear Power Plant are so called thermophilic species (*Aspius aspius* – asp, *Gymnocephalus baloni* – Balon's ruffle, *Gymnocephalus schraetser* – schraetser, *Pelecus cultratus* – sabre carp, *Romanogobio vladykovi* – Danube whitefin gudgeon, *Rutilus pigus* – pigo, *Sabanejewia aurata* – Golden spined loach, *Zingel streber* – zingel streber, *Zingel zingel* – zingel). Their exact temperature requirements may differ, but no accurate knowledge is available on this aspect. These species may react by emigration to increased heat load, but the extent of water temperature increase in the model simulation runs does not affect fish populations in any substantial way and do not trigger migration of Natura 2000 fish species living in the area.

Heat loads may be tolerated less by more sensitive and less tolerant hillside river species such as the (goldside loach, zingel streber, zingel and schraetser) but their stock is expected to be stressed by the temperature changes due to climate change and not so much the heat load from the power plant. Compared to climate change power plant heat loads can be considered as local even though it may have an impact on the dispersion pattern of species in the most critical period when the heat load is the highest. Based on known data from taxonomically relatively close species with similar needs the upper lethal (deadly) water temperature limit for these species may be at around 30 °C, but their exact requirements could only be justified by laboratory tests, because thermal adaptation of these fishes is very intensive. Certain Natura 2000 species for instance such as asp and Balon'd ruffle thrive in large populations in the Balaton water warmed up to 29-30 degrees. Warming up for a couple of says not affecting the entire area of the Lake Balaton does not represent any risk to their populations. A similar phenomenon can be expected along the Tolna Danube section as a consequence of the proposed heat load. With the changes in temperature in the Danube associated with the climate change the spawning properties of the species may also be altered (for instance spawning intervals, starting date, spawning frequency).

5.2.2.1 Which measures can be recommended to suppress invasive species?

The most common invasive fish species found in the Danube at the time being are representatives of the family Gobidae. They can not be suppressed by fishing methods. It is assumed that their stocks integrate in to the food web of the Danube without displacing native species. An exception may be the vanishing of Danube stock of the bullhead. However, no information is available on to which extent the invasive species impact the quantitative conditions of individual fish species, a much higher intensity monitoring programme would be needed to reveal such connections. Invasion of Gobidae is a typical process along the entire middle and upper stretch of the Danube river, it can not be associated with the Paks impact area only.

5.2.2.2 "In the case of fishes biological monitoring is envisaged along a 5 kilometres long section with three years sampling interval. Having regard to the 11 kilometres long impact area of the heat plume the extension of the area under consideration should be recommended for fish."

When assessing the changes encountered in the structural composition of fish stocks, three main sampling sections can be best distinguished along the entire impact area of the heat plume:

1) "natural" section not affected by any heat load, situated upstream of the Paks Nuclear Power Plant along a 10 km long stretch measured from the power plant (5 x 500 m long sampling units),
2) the section most influenced by heat loads (10 km long stretch measured from the outlet of the hot water canal, 5 x 500 m long sampling units),
3) the section least influenced by heat loads, situated downstream of the heat plume in a length of 10-15 km (5 x 500 m long sampling units).

Test sites are assigned on both banks of the Danube.

5.2.3 Which measures can be considered to reduce the destruction of the river clubtail or yellow-legged dragonfly (Stylurus fiavipes, Gomphus fiavipes) specimen predicted to happen as a result of the proposed interventions in the Danube bed (Volume III, Wildlife, ecosystem Page 76)?

Adult individuals of the yellow legged dragonfly are good flyers to larger distances, they find new habitats for themselves when disturbed (for instance in the water spaces of the gallery forest downstream of the power plant, where they may lay eggs in the reproduction period just as well). Larvae are relatively agile and can withdrawn to another section of the Danube when disturbed. No special measures are deemed to be necessary, having regard to the fact that the Danube bed is disturbed only on a relatively short section.

5.2.4 If known, identify the exact location of material extraction sites necessary for the construction works (earthen material, rock and gravel, sand and pebble, etc.). If such sites concern any nature conservation area, the baseline survey of wildlife conservation must be carried out and the impact of material extraction on the wildlife need to be assessed.

The exact location of material extraction sites for the construction works at this stage of the design is not yet known.

5.2.5 "As a result of the investment project, nesting places and feeding grounds for a number of protected bird species may be eliminated (Volume III, Wildlife, ecosystem, Pages 81 and 92.) both on the "Island", and the Tolna Danube Natura 2000 area (for instance: woodpecker, goatsucker). What kind of measures, solutions, or compensation recommendations can be envisaged to mitigate damages to nature conservation efforts?"

As a consequence of the extension project of the nuclear power plant, changes are expected to occur in the world of birds in the two areas mentioned above. In order to mitigate the damage, the works need to be conducted in the areas concerned in off-nesting season, possible in the winter period. With the help of this procedure, even the destruction of the entire brood can be prevented. Following the extension the area needs reforestation – which may entail the return of the affected bird species. With the support and promotion of species protection programmes the integrity of the bird populations in the adjacent, less affected or unaffected areas Natura 2000 areas with similar habitat properties can be preserved and species may resettle from there with a great degree of probability. This natural process will mitigate the damages caused by the construction works. Joint application of the solutions referred to above may on the long term reduce or eliminate adverse effects caused by the construction project.

5.2.5.1 What kind of measures can be recommended to mitigate the impact of dusting encountered during construction on birds? (Volume III, Wildlife, ecosystem Page 86)

Due to grading, foundation and earth works during the implementation works temporary increase of dust exposure must be anticipated. Moved, dusted solid soil is spread in the air and a part of it settles. The extent of settling is influences substantially by the properties of the soil (structure, wetness), and the prevailing meteorological conditions in place from time to time (wind speed, humidity). Dusted soil is carried away to any larger distances only in the case of strong wind, therefore in such extreme situations it is advisable to suspend working processes involving intensive dust generation. In dry periods dusting can be reduced by watering.

The negative impacts can be reduced by the consideration of the following aspects:

- proper covering of the means of transport and containers (tent trucks),
- minimising outdoor accumulation of substances generating dust pollution,
- where open air storage is unavoidable, the application of the appropriate technology and avoidance of dusting,
- watering roads in dry weather,

Upon completion of the work improvement of the vegetation cover of the ground is recommended to prevent the generation of excess volatile dust.

5.2.6 What kind of measures can be envisaged to reduce the adverse impact of light pollution associated with the construction works to nocturnal animal species (insects, bats, etc.)?

Photophilia of nocturnal insects is known for a long time. The attraction of different species of animals is substantially influenced by the spectral composition of the light source. Light sources rich in UV frequency components attract a lot more insects. However, there are large differences in this respect even within the same taxons of animals, for instance active nocturnal moths like dart-moths, gypsy moths, tigermoths, hawk-moths are attracted to UV rich (for instance mercury-vapour lamps) light sources, while this preference is a lot less intensive for heath moths. Another consideration is the intensity of the light. The stronger the light source, the more significant its attraction force from a distance.

In the case of bats the case is double fold. Bats frequently prey on insects flickering around the light or sitting in the light circle. This is a positive impact. It represents negative impact that bats can be caught by their predators more easily in the light.

In the light of all these the least damage is caused by point like light sources with the least light intensity and lean on UV components in the nocturnal fauna around the construction site. Light sources must be switched off when not needed for a longer period of time. Light sources must be directed towards the centre of the construction site.

5.2.7 Prepare a consolidated table on the restrictions to be put in place during the implementation phase

The most dangerous seasons of the year vary from species to species for both plants and animals. Consequently, no execution schedule can be prepared which definitely does not do any harm to the flora or fauna. However, the extent of impacts can be reduced by structuring the completion of each task in space and time.

In order to preserve the wildlife in the area preventive measures are most effective and most important. Therefore, it is not the period of implementation which needs restrictions, but preventive measures must be completed carefully and in a workmanlike manner. For this work the involvement of the appropriate specialists is needed.

Before the commencement of the construction works the protected sites (refuges) should be identified where plant and animal species are to be resettled and where animals will migrate to by themselves as a result of the disturbing effects of construction works. Upon completion of the project resettlement and recolonisation from these places may happen. The recommended areas are as follows:

1. On both sides of the thermal pipeline of the mobilisation area an area with the total extension of approximately ~10 ha. This is a place providing appropriate shelter to the plants, invertebrates and reptiles living in the area.

2. An approximately 10 hectares forested area between the Fishing Pond No 1 of the Paks Anglers' Association and the hot water canal of the power plant. This area provides shelter to the birds and bats living on the "Island".

The following special tasks need to be accomplished with respect to the vegetation:

Damage to the protected plant species can not be excluded on the mobilisation area, therefore preventive measures presented below are necessary to accompany the implementation of the investment project.

A substantial part of the mobilisation area is covered by three awn feather grass or needlegrass populations. Replantation and success of resettlement is questionable in the case of this species, therefore saving of this kind of grass should be taken care of in another way. Seeds should be collected once a year in the years preceding the project. Collecting seeds is possible holding the appropriate permits. Submission of seeds should be made preferably to the Pannonian Seedbank (with associated institutions such as the Plant Diversity Centre Tápiószele, MTA Ecological Research Centre Ecological and Botanical Institute - Vácrátót, Aggtelek National Park Directorate). If these institutions can not accept the seeds, their further fate should be discussed with the Danube-Drava national Park Directorate.

In order to accomplish seed collection properly hay cutting of the mobilisation area must be timed so that mature seeds could be collected beforehand. Needlegrass seeds must be collected with the three awns of the external husk, pending on the weather during May to June in dry weather and from dry individuals, when seeds can be easily removed from the plant by pulling. The goal is to collect at least 5000 seeds from minimum 200 individuals in a random manner in order to ensure representative collection and to preserve allele frequency. The amount of seeds can be reduced when it exceeds the annual yield of seeds with respect to the mobilisation area. Being a protected species, any higher rate of collection would endanger the population. It should also be reckoned with respect to the investment project that not the entire population may be destroyed, eventual survival of the population must be ensured. Wherever exposure is obvious, the higher rate of annual seed production of the individuals identified need to be attempted. Collection should be made by competent specialists. Beside a written documentation (data on the habitat, population, plant individual) a photographic evidence containing sharp, properly exposed pictures in a size of at least 2 megapixels need to be attached on the taxonomic traits, phenological phase of flowering, and the environment.

Individuals of protected tickseed, feathered pink plants growing in the route of the transmission line should be protected in their original places which must be fenced off and marked for the time of construction. Seeds of three awns needlegrass species must be collected in the year preceding the installation of the transmission line in a documented manner (10% of the seeding stock as a minimum), and scatter around the stripe along the transmission line route which is already not disturbed by the investment without its awns, this way ensuring a richer than existing source of propagules for resettlement.

When the investment project is planned, possible methods to prevent the penetration of invasive plant species must be developed.

For the purposes of resettlement of protected plant species and collecting the seeds of protected plant species consultations should be carried out with the Danube-Drava National Park Directorate. For any operation along the route of the power transmission line the official nature conservation permit must be applied for at the Mid- Transdanubian Environmental and Nature Conservation Inspectorate.

The following special tasks need to be accomplished with respect to the wildlife:

Before the commencement of the hibernation (suspended animation) of amphibians and reptiles living in the area need to be resettled to undisturbed habitats. This work must be completed in the Autumn (September, October) in the year before the commencement of the construction project.

The investment must be started before the reproduction period of birds, i.e. before March. At this time the specimen living in the area wander away from the disturbing effects or individuals looking for nesting places do not immigrate from the neighbourhood.

Before the commencement of the implementation works the bats living on the “Island” and gleaner mouse colonies living along the route of the transmission line need to be resettled.

During the works affecting the Danube bed a spatial restriction approach seems to be most effective. Disturbing the natural environment need to be restricted to the least possible extent including activities eliminating habitats and influencing the shaping of the riparian zone. If technically possible, these operations should be carried out in May to July.

5.2.8 Please clarify for how long the existing and proposed units are expected to operate jointly. In Volume III Chapter Wildlife and ecosystem only two years are indicated on Page 99 (2030-2032). In other chapters more years were indicated.

Joint operation of the existing and proposed nuclear power plant units is scheduled for the period between 2025 and 2037. During this period first the new units are anticipated to be commissioned and put into commercial operation, then current and proposed units operate jointly, finally the current units are gradually shut down (see Table Table 5-1.).

Activity	Time interval
Joint operation of Units 1 to 4 of Paks Nuclear Power Plant and Unit 1 of Paks II	2025-2030
Joint operation of Units 1 to 4 of Paks Nuclear Power Plant and Unit 1 and 2 of Paks II	2030-2032
Final shut down of Units 1 to 4 of Paks Nuclear Power Plant reaching the end of their extended lifetime	2032-2037
Joint independent operation of Units 1 and 2 in Paks II following the final shut down of Units 1 to 4 of Paks Nuclear Power Plant	2037-2085
Expiry of service period in Paks II Unit 1	2085
Independent operation of Paks II Unit 2 following shut down of Paks II Unit 2	2085-2090
Expiry of service period in Paks II Unit 2	2090

Table 5-1: Service periods of Paks II Units and joint operation with existing units of Paks Nuclear Power Plant

The most significant environmental impact from the units is expected in the period between 2030 and 2032 when the proposed 2 new units are also in service in addition to the currently operational four units, therefore among others this period was highlighted as the period associated with the most significant environmental impact in the case of topics related to the hot water discharge.

5.2.9 Having regard to the low water stages during summer what kind of additional cooling can be designed and implemented with a view to the considerations included on Page 245 of Danube WFD (EIS 12.)?

The period of joint operation of Units 1 to 4 of Paks Nuclear Power Plant and Unit 1 and 2 of Paks II is 2030 to 2032. After this period units in the Paks Nuclear Power Plant are shut down on a scheduled basis, therefore for the purposes of discharges the period between the year 2030 and 2032 can be considered to be the most robust, loads are gradually reduced thereafter to the level of stand alone operation.

No qualitative differences occur in the impacts, their quantity however is larger. Due to the thermal limit the Δt value does not change in the period of joint operation of Units 1 to 4 of Paks Nuclear Power Plant and Unit 1 and 2 of Paks II between 2030 and 2032, but the amount of cooling water discharged results in a substantial longitudinal protraction of the heat loads. Of the impacts assessed, this period and this impact can be seen as the strongest and most important.

During summer when Danube water temperature may exceed 25 °C and this coincides with a discharge rate below the middle stage rate of flow on the Danube, the application of a supplementary solution may become necessary if the thermal limit of T_{max}=30 °C provided for the 500 metres Danube profile on the downstream section of the hot water discharge point is to be met, in particular if the background temperature of the Danube water is considered which is expected to grow over time as a consequence of the climate change.

In order to comply with the requirements of environmental protection the following options were considered:

- Limiting electric output of the unit
- Mixing in of additional cold water
- The application of supplementary cooling.

The benchmark for the analysis was a 3 °C cooling effect to be achieved from the hot water discharge point up to the 500 m Danube profile downstream originating mainly from blending, which allows this way a maximum temperature of 33 °C for the hot water at the discharge point.

Limiting electric output of the unit

When this solution is applied, the maximum permitted temperature of the warmed up cooling water is kept by limiting the electric power output of the nuclear power plant unit. By the reduction of the electric output the amount of heat to be dissipated in the condenser is also reduced, therefore – in the event of the same volume rate of flow – the rate of cooling warm up is reduced as well.

Mixing in of additional cold water

In this cooling alternative the maximum permitted temperature of the warmed up cooling water is kept by the adding of additional Danube water transferred from the cold water canal directly into the hot water canal by-passing the turbine condensers. Extra water necessary for cold water mixing is provided by an additional pump installed in the water extraction plant which can be replaced by the pumps of the existing water extraction plant once the units currently in service are shut down. Cooling water warmed up through the condenser and the cold water mixed in the necessary amount is discharged into the Danube through the existing hot water canal passing an appropriate structure improving its blending potential at the inlet point into the Danube.

The application of supplementary cooling

When supplementary cooling is used the maximum permitted temperature of the warmed up cooling water is accomplished by full flow cooling of the warmed up cooling water exiting from the turbine condensers on a forced ventilation cell based cooling tower. The volume flown through the additional cooler can be optimised. Cooling water flown through the condenser and cooled on the supplementary cooling facility is discharged into the Danube through the existing hot water canal passing an appropriate structure improving its blending potential.

Evaluation

Each of the supplementary solutions assessed are suitable to keep the temperature of the warmed up cooling water returned into the Danube below the desired level of 33 °C.

The limiting factor of power output cut back on Paks II if the minimum allowable partial load on the units, cold water mixing at minimum Danube discharge rates, joint water extraction for cooling in Paks Nuclear Power Plant and Paks II, enlargement of joint structures, and noise, a limit to aftercooling. However, these limiting factors would not render any version technically impossible when the basic assumptions are held.

Studies suggest that taking into account all technical, profitability and environmental protection aspects of the three technical options outlined, various benefits can be expected, but according to our current knowledge the optimum solution would be a temporary reduction of the electrical output of the unit, both based on the results of lifetime cost analysis and environmental protection aspects, since it does not represent any environmental discharge or use of additional areas.

6 LIST OF REFERENCES

[1] AES-2006 Baltic NPP Unit 1 Preliminary Safety Analysis report Chapter 18 Decommissioning, 2009