EXTRAORDINARY NATIONAL REPORT

Prepared under the Convention on Nuclear Safety

2012

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Introduction

Based on the preliminary experiences of the nuclear accident that occurred in Fukushima, the European Commission has launched the Targeted Safety Reassessment (the so-called stress-test) of the European nuclear power plants. The Hungarian nuclear safety authority has accordingly ordered the Targeted Safety Reassessment of Paks Nuclear Power Plant. As a result of the analyses performed within the frame of the reassessment the Hungarian Atomic Energy Authority, as the national regulator compiled, and at the end of 2011 submitted, the Hungarian National Report on Targeted Safety Reassessment to the European Commission. This Extraordinary National Report prepared under the umbrella of the Convention on Nuclear Safety takes the results of the Targeted Safety Reassessment as a basis by supplementing with newer results.

Reference date of this National Report is February 29th 2011.

The analyses performed during the Targeted Safety Reassessment process have not revealed any such implication in relation to earthquakes, external flooding and extreme weather conditions, which might directly lead to a cliff edge effect. The new meteorological hazard analysis, using the most recent meteorological data, demonstrated that no such meteorological event is known, the occurrence of which would significantly change the load conditions, so in this regard the potential for a cliff-edge effect also should not be considered.

Short description of the site and the units

The site of Paks NPP is located 5 km south of the city centre of Paks, 114 km south of Budapest, 1 km west of the Danube River and 1.5 km east of the main road No. 6 (Figure 0-1). The elevation of the site is at Bf 97.15 m (above Baltic Sea level). An aerial photo of the site can be seen in Figure 0-2.

Figure 0-1: Location of Paks Nuclear Power Plant

The plant obtains the cooling water for the operation directly from the Danube. Since fresh water cooling technology is used, no cooling towers have been constructed for the NPP units. The water from the river is directed to the water intake structure of the plant through a cold water canal. The primary skimmer is placed at the branch of the river.

The pump stations placed in the two (serving 2-2 units) water intake structures deliver the water towards the units for various cooling purposes (condensers, process consumers, safety systems). The used cooling water is returned by way of closed pipes along the units, reaching the river through the open discharge water canal, across an energy breaker structure. In cold periods, to prevent icing and to continuously melt the ice floating in from the Danube it is possible to partially mix the warmer water from the discharge water canal.

Figure 0-2: Site of Paks Nuclear Power Plant

Altogether 4 units were constructed on the site, which are placed in two building structures in a twin arrangement. The first building houses Units 1 and 2 (called Installation I), while the second houses Units 3 and 4 (Installation II).

The licensee of the site is Paks Nuclear Plant Limited. The four units of the plant are of VVER-440/V-213 type, light water cooled, light water moderated pressurized water reactors. The normal thermal power of the units is 1485 MW. The electric output is 500 MWe, which has been achieved by a two step power uprate from the original 440 MWe. The total capacity of the plant is accordingly 2000 MWe.

Normal values of the main technological parameters are described in Table 1-1.

Table 1-1: Main technological parameters of the units

Parameter	Value
Thermal power of reactor	1,485 MW
Primary coolant volume flow rate	42,000 m^3/h
Primary pressure	123 bar
Primary circuit cold leg temperature	267 °C
Primary circuit hot leg temperature	299.5 °C
Shutdown boric acid concentration	13.5 g/kg
Fresh steam pressure	46 bar
Fresh steam mass flow rate	2,940 t/h
Fresh steam temperature	255 °C

The dates of first connection of the units to the national electricity grid are as follows:

Unit 1: December 28, 1982,
Unit 2: September 6, 1984,
Unit 3: September 28, 1986,
Unit 4: August 16, 1987.

Identification of hazard factors

According to the results of the Level 1 probabilistic safety assessment (PSA), in the current scope of the analyses, the calculated total core damage frequency is less than the target value of 10^{-4}/year recommended in the Hungarian regulations and in the international documents: the requirement is numerically met.

No system or component can be identified, which would significantly contribute to the core damage frequency, i.e. the risk components are acceptably balanced.

The numeric results show that among the analyzed initiating events earthquakes, and among the analyzed errors human failures, are the dominant contributors to core damage. In order to decrease these effects, corrective measures were implemented based on PSA analyses well before the Fukushima accident. These measures included, among others, the extension of qualification scope of seismic reinforcements of electrical, instrumentation and control equipment, and the development of further operator aids and instructions.

Except for earthquakes, the analysis of external hazards does not belong to the scope of the current PSA, but the respective assessment is in progress.

External events

According to the current Hungarian legislation every such postulated event shall be taken into account as part of the design basis of the plant endangering its safety that:

a) is natural and corresponds to the site and its vicinity;
b) is intentional but not directed against the nuclear power plant or it is a consequence of unintentional human activities on or off the site;
c) originates from the operation of the nuclear power plant or random failure of its system, structure or component.

Resulting in a still acceptable level of safety a practical, yet manageable, screening of the design basis events is possible according to the legislation. The following ones can be screened out from the scope of postulated design basis events:

a) internal events resulting from the failure of systems, structures and components and/or a human failure, if their frequency is less than 10^{-5}/year;
b) such external human induced events characteristic for the site, the frequency of which is less than 10^{-7}/year, or either the hazard is at such a distance or such evidence can be provided that the impact on the nuclear power plant cannot be anticipated;
c) initiating events induced by external natural impact with a recurrence frequency of less than 10^{-4}/year.

The conditions a)-c) above are valid for the consideration of the external hazards in the design basis, but such a restriction of the design basis does not at the same time imply the omission of the initiating events to be analyzed during safety assessments. During the probabilistic safety assessment of the risks related to the screening of low probability events from the design basis, the initiating events shall be taken into account minimum to a frequency of 10^{-7}/year.

This National Report, in line with the guidance provided, does not cover the review of external human induced hazards, it took place in full scope during the last periodic safety review and it was determined that such an external hazard does not exist, which would endanger the safety of Paks NPP units.

Out of the external impacts the seismic hazards of the site and other natural hazards potentially occurring at the site will be described, such as flooding of the Danube, low water level of the Danube, site-specific meteorological impacts, and forest-fires in the vicinity of the plant. Load characteristics are available for all mentioned natural hazards both within and beyond the design basis. Seismic safety of the plant is the key issue to the protection of the plant against external impacts, so this phenomenon will be in the focus of the report with a detailed discussion below. With regard to other natural phenomenon, evidence was provided that due to its features, its relatively high location compared to the river bed of the Danube, as well as due to the dikes, flooding of the site could not occur; extraordinary low level of the Danube can be safely managed by due technical arrangements provided by the plant; the forest-fires in the vicinity of the plant do not cause hazards to the operation of the plant. Assessment of meteorological extreme events is still in progress, however according to the results already available these do not challenge the safety of the plant more seriously than acceptable.

1. External events

1.1 Short description of analyses

1.1.1 Earthquake

During the technical design at the beginning of the 1970s, the seismicity of the site was determined based on historical and instrumental earthquake records and it was characterized by 5 balls on the MSK-64 macro-seismic intensity scale. The design basis intensity, i.e. the intensity of the so-called maximum design earthquake of the design basis was taken higher by an intensity degree and the standard acceleration values were assigned thereto, which resulted in 0.025-0.05 g.

Comprehensive geological assessment of the Paks site, including the determination of design basis earthquake for the site began in 1986. Evaluation of seismic hazards and the design basis earthquake (safe shutdown earthquake, SSE) was completed in 1996. The work was supported by the "Regional Programme for Nuclear Safety 4.2.1 VVER 440-213 Seismic Hazard Re-evaluation" PHARE project of the European Commission and by the technical cooperation projects and review missions of the IAEA.

Re-design, re-qualification of critical systems, and where necessary their reinforcement for design basis earthquake, took place in the 1990s within the frame of a comprehensive review programme.

Compliance of determination of seismic hazards was already assessed during the first periodic safety review (1996-1999) based on microseismic data having been recorded since commissioning of the first unit and by using the results of the neotectonics assessment. Seismic vulnerability was reviewed within the frame of the grounding of the environmental license of service life extension (2004-2005), and in 2007 during the second periodic safety review, when beyond the consideration of the current scientific results the compliance with the IAEA standards (revised in the meantime) was also assessed.

Characteristics of design basis earthquake

Due to the geological and seismological circumstances, the seismic hazards of the site were determined using probabilistic methodology. The mains steps of the methodology were:

- identification and characterization of earthquake source-zone models (magnitude-frequency distributions and cut-off magnitudes),
- selection of attenuation laws,
- calculation of the hazard curve using a logic tree (probabilistic method),
- calculation of the response spectra for the bedrock (Pannonian surface),
- calculation of free-field (ground motion) response spectra taking into account the non-linear transfer through the young sedimentary soil covering the Pannonian surface.

The seismic hazard curve for the site can be observed in Figure 1-1which, at various confidence levels, contains the annual exceedance probability of the more frequent design basis earthquakes causing less load and of the rare beyond design basis earthquakes causing more significant load. The expected value of peak ground acceleration of the design basis earthquake has been set to 0.25 g for the horizontal and 0.2 g for the vertical components taken at 10^{-4}/year frequency level on the weighted mean hazard curve. The free field horizontal acceleration response spectra at 5% attenuation can be seen in Figure 1-2.

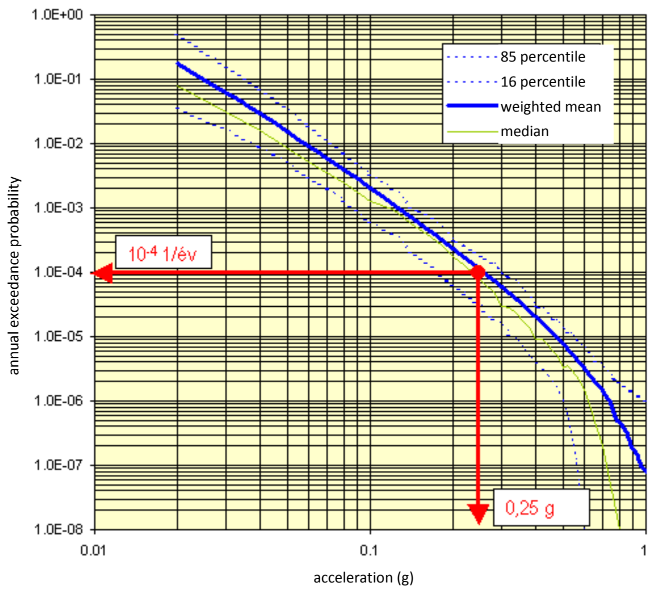

Figure 1-1: Seismic hazard curve

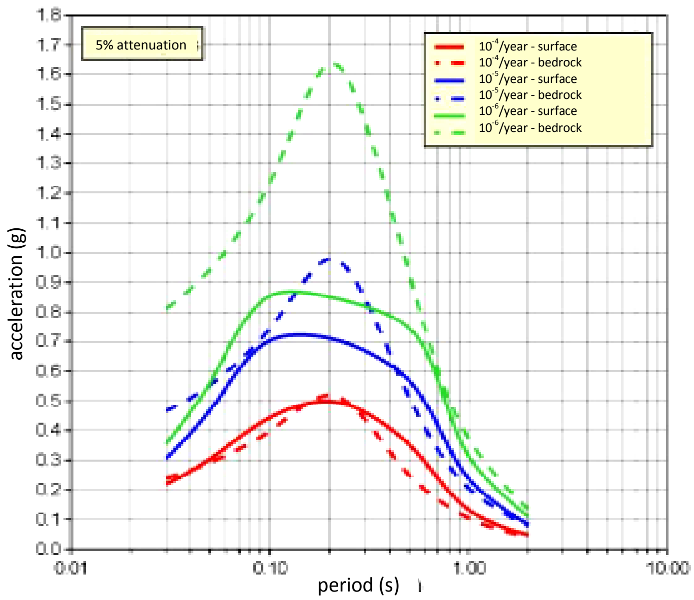

Figure 1-2: Uniform hazard response spectra of ground acceleration for various non-exceedance frequencies

Compliance of determination of seismic hazard

The development of the geological structural model took into account the geological, geomechanical, geophysical, stratigraphy, hydrogeological and geological evolution, as well as the seismological assessments.

The area subjected to detailed review covered a territory having a radius of >300 km around the site. This is shown in Figure 1-3 that displays one of the three earthquake source models considered by the review. The total source area considered in the review was divided into source zones, where homogenous seismicity was assumed. Seismic activity and earthquake frequency parameters were determined for each zone.

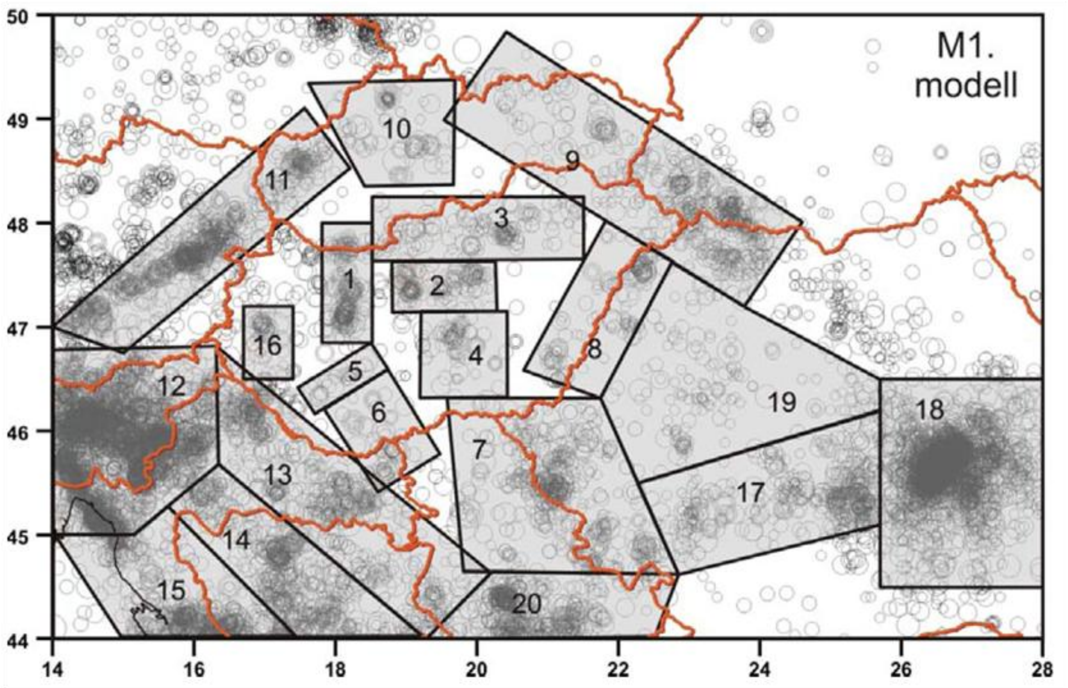

Figure 1-3: One of the earthquake zone models with the earthquake epicenters

The assessment of the site, in addition to geological drillings, included shallow seismic profiling, geo-radar examinations and a detailed geotechnical survey. Since 1995 the data and knowledge-base obtained during the site investigation and used for hazard evaluation, has been supplemented and updated with new scientific results on neotectonics and seismology. This information has been annually updated since the last decade with the data of the microseismic monitoring system installed in the wider vicinity of the site, as well as with geotechnical assessment results. Arrangement of the seismic observation network in the vicinity of the site can be seen in Figure 1-4.

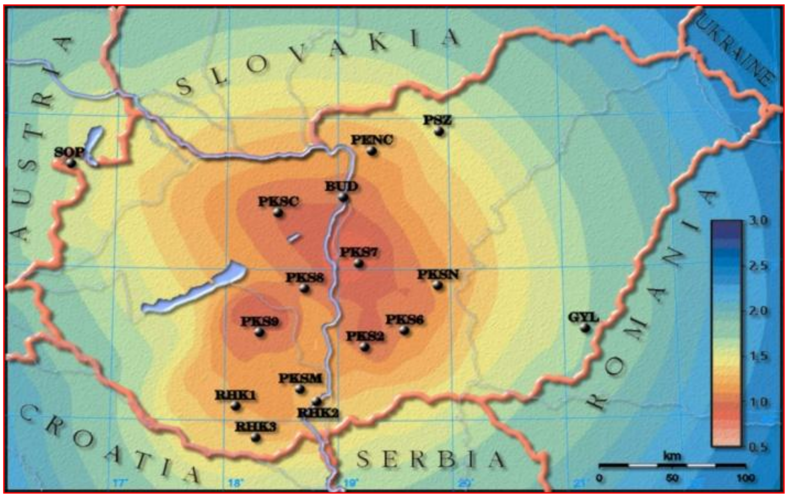

Figure 1-4: Seismic observation network and its observation area in the wider region of the site

The design basis earthquake of the plant is an earthquake having 10^{-4}/year frequency, which is characterized by the peak ground free-surface horizontal and vertical accelerations and response spectra, and duration of the strong quake.

Determination of the design basis may take place based on the mean, median or a quantile hazard curve derived from the curve manifold obtained as a result of the probabilistic seismic hazard assessment. The current Hungarian regulation takes the free-surface peak ground acceleration (PGA) taken from the median curve and the free-surface response spectra as basis for the design. Notwithstanding, the design basis of Paks NPP was specified more conservatively, on the 10^{-4}/year exceedance level using the weighted mean hazard curve. Figure 1-1 shows the mean, weighted mean and various quantiles of the hazard curve.

The uniform hazard response spectra of the earthquake of 10^{-4}/year exceedance frequency were determined for the Pannonian surface, as for outcrop. Calculation of the free-surface response spectra took place by consideration of the non-linear transmission of the upper unfixed covering layers. Figure 1-2 shows the response spectra calculated for rock outcrop and free-field surface acceleration.

Evaluation of soil liquefaction hazards

Under the upper soil layer, there is Pleistocene layer of 25-30 m, the upper 12-15 m part of the alluvium consists of fine structure, well classified sand, while its lower part consists of sandy gravel and gravel, gravel-scattered sand. Under the Pleistocene sediment, there are layers of lacustrine origin, variously developed upper Pannonian layers, which are irregularly divided by sandstone ridges. These ridges are cemented to various extents and can be regarded as semi-rocks.

Potential of occurrence of soil liquefaction cannot be excluded based on the soil characteristics. On the basis of assessments with simple empiric or semi-empiric methods, the safety margin against soil liquefaction within the layers between 10 and 20 m is approximately 1.1 using conservative calculations only. So, additional assessments became necessary in two directions, using two methods as follows:

- a probabilistic method considering the variation and uncertainty of the soil characteristics and other parameters of the analysis; and
- an analytic method, applying linear and nonlinear calculation methods to determine the stress.

According to the calculations performed with probabilistic methods, considering the soil-building interaction that modifies the cyclic shearing stress, the recurrence time of soil liquefaction in the soil layers loaded by the main building is 14,000-18,000 years. It means that this phenomenon can be excluded from the design basis.
In relation to the pore water pressure typical for soil liquefaction, by using detailed stress calculation methods, the margins are obtained to be larger compared to that described above, since the non-linear effect has become stronger in the range of larger quakes.

Soil liquefaction does not lead to loss of stability, but may cause the settlement of the buildings. Supplementary investigations in other projects are currently being carried out in order to more accurately assess the potential building settlement after an earthquake.

Potential for permanent surface deformation

The basic issue of the complex geological survey of the site was whether the structures around the site have been active during the current tectonic regime (2.5 million years) or in other words, whether the many fault lines in the Pannonian layer seen in the seismic profiles in the vicinity of the site have been active during the Quaternary Period.

The detailed geological survey and geophysical profiling performed in the vicinity of the site showed that there is no obvious sign of Quaternary faults, the faults existing in the Pannonian layers have not penetrated the upper Quaternary layer, which is at least 45 thousand years old. At a larger distance from the site, where data could be obtained, the Quaternary sediment is not disturbed.

The information obtained from micro-seismic monitoring of over more than a decade demonstrates that the activity of the structures around the NPP (within a distance of 10 km) is negligible, though the amount of measurement data is relatively small due to moderate seismicity. On the basis of events registered, it can be stated that most of the recent earthquakes are correlated with distant sources formerly identified. Considering the detection capabilities of the measurement network around the Paks site, it can be established with a high degree of confidence that there was no such earthquake in the 50 km environment of the Paks NPP during the monitoring period, which would require the revision of the former conservative assumptions regarding seismic activity.

Thus, according to the evaluation of the indirect data performed by Hungarian and international experts, there is no geological and geomorphologic evidence on the activity of the faults located in the vicinity of the site. In conclusion, the structures existing in the Pannonian layers in the vicinity of the site are not active with high probability; consequently, they do not cause permanent surface deformation with very high probability.

1.1.2 External flooding

Potential for flooding and external inundation

According to the statistical assessment of the water level characteristics collected at the local water-gauges in the Danube, it was determined that in the vicinity of the site the level of icy flood of 10^{-4}/year frequency is 96.07 m (above the level of the Baltic Sea), while the level of open river flood may be 95.51 m. Since the formation level of the embankment of the site is higher than these flooding levels, flooding hazard of natural origin shall not be taken into account as basis for design of the safety systems of the plant.

The formation level of the upstream embankment is lower than the filled up level of the site, and the formation level of the embankment on the opposite side of the Danube is also lower. So in the case of floods less frequent than 10^{-4}/year, it can surely be expected that the river floods the areas beyond the embankments located north of and opposite to the site. Based on all these it is assumed that extreme floods cannot reach the site of Paks NPP.

The possible highest ice-free flood level, calculated by the one-dimensional model that considers actual river bed and embankment conditions is Bf 96.14 m.

The worst flood case situation modeled was determined from the historically worst high water conditions, the flood flow of which was conservatively modified to be equal to the formation level of the embankments at the Bratislava section of the Danube. In addition, the worst failure of the reservoir of Bős (resulting in an additive downstream flood-wave) was assumed. In order to further increase the effect of the worst flood-wave, it was assumed that each of the significant tributaries of the Danube feeds the river with the maximum flood-wave in such a way that the highest stream flow of the tributaries enters the river when the stream flow of the Danube also peaks.

According to the model calculations the level increase due to ice-packing in the downstream section of the site cannot cause a higher water level than 95.90 m above the level of the Baltic Sea.

All these mean that a water level that would exceed the formation level of the embankment on the right bank or the site elevation level, which is situated even higher, is not possible even in the case of extreme high-water loads or ice-blocks that substantially exceed the design basis.

1.1.3 Low water level of the Danube

Very low water levels have occurred several times recently, for the effect of which the statistical results had to be corrected; the current value is 84.07 m above the level of the Baltic Sea. Based on the lowest anticipated water level determined this way, the essential service water pumps were extended, their suction elbows were replaced, solutions which provide that the pumps can be started and operated up to 83.5 m.

If the water level is extremely low, which may occur less frequently than the design basis value, the pre-screening parts of the water intake plants might be separated from the cold water channel by block-gates to ensure their filling-up. The block-gates equipped with submersible pumps and the Diesel driven feed pumps placed on floating pontoons provide sufficient quantity of cooling water for the essential service water system.

The occurrence of low water level is a gradual, long lasting process thus, it can be followed by the operator of the plant. To ensure a back-up supply for the essential service water systems, four stages of actions shall be performed as a function of the water level from the occurrence of 85.00 m, which is the limit of undisturbed operation.

The feasibility of the above actions was tested earlier and, based on a recent re-assessment, measures were taken to improve the regular and full-scope inspection, maintenance and testing of the equipment listed in the action plan.

1.1.4 External fires

A biomass map was constructed in 2010 in the frame of a measure prescribed following an earlier periodic safety review to survey the potential and frequency of off-site forest and parking lot fires of various extents, and to determine the respective loads. Subsequently, by way of a fire and smoke propagation model, the plant performed model calculations. Based on that the characteristic emission values, potentially causing hazard for the plant, were determined.

The forest fire might endanger the site through two potential impacts: thermal radiation and dispersion of combustion products. Based on the distance of the site and type of fire, an expert concluded that the direct thermal radiation does not mean a hazard source. It was also determined that the smoke may overlay the site. Further modeling required the laboratory analyses of sampled biomass, calculations on the composition of the smoke and generation of its intensity to produce input data.

The assessment on the consequences of forest fires concluded that the CO content of the smoke does not occur in such a concentration at the site, which would influence the activity of the operating organization if entering the buildings via the venting systems. No emergency has to be considered on the site due to such fire.

Also fires of vehicles left in the parking lot located next to the site were examined. The causes of vehicle fires are many times more difficult to identify. The main source of danger is the fuel, since the petrol in the tank may overheat due to the fire and the tank may explode due to the evolved overpressure. The petrol released to the environment may catch fire and produce a large fireball. The fireball causes a relatively short but very intensive thermal radiation in the close vicinity and the burning petrol spreading to several meters may accelerate the propagation of the fire. Flammable parts of the vehicles, first of all their tires also support the propagation.

According to the calculation results, it could be determined that even the simultaneous fire of several vehicles at the closest location to the units would not lead to such consequences, which would endanger the safety of the nuclear power plant. The results showed that the overpressure induced by a potential explosion would not reach the buildings of the plant. Equivalent statements can be obtained for the thermal radiation zones of the fireball and the pool fire. No emergency on the site would occur as a consequence of the pressure wave caused by the explosion, the thermal radiation zone of the fireball and of the pool fire generated by 200 liters of petrol.

1.1.5 Extreme weather

A new hazard analysis was prepared on the basis of the latest meteorological data available: observations of the Paks meteorological station of the Hungarian Meteorological Service between 1980 and 2010 were used as input data. $1 \div 10^7$/year recurrence frequencies with the various confidence levels were determined for each external hazard.

Extreme wind

Data of the wind measurement instrument placed at 9.8 m above the ground at the main meteorological station was used to determine the statistical characteristics of the wind conditions. The hourly wind direction and wind speed data collected between 1980 and 2010, as well as the maximum wind gust values were processed. Wind direction frequencies were classified based on wind speed categories. The prevailing wind direction in the vicinity of Paks blows from the NW. The assessment also revealed the joint wind speed and wind direction frequencies, which showed that the stronger winds (>15 m/s) are from the NW with the highest probability.

In the case of a tornado, as a devastating whirlwind, it is not necessary to manage the hazard separately; because it is the feature of the regions having similarly low frequency of tornados that the maximum wind load from horizontal winds exceeds the tornado induced loads. The maximum wind gust (41.5 m/s) with a recurrence frequency of 10,000 years is less than the maximum design wind gust (48.8 m/s) taken into account in the design basis and strength calculations of buildings and open air facilities.

Extreme external temperatures

Temperature measurement and collection of measured data take place on a regular basis at the meteorological station, including the registration of daily maximums and minimums. Extreme temperature values can be determined based on the analysis of extreme values of daily minimums and maximums. Besides the extreme temperature values, the duration of the given values may also be important as far as its impact is concerned on the operation of the unit.

The extreme maximum temperature to be assumed in the design basis is 45.3 °C, while the minimum temperature is -47.9 °C.

The specific temperature minimum and maximum values are parts of the design basis of the safety classified nuclear power plant buildings and open air technology equipment. Temperature maximum is also considered in the design basis of the venting systems.

Extreme rain

Determination of the design basis precipitation takes place based on precipitation averages generated for various time periods. Extremely intense precipitation can be determined by measuring short, even 10 minutes of precipitation. 24 hours precipitation or the time average definitive from drainage or flooding of the site occurs in the design basis. From the aspect of external flooding, the precipitation over a short time is the most important, which shall be drained by the canal system of the site.

Table 1-1: Recurrence frequencies of annual maximum precipitation yields for various durations based on Gumbel distribution (mm)

Recurrence time [year]	10 minutes	20 minutes	60 minutes	24 hours
10 000	42.0	58.4	93.3	132.0

The precipitation is assessed based on the daily data measured at the precipitation measurement station having been operated in the Paks region since 1951. The annual average total precipitation is around 577.5 mm (country average 600 mm). The annual maximum precipitation yields of 10, 000 years recurrence frequency can be observed in Table 1-1.

Extreme snow

The snow layer accumulating for a longer time on the surface during the winter months might contain a significant amount of water. The snow load depends on the thickness and density of the snow layer; additionally, the height of a potential snow barrage appearing for the effect of a snowdrift caused by strong winds also needs to be considered. The forecasted maximum snow thickness with 10^{-4}/year frequency is 108 cm, the design basis of safety classified nuclear power plant buildings and open air process equipment considers a 1.5 kPa snow load pressure contribution, which means an overdesign if the densities typical for fresh snow are taken into account.

Extreme frost and freezing rain are part of disturbance of the external electrical grid, so the report does not deal with this phenomenon as a separate external impact.

Lightning

As an average, 1 to 3 lightning strikes per square km shall be taken into account in Hungary. The frequency of lightning in the vicinity of the site is 1.27 lightning/km^2/year, which is more or less equal to the country average.

Larger physical damages directly caused by a lightning strike as primary effects are supposed to be eliminated by the external lightning protection system, which contains lightning rods, conductors and earthing devices. Secondary effects of a lightning strike are such flashovers within buildings, especially inside electric equipment that may cause the inoperability thereof. Internal lightning protection is applied against damages induced by such secondary effects. Its task is twofold: to decrease the voltage occurring due to secondary effects and to conduct the over-voltage of the equipment still penetrating therein and thereby to protect the sensitive parts thereof.

Description of lightning needs a methodology different from the evaluation of other meteorological factors, since lightning cannot be characterized by a single parameter. Consequently, the design basis concerning lightning cannot be specified as a single value, but shall be demonstrated how it complies with the standards. Lightning is a part of the design basis of safety classified buildings and open air technological equipment of the NPP. Electro-magnetic effects of lightning have to be taken into account in the design basis of safety classified instrumentation and control equipment of the NPP.

Extreme external cooling water temperatures

The temperature of the Danube is regularly measured in the water measurement section at the site. The water temperature increases proportionally to the air temperature and duration of sunny hours, it is inversely proportional to the flow rate of the river. The highest water temperature was 26.7 °C measured during the operation of the nuclear power plant.

The maximum Danube water temperature is a part of the design basis of the essential service water system and the consumers of the essential service water. In the design basis of the essential service water system the maximum cooling water temperature that was taken into account to maintain the cooling efficiency is 33 °C.

Considering that a limit of 30 °C is in place for the maximum temperature of the cooling water plum discharged back to the Danube from Paks NPP, the unit shall be shut down and cooled down well before reaching the mentioned design value. In such a way the residual heat of the shutdown, cold reactor can safely be removed.

1.1.6 Beyond design basis external impacts

Vulnerability of the electric power supply and ultimate heat sink functions for beyond design basis external impacts

The plant shall be protected against any external impacts having a frequency higher than 10^{-4}/year. There are no design requirements for the margins beyond this hazard level, however also these external events of low frequency shall be taken into account in the safety analysis at least down to 10^{-7}/year occurrence probability. The review scope includes all potentially important hazards of natural origin. Among the external hazards, the extreme low and extreme high water levels of the Danube need not be accounted. In relation to evaluation of the meteorological effects causing extreme loads, currently there are no such results available, based on which the beyond design basis margin can be evaluated. In summary, from the aspect of assessment of beyond design basis margins the only external event that can be evaluated is the earthquake. Only those cases are included in this chapter from the aspect of the containment, when the containment function is directly jeopardized by the external impact.

During the probabilistic safety assessment of earthquake effects, all systems, structures (buildings) and components contributing to the hazard were taken into account and the vulnerabilities thereof were determined. Consequently, the probability of loss of function for each component is known for the earthquake of the particular magnitude. Using the model parts and data related to these systems specific models were developed for the loss of the electric supply, the ultimate heat sink and of the containment function. Margins beyond the design basis were determined based on the evaluation of the model.

Vulnerability of electric supply and ultimate heat sink function

The average vulnerability curve for loss of electric power supply function is shown in Figure 1-5, while for the loss of the ultimate heat sink function in Figure 1-6. The figures show the conservative probability of the final state, as a function of load, in terms of free-field acceleration related to the so-called Pannonian-layer located at 30 m underground. The figures also reveal the horizontal ground acceleration for the design basis earthquake. Based on the results it can be declared that there is no certainty that the systems of electric power supply and ultimate heat sink functions will be impaired even after a beyond design basis earthquake, but the probability of loss of function is increased with the strength of the earthquake.

The mean probability of occurrence of loss of electric supply function reaches the value of 0.5 at 0.46 g acceleration, which acceleration is typical for an earthquake having an occurrence frequency of only 10^{-5}/year, which is significantly less than the design basis.

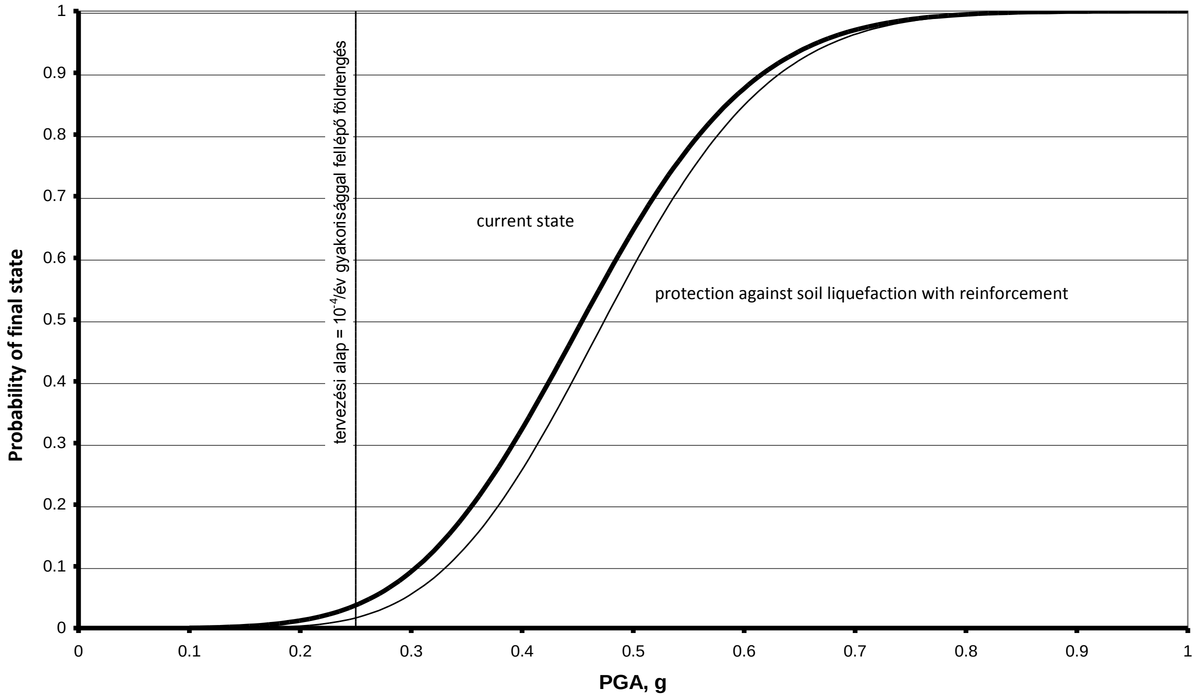

Figure 1-5: Mean probability of loss of electric power supply due to earthquake as function of peak ground acceleration (PGA)

The mean probability of occurrence of ultimate heat sink function reaches the value of 0.5 at 0.42 g acceleration.

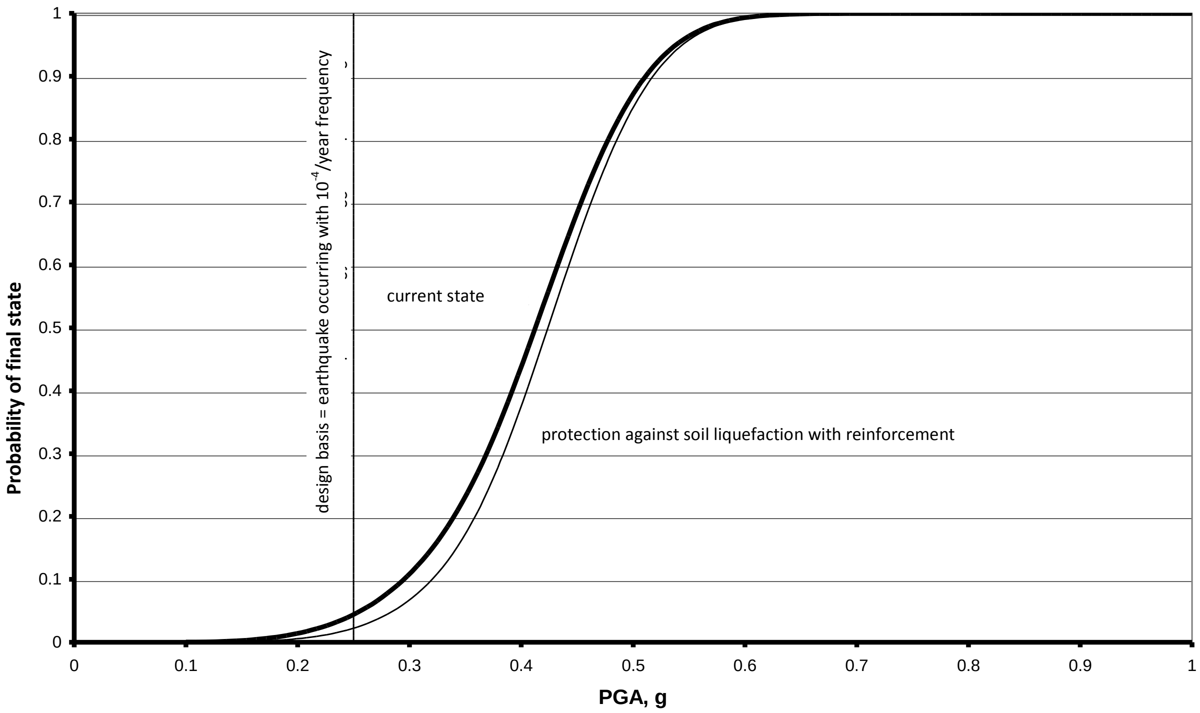

Figure 1-6: Mean probability of loss of ultimate heat sink due to earthquake as a function of peak ground acceleration (PGA)

It can be determined based on the results that in the lower acceleration range the soil liquefaction that causes settlement of the main building plays a dominant role in the occurrence probability of the final state. It shall therefore be assessed as to how the margins would change if reinforcement were applied against the effects of soil liquefaction. If, by reinforcement, it would be successful to improve the characteristics of the seismic damage state caused by the settlement of the main building due to soil liquefaction to the vulnerability of mechanical components and structures characterized by the lower threshold value, then the mean vulnerability curve for the loss of electric supply would modify as marked by the light line in Figure 1-5. It is observable that in the case of earthquakes slightly exceeding the design basis earthquake, the margins would increase significantly. The same increase can be experienced concerning the ultimate heat sink according to Figure 1-6.

From the aspect of damage causing the loss of electric power supply, the reactor and the spent fuel pool are not different from each other; the loss of electric power supply simultaneously affects both the reactor and the spent fuel pool. The probability of long term loss of electric power supply and the margin against beyond design basis earthquakes do not depend on the operational state of the reactor or the spent fuel pool. Consequently, the beyond design basis margin can be considered identical in each service state.

The described numerical values of the probability of loss of ultimate heat sink or the margins for beyond design basis earthquake are considered to be directly valid for that service state of the reactor, during which the temperature of the primary circuit is above 150 °C. The situation is somewhat more favorable for service states when the reactor is open.

In the remaining service states, that is when the temperature of the primary circuit is under 150 °C but the reactor is not open, the probability of loss of the ultimate heat sink is higher than in the above described case, therefore the margin against beyond design basis earthquakes becomes lower. Taking into account that these are transient service states that occur during starting up and shutting down of the reactor, the duration of which is significantly shorter than the other service states, the lower design margins pertaining to them are not considered as a safety issue. Additionally, the closed reactor service state under the temperature of 150°C shall also be assessed by probabilistic methods, to assess whether the establishment and introduction of a time limit, considering the balanced distribution of risk, is reasonable.

Concerning the combination of the two events assessed so far, it can be determined that the loss of the electric power supply also entails the loss of the ultimate heat sink. Without electric power supply the essential service water system cannot operate and so there is no way to carry out heat removal through the steam generators or through the Emergency Core Cooling System (ECCS) heat exchangers. The opposite statement is not necessarily true, because the systems providing the cooling can fail even if electric supply is available. Consequently, the combination of the two final states is equal to the occurrence of loss of electric power supply, so the beyond design basis margin of the combined events is enveloped by the safety margin of the loss of electric power supply.

Vulnerability of containment function

As part of the containment function, the scope of the assessment covered pressure reduction and isolation of the containment. Loss of pressure decreasing ability in the containment always entails the occurrence of one of the above assessed final states, so no further assessment was necessary. The total mean vulnerability curve related to loss of the isolation function of the containment is shown in Figure 1-7.

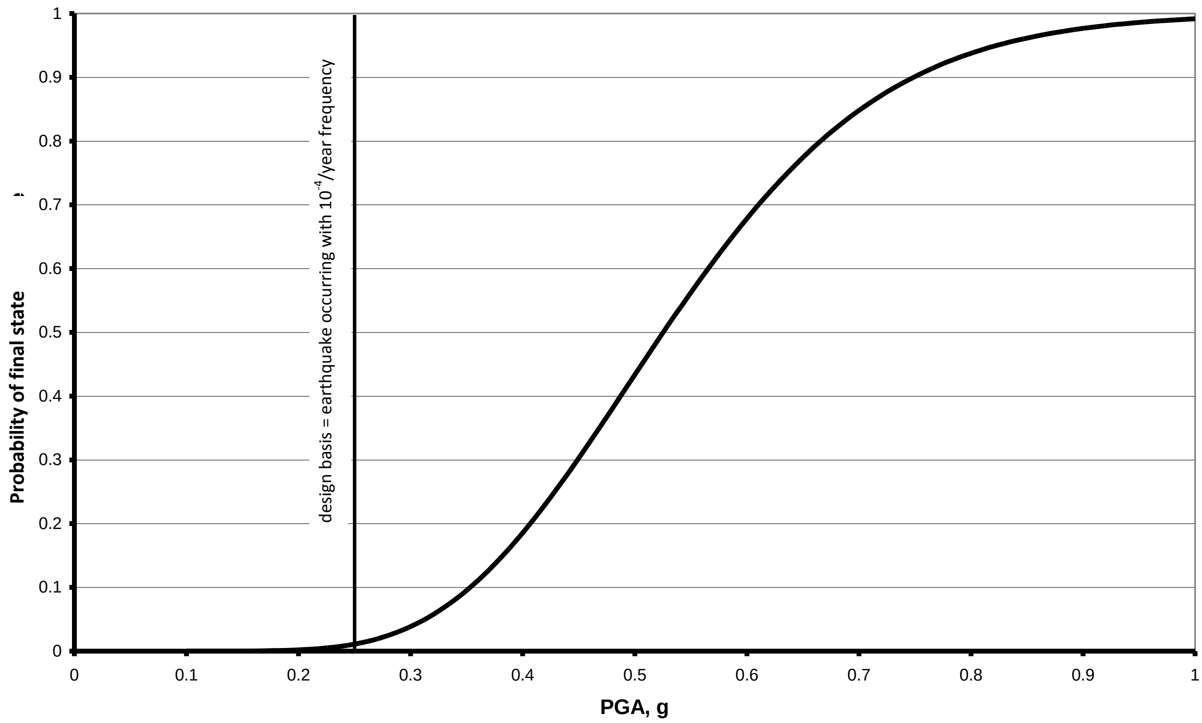

Figure 1-7: Mean probability of loss of containment function due to earthquake as function of peak ground acceleration (PGA)

It can be determined that the vulnerability of the containment function has significant margins against beyond design basis earthquakes. Mean probability of occurrence reaches the value of 0.5 at 0.53 g ground acceleration. On the other hand, the loss of containment function alone does not mean risk to the environment, only if an additional event takes place, which necessitates the availability of the function. Consequently, the containment function should also be assessed as a combination with the earlier analyzed events and not only separately.

Among those possible, the combination of loss of electric power supply, loss of containment function, the combination of loss of ultimate heat sink and loss of containment function were assessed. These proved to be enough to characterize all possible event combinations. On the basis of the assessment of the first combination it could be determined that the probability of simultaneous occurrence of the events varies only negligibly compared to the probability of loss of containment function, while compared to the probability of loss of electric power supply event alone, the probability of simultaneous occurrence is half in the lower acceleration ranges. In relation to sensitivity to an earthquake, the combination of loss of ultimate heat sink and loss of containment function is equivalent with the loss of containment function event.

Containment function is not interpreted for the spent fuel pool, since the pool is located outside the containment. Radioactive releases from the spent fuel pool would reach the environment through the reactor hall due to its low retention capability.

1.2 Activities of the operator

1.2.a Actions of Paks NPP Ltd

Activities aimed at improving seismic safety

Paks NPP has not been designed for seismic loads neither from structural, nor from system engineering and process points of view. The active components have not been seismically qualified.

A seismic-safety programme was launched in 1993 with the objective of qualifying the Paks NPP from the structural (pressure retention and load bearing) and system points of view for the design basis earthquake.

As for the initial condition, normal power operation has been assumed in the safety analyses. The rupture of the main circulation loop reinforced for earthquakes was not considered, and it was assumed that the external electric power and demineralised water supply and off-site fuel supply for the Diesel generators was not available for 72 hours.

The most important review, reinforcement and qualification measures implemented between 1993 and 2003 were as follows:

- all systems, structures and components of the NPP, the structural integrity or operability of which is required for ensuring the basic safety functions during and after an earthquake were identified and classified into seismic safety classes, and also those non safety systems, structures and components were identified, which might jeopardize the fulfillment of a safety function by their failure (collapse, fire, flooding etc.),
- seismic safety evaluation (structural integrity, performance of active functions) of the NPP was performed for the newly defined (1996) design basis, essentially following the design basis requirements; the necessary reinforcements were designed and implemented and the active system components were qualified,
- pre-earthquake procedures and instructions were developed for operators, and the respective seismic instrumentation was installed,
- procedures were introduced for appropriate operational housekeeping and to ensure the observation of seismic safety requirements during purchases and modifications.

The main tasks were implemented as described below:

In order to avoid the rupture of primary cooling circuit components due to a design basis earthquake, they were reinforced with viscous snubbers where necessary. By this step the avoidance of primary circuit ruptures was ensured. Figure 1-8 shows a typical reinforcement location.

Figure 1-8: Reinforcement by viscous snubbers

The emergency core cooling systems and the active pressure relief system of the hermetic compartments were reinforced. Consequently if a loss of coolant accident takes place after an earthquake, the main safety functions can be maintained.

Reactor shutdown, cool-down, and long term cooling processes developed for an earthquake situation are performed with the same original operational and safety system and essentially in the same way as during any other normal or emergency shutdown situation.

Reactivity control is performed by way of the safety and control system and by injecting boric acid to the volume above the core via the high pressure emergency core cooling pumps through the venting line of the reactor head.

Initially, the removal of decay heat is performed with the secondary steam blow-down system into the atmosphere or, by the opening of safety valves of the steam generators and injection of demineralised water if necessary. Later, in the lower temperature range, the normal operational cool-down system removes the residual heat. Each component of the cooling technology was qualified and reinforced if necessary.

Cooling down and borating should be performed during natural circulation of the primary coolant. Systems required for this function were qualified for the design basis earthquake and reinforced when appropriate.

It was demonstrated through shaking table testing of the safety and control assemblies that, they would not lose their functionality even if a load much larger than that caused by the design basis earthquake should occur in the reactor; hence, shutdown can be ensured during or after any earthquake.

The preconditions for shutdown, cool-down and long term cooling of the reactor and for cooling of the spent fuel pool after an earthquake are: the availability of safety power supply and the operability of the essential service water systems. Their qualifications and necessary reinforcements were also implemented.

An appropriate instrumentation and alarm system serves for the automatic isolation of the non-safety related and non-reinforced systems in order to support the control of criteria of the safe operation and the plant status.

No automatic emergency reactor shutdown function is installed for when exceeding a pre-set acceleration level. The reason is that an unjustified/spurious shutdown and simultaneous disconnection of all four of the units from the electric power grid may have more severe safety consequences than a somewhat delayed shutdown of the reactors due to any abnormal technological signal or damage caused by the earthquake.

As part of the seismic upgrading programme, the integrity of the spent fuel pool was also evaluated. It was demonstrated, by analysis, that the reinforced concrete block of the reactor building preserves its structural integrity for the seismic loads of a design basis earthquake; consequently the integrity of the spent fuel pool, which is part of the reinforced concrete block, is ensured. No additional reinforcement was necessary in this case. Damage to the roof structure above the pools in the reactor building caused by the earthquake would endanger the fuel elements stored in the spent fuel pool. Seismic protection of the reactor hall was assessed and such reinforcements were implemented which provide the integrity of the reactor hall and avoid the collapse of roof panels. Stability of the parking position of the refueling and hoisting machines above the open spent fuel pool was assessed, and it was concluded that collapse of these machines need not be assumed. Probability of earthquakes during displacement of the relatively rarely used hoisting machines is significantly lower; the contribution of such cases to the overall risk was evaluated in the probabilistic safety assessments.

Those elements of the spent fuel and refueling pools, which ensure continuous circulation of the coolant, or are necessary to avoid loss of coolant, were qualified and reinforced, if found to be necessary.

A special emergency procedure regulates the operators' activity in response to earthquakes. The procedure defines the inspections and walk-down necessary for condition survey after an earthquake. The number of operating personnel was determined to be able to carry out the interventions in response to an earthquake (design basis earthquake affecting all four units).

The units withstand the earthquakes below the level of design basis earthquake without significant radioactive release. At the same time, damage, such as fires, etc. might occur on the site as a consequence of the earthquake in the conventional portions of the plant not reinforced for earthquakes. In the case of cable and oil fires, floods or other extraordinary situations occurring in consequence of the earthquake, the plant fire brigade is the prime response organization being equipped with modern tools and provided with the necessary resources.

Improvement of protection against events caused by other external causes

The extreme environment effects were not comprehensively taken into account during the design of the nuclear power plant. Documentation of compliance for each external load and their possible combinations is therefore not yet complete.

It was concluded from the formerly conducted periodic safety review that the loads and conditions caused by meteorologically originated hazards (being much less critical than an earthquake), which cannot be completely excluded (based on the frequency) from the design basis of certain systems, were not systematically documented. Implementation, of the corrective measures necessary in this respect, was launched.

Within the frame of the measures, a system-technology evaluation shall be prepared to determine all those systems and building structures, in the design basis of which the effect of an external hazard could appear. The influence of the given external effect on the safety functions shall be systematically established for these systems and building structures. Subsequently an item-by-item verification of the documentation was carried out concerning the compliance with the design basis and completeness of documentation. If necessary, the given system of the enveloping building is reinforced. This work is still in progress.

Protection of the systems of various service buildings against external impacts are ensured by the protective features of buildings and the respective building engineering (venting, air-conditioning, heating) systems themselves. Update of strength and static review calculations were performed recently concerning all of the respective buildings by taking into account the environmental loads according to the design basis. In some cases the calculations justified the need for reinforcements, the implementation of which is in progress.

No improvement measures are necessary in relation to external flooding, the low level of the Danube or external fires.

1.2.b Implementation of planned activities

Implementation of the measures aimed at improving seismic safety

After the implementation of the measures summarized in the chapter above the modern seismic safety requirements are complied with by Paks NPP.

It is required by law to review the site characteristics (assessment and evaluation of actual status) every 10 years within the frame of the Periodic Safety Review (PSR). Such a review took place in 2007 within the frame of the last PSR. The plant has demonstrated the results of those probabilistic safety analyses, which justified the sufficiently low level of the hazard corresponding to seismic safety after the implementation of the improvement measures.

Repeated review of design basis seismic safety, pointed out some such indirect effects of the earthquake, by the elimination of which the level of safety can be improved. Some of the respective improvement measures are aimed at qualifying such buildings and facilities for earthquakes, which do not have a direct safety function, but the damage of which may hinder the general response activity in a post-earthquake situation or might indirectly jeopardize safety related equipment.

In order to improve the seismic safety, some of the currently unqualified reinforced concrete buildings have to be qualified and reinforced as necessary, even though they are not directly safety related. The demineralised water tanks in Installation II have to be protected against the possible impact from the collapsing walls of the medical building above the tanks. The necessity of implementing an automatic reactor shutdown function during the planned modernization of seismic instrumentation shall be investigated. Appropriate fixing of tools and appliances, used during outages and stored at the units, has to be ensured in order to avoid adverse impacts on process equipment during earthquakes.

It has to be analyzed if the lack of seismic qualification of the filter structures (machine racks and travelling water band screens) of the essential service water system may jeopardize the ultimate heat sink function and, if necessary, the adequate exclusion measures have to be implemented.

The database containing seismic safety classification of the components has to be reviewed to provide that the classification is in agreement with the information given in the licensing documentation of seismic safety improvement modifications.

Implementation of the measures aimed at improving the protection against events due to other external causes

A list of such system components important to safety, which are endangered by electromagnetic effects (including the effects induced by lightning) and thereby needs to be classified accordingly, has to be compiled to display whether or not a given component is adequately qualified.

1.2.c Results, further actions

It could be determined, based on the evaluation of the Targeted Safety Re-assessment, that Paks Nuclear Power Plant is safe and no further immediate action is necessary. However, besides the positive statements there are some opportunities still in existence, the realization of which may further improve the safety of the plant. Complete implementation of the improvement measures will result in an increased safety of Paks Nuclear Power Plant.

1.3 Activities of the regulator

1.3.a Actions of the regulator

Section 1.2.1. of Resolution HA5444 of the Authority requires that: it shall be analyzed if the lack of seismic qualification of the machine racks and travelling water band screens of the essential service water system may jeopardize the ultimate heat sink function and, if necessary, the adequate exclusion measures have to be implemented.

Section 1.2.2. of Resolution HA5444 of the Authority requires that: the database containing seismic safety classification of the components shall be reviewed to provide that the classification is in agreement with the information given in the licensing documentation of seismic safety improvement modifications.

Section 2.1. of Resolution HA5444 of the Authority requires that: in order to improve the seismic safety, some of the currently unqualified reinforced concrete buildings shall be qualified and reinforced as necessary, even though they are not directly safety related. Within the scope of this task the seismic resistance of the 400 kV and 120 kV substations, the fire brigade barrack, shelters at the site and non-earthquake resistant equipment in the shelters shall be improved. The demineralised water tanks in Installation II (unit 3 and 4) shall be protected against the possible impact from collapsing walls of the medical building above the tanks. The need to implement an automatic reactor shutdown function during the planned modernization of seismic instrumentation shall be investigated. Appropriate fixing of tools and appliances used during outages and stored at the units shall be ensured in order to avoid adverse impacts on process equipment during earthquakes.

Section 2.2. of Resolution HA5444 of the Authority requires that: measures to avoid failures originating from building settlement caused by an earthquake shall be identified. An analysis shall be performed for the appropriate assessment of the existing margins of earthquake-initiated building settlement and soil liquefaction phenomena. The affected underground lines and connections shall be re-qualified or modified to allow for a relative displacement.

Section 2.3. of Resolution HA5444 of the Authority requires that: flooding protection of some service compartments shall be improved. Adequate protection shall be installed to stop the main condenser coolant pumps when the main condenser coolant pipeline becomes damaged. It shall be ensured that the pipeline trenches are pertinent to receive and drain the discharged water. If necessary the slope shall be elevated, or a protective dam shall be constructed, to avoid the flooding of the turbine hall or the cable tunnels. In the machine room of the essential service water system pumps, the penetrations of the machine room wall shall be modified to a water sealed design.

Section 1.2.3. of Resolution HA5444 of the Authority requires that: the list of such system components important to safety, which are endangered by electromagnetic effects (including the effects induced by lightning) and thereby needs to be classified accordingly, shall be compiled to display whether or not a given component is adequately qualified.

Section 1.2.4. of Resolution HA5444 of the Authority requires that: beyond the safety improvement measure proposed by the operator for the close reactor state, when the primary temperature is under 150 °C, a probabilistic safety analysis shall be performed to assess whether the establishment and introduction of a time limit, taking into consideration the balanced distribution of risk, is reasonable.

1.3.b Implementation of planned activities

The licensee of Paks NPP shall submit an action plan by June 30th 2012, which shall be subject to review by the nuclear safety authority.

1.3.c Results, further actions

Following the termination of the international review, based on its results and the summary of the experiences, the HAEA will examine the need for additional modifications, and is ready to comply with the appropriate actions.

2. Design issues

2.1 Short description of analyses

2.1.1 Prolonged loss of electric power supply

Design, performance and operation of systems providing electric supply function

Without electrical power the cooling of the fuel elements, either in the reactors being in shutdown state or in the spent fuel pool, cannot be maintained on the long term. The continuously generated heat warms up then evaporates the cooling water, the fuel elements dry out, thereby being damaged, and then melt. The heating up process takes place within a few hours; the lost electric supply needs to be recovered within this period.

The total and permanent loss of electrical supply, because of its low probability, is not included in the design basis of the plant; however, as a beyond design basis event it was assessed.

The re-assessment encompassed the review and evaluation of the performance of the safety systems designed to prevent the occurrence of prolonged loss of the electric power supply regarding removal of the decay heat of operating reactors, shutdown reactors and also spent fuel pools.
The assessment covered:

- high voltage substations,
- diesel generators, and
- alternating and direct current internal power supply systems.

High voltage substations

The external electric power grid, when necessary, can provide the plant with electricity as an external source of energy even if all units are shut down. This is included in the design basis of the units.

In the case of disturbance in, or loss of, the off-site electrical power grid, as the first level of defense in depth the units are automatically separated from the national grid to island service mode and controlled to in-house load level. In this mode the units detach from the national grid, but do not or not all of them shut down.

This reduced power level of only one unit is still sufficient to supply the needed electric power to the in-house consumers of all four units as long as the 400 kV sub-station belonging to the operating unit remains operable and, the necessary cross-connections between the units can be established.

Electric power from the external grid can still be obtained even if all units of the plant shut down, if the external grid and the substation remain operable. An important circumstance from this aspect is that for the total collapse of the external power grid, as a result of a recent improvement, dedicated supply routes were established from gas turbines of plants located in Százhalombatta at 120 kV voltage level and in Litér at 400 kV voltage level.

In normal service the measurements and interventions at the substations receive alternating current power supply from the house service buses via two local inverter battery stations. In the case of loss of normal supply, these battery stations can provide power for the measurements and necessary interventions for 3.5 hours.

Diesel generators

If all four units shut down and the high voltage substations are not operable, that is electrical power cannot be provided either from an external source or from the twin unit, then the automatic start-up of the safety Diesel generators of the unit will supply the electrical power needed for cooling down and maintaining the cold state.

According to the threefold redundancy of the safety systems, the Diesel generators are also composed of three totally independent lines having identical arrangements. The applied threefold redundancy and the independence of the redundant lines guarantee the required highly reliable functioning of the system.

It can be concluded from system reliability analyses that the individual reliability of system components, and their architecture, guarantee the high level operability of system functions.

Each of the 12 safety Diesel generators is equipped with a 100 m^3 underground fuel tank, in which 70 m^3 of fuel shall be stored according to the Technical Specifications, being protected against earthquake and flooding. This fuel amount, taking into account the typical consumption of the Diesel generators, is sufficient for at least 120 hours of operation. So this time is available to recover the internal or external electric power supply or to bring additional fuel to the site. Considering the on-site storage capacity of the fuel, the quantity of stored fuel has to be increased by the modification of the Technical Specifications and the operating instructions in order to enable more than 120 hours of service of each Diesel generator without supplementation of the fuel.

Essential service water is used for the cooling of the Diesel generators; if it is lost, the operation of the Diesel generators can be maintained only for a short period of time. Cooling shall be supplemented from the fire water system in this case. This case is discussed in details in Section "Alternate cooling water resources". The necessary measurements and controls are developed with the same redundancy as the Diesel generators and independently of the two other systems.

The total loss of all Diesel generators is not included in the design basis. Should such an event occur, the sufficient long term cooling of the reactor and the spent fuel pool cannot be ensured. The preventive accident management and recovery activities for this latter case are described in Section 3.

Alternating and direct current internal power supply

The internal electric consumers of the units are provided by the in-house transformers from the generator, being in normal service, and from the external grid in out of normal service. If there is no voltage on the buses, in an emergency situation, the buses supplying the safety consumers are supplied by power from the Diesel generators. The systems providing the in-house load electrical power supply of the nuclear power plant are grouped into three categories regarding permissible durations of their loss.

- In the case of Category I, uninterruptable direct and alternating current electric equipment, the duration of loss of supply shall not exceed a fraction of a second. There are supply systems which have safety function and so their architecture is accordingly of threefold redundancy. Their ultimate electrical power sources are always the batteries.

Figure 2-1: Batteries of direct current supply of a unit

The capacity of the batteries is sufficient for a minimum of 3.5 hours, even at the greatest load. Following theirs start-up the Diesel generators also charge the batteries. The battery sets and inverters of the system are shown in Figure 2-1 and 2-2.

- In the case of Category II, safety essential consumers supplied by usually alternating current, the duration of loss of supply shall not exceed a few minutes. Three independent safety electric power supply systems were constructed following the threefold redundancy of the process.

Figure 2-2: Inverters of direct current supply of a unit

All the three systems can alone shut down the reactor and keep the reactor and the spent fuel pool in cold shutdown state in all cases. When the normal service supply terminates, the automatism switches the safety systems to the Diesel generators in accordance with the Sequential Start-up Programme. The ultimate electric power sources of the consumers supplied by Category II electric power are the Diesel generators.

- There is no time limitation for the loss of electric supply of Category III electric equipment. They do not have safety functions; they are supplied from the unit, backup and in-house transformers.

The design of safety alternating and direct current systems took place by widely considering the concept of redundancy, independence and self-control. There are no common paths and the full independence of the redundant systems is ensured.

The measurements, control circuits and data collectors of the safety systems receive power from the alternating or direct current safety buses, which are made uninterruptible by means of batteries.

Hazards for the electric power supply systems

It can be determined that for internaly caused events the design basis of the plant practically excludes the case of loss of both the internal and external electric power supplies with simultaneous unsuccessful startup of Diesel generators.

Flooding related hazards are not included in the design basis of any systems in the service area, so the flooding of the Danube, as a potential hazard, need not be considered in the design basis of the electric power supply systems.

The operability and availability of safety electric power supply is a necessary condition for shutting down, cooling down and maintaining the cold condition of the reactor after an earthquake. The subsystems playing relevant roles are as follows:

- redundant battery sets of the unit, which are the ultimate power source for Category I safety electric power systems;
- Diesel generators, which are the ultimate power source for Category II safety electric power systems.

Electric power supply under low water condition of the Danube

Low water levels of the Danube may influence the operability of the electric supply system through the cooling systems ensuring cooling of the systems and components. Evaluation of cooling water supply is discussed in the section of the ultimate heat sink.

Safety electric supply under extreme environmental conditions

The extreme environmental effects were not comprehensively taken into account during the design of the nuclear power plant. The review aimed at the verification and documentation of the capability to withstand extreme environmental impacts is still in progress.

A system technology evaluation was completed in 2011 for the safety electric power supply systems, the preliminary results of which are as detailed below.

Extreme wind load

The systems of safety electric power supply and the Diesel generators are installed in adequately protected buildings; therefore, their loss needs not to be considered for the effect of wind load. Against the secondary effects accompanying extreme strong winds (e.g. extreme amount of sand, dust penetrating through broken windows) each piece of equipment is appropriately protected, the prolonged dust load and so the loss of function can be avoided by venting systems and/or intervention (coverage, venting). Appropriate instructions are in place on the interventions to be implemented in such cases.

Extreme temperatures

In-building compartments accommodating the systems of electric power supply are air-conditioned. If cooling or heating of these compartments would not be available, due preparations could be performed based on weather forecasts for the effects of extreme environmental conditions, mobile heating devices or air-conditioners can be deployed. Appropriate operator instructions are in place on the interventions to be implemented in such cases.

Extreme rain

Evaluation of the effect of an extreme amount of precipitation has not yet been completed. Hydraulic model of the rainpipe network of the NPP has already been developed. Critical locations for the various loads shall be identified, as well as it shall be determined which equipment, important to safety, is endangered by short term flooding at the specific location. Determination of necessary corrective actions is possible thereafter.

Extreme snow

Due tools are available on the site of the NPP for de-icing and the removal of snow. Traffic routes and the vicinity of the service buildings are continuously cleaned. The snow removed from the service areas is transported from the site; this ensures that no flooding hazard occurs during melting. Thanks to design solutions the open air equipment can withstand the consequences of extreme snow.

Lightning

The external lightning protection system of the plant was designed and constructed in accordance with the respective standards. The lightning protection equipment complies with the 200 kA load both from strength and thermal points of view. Revision of the lightning protection equipment was performed and modifications were carried out in some cases.

Options for prevention of prolonged loss of electric power supply and preventive accident management

In the case of accidents occurring during operation at normal power, without electrical power supply, the core damage may occur within about ten hours after the loss of power.

Without electrical power supply, damage to the cladding of the fuel assemblies may commence after about 19 hours according to conservative analysis. This period might be 25 hours, if the water level is higher during refueling outages.

The operators have to recover the electric power supply or ensure an alternate power source within the periods specified above to avoid that the situation evolves to severe accident. The emergency operating instruction includes all those measures to manage the condition without electric power supply, which provide delay in the damage to the active core or to the spent fuel pool.

Use and method of use of mobile, backup Diesel generators

The existing severe accident Diesel generators, described in the section on the management of severe accidents, are not suitable to supply electrical power to safety consumers or cooling water pumps. Independent accident Diesel generators have to be therefore installed, which can supply power for the safety consumers having roles in severe accident prevention and long term accident management.

Alternative alternating current supply available on the site

It can be determined in relation to the electric connections available at the site between the units, that there are appropriate solutions for coping with loss of off-site power, if at least one unit can provide in-house power supply independently of the external grid or the safety Diesel generators at any unit are available.

Usability of distant plant as backup supply through the transmission grid

Distant power sources available through the transmission grid can be used to supply the nuclear power plant, if the respective transmission line systems and switching yards are not damaged or can be recovered.

Currently, Paks NPP has two alternative external power routes to supply the safety consumers if the safety or normal in-house electric supplies are unavailable. The usability of these electric power supply routes is justified by tests. The two external supplies are connected to the plant via independent, physically separated and different routes from the "Dunamenti" Gas Turbine Plant and from the Gas Turbine Plant in Litér; however the latter currently has no black-start capability.

2.1.2 Prolonged loss of ultimate heat sink

Design, performance and limits of the systems providing ultimate heat sink function

Operation of several systems of the plant needs permanent or periodic water cooling. The residual heat from the reactors and the spent fuel pools, as well as the heat generated in the service equipment are removed by the cooling systems through various routes. The heat sink function is implemented by the chain of several systems, the ultimate element of which is the Danube. The heat removal from the fuel may be lost, if the connection were to be lost between the cooling systems of the plant and the Danube.

The complete loss of the ultimate heat sink is not part of the design basis of nuclear power plants. The design of the nuclear power plants provides a very low probability of such events; at most it might happen due to a beyond design basis external event or rather due to combinations thereof. The assessments however, had to include these cases. The scope of the re-assessment included the review and evaluation of the capability of the following systems playing a key role in the decay heat removal from the reactor and cooling of the spent fuel pool, and those circumstances which may hinder the removal of the decay heat. All those systems were therefore assessed having key role in this process:

- the essential service water system,
- the demineralised water system,
- the emergency feedwater system,
- the auxiliary emergency feedwater system, and
- the cooling circuit of the spent fuel pool.

Essential service water system

The system is installed according to the safety principle of threefold redundancy with two cooling water pumps in each of the three redundant lines (i.e.6 pumps/installation in total) that siphon the cooling water from the cold water channel through a pre-screening process.

As an improvement action the safety electrical power supply of the screens have to be solved in order to prevent the blockage of the screens of the essential service water system.

In normal service state 3×1 pumps operate, while in an emergency situation all six pumps are started. The water delivered by the pumps from the water intake structure reaches the turbine hall through further filters and three underground pipelines of 700 mm diameter. Each redundant branch connects to a separate storage tank of 100 m^3, which provides temporary cooling water reserve. The pipelines of the systems common for the twin units up to this point ramify towards the two units.

Such a postulated accident is taken as design basis for the system, when a large break loss of coolant accident is managed at one of the units, while cooling down process is going on at the twin unit. The pumps' nominal delivery is 1656 m^3/h which is sufficient to meet the design demand and additionally to ensure the cooling down of the twin unit.

The required mechanical independence is implemented by the individual branches (i.e. filters, pumps and pipelines), while electric and instrumentation supply is provided from different safety electric distributors for each system. Regarding civil engineering, the essential service water pump station is placed in a common water intake structure for the twin units, but they are well separated at system level and constructed in separate rooms. The compliance with single failure criterion of the essential service water system is guaranteed by the applied threefold redundancy and independence of the redundant branches.

Electric power supply of the essential service water pumps are Category II, it is provided from the 6 kV safety essential system; consequently it means that the pumps can fulfill their function even if a loss of off-site power event takes place. The protection logic starting the essential service water pump, and actuating the valves, is constructed with threefold redundancy in the safety instrumentation and control system, which is in harmony with the redundancy of the process.

Demineralised water system

The demineralised water system plays a significant role if the ultimate heat sink is lost, since its water inventory can be used for long-term removal of the residual heat of the core.

During accidents of the unit, the emergency water to the secondary circuit can be supplied by the demineralised water system, through seismic reinforced system components in two different ways as follows:

- if the emergency feedwater pumps of the emergency feedwater system work, then the unit is cooled by water supplied from the feedwater tanks to the secondary side of the steam generators; the water from the feedwater tanks is continuously made up by the demineralised water pumps having 65 t/h capacity;
- if the emergency feedwater pumps are not able to stabilize the water level of the steam generators, then the auxiliary emergency feedwater pumps supply water directly from the main pipeline of the demineralised water tanks to the steam generators.

Three demineralised water tanks, each having 900 m^3 capacities, are installed per twin-units, which shall always contain 500 m^3 of water inventory as a minimum. The demineralised water tanks are reinforced against earthquakes; their availability is ensured. The tanks of Installation II are shown in Figure 2-3.

Figure 2-3: Demineralised water tanks of Installation II

According to the principles of redundancy and independence, the demineralised water system is protected against single failure; it is able to perform its function even if one line is lost.

The demineralised water pumps and the connecting motor operated gate valves have Category II electrical power supply; the electric power is supplied from the safety essential 6 kV system; therefore they perform their function even if the external power supply is lost.

The measurements of the system guarantee the control of the service parameters and the limit values required for automatic actuations based on the control logic. Taking account of the normal state, the inventory of the tanks is sufficient for cooling for more than two days. This period of time is available for the restoration of the essential service water system or for the implementation of other preventive measures.

Emergency feedwater system

The basic task of the system is to supply the steam generators with water during shutdown and startup of the unit (below 5% power). Moreover, if a unit shuts down under accident conditions (e.g. due to the loss of the essential service water system), then the emergency feedwater system is needed for the removal of the residual heat, such a system supplies feedwater from two feedwater tanks to the steam generators by way of two pumps having 65 m^3/h capacity.

The electrical power to the emergency feedwater system is supplied by the Category II safety system, thus it re-starts after the loss of electrical power. The emergency feedwater system is earthquake resistant.

Taking account of the results of previously carried out system reliability analyses it can be stated that the individual reliability of the components composing the system, their redundant and diverse arrangement in the required extent, and the construction of the support systems, electrical, instrumentation and control systems together guarantee the availability of the system functions even if the assumed failures occur.

Auxiliary emergency feedwater system

The function of the auxiliary emergency feedwater system is to supply water directly from the demineralised water tanks to make-up the steam generators in order to remove the residual heat of the reactor, should the normal feedwater and emergency feedwater systems both fail. The delivery capacity of the pumps is identical with the emergency feedwater pumps.

The auxiliary emergency feedwater system is independent of the emergency feedwater system; the system itself, as well as the demineralised water tanks and the connecting pipelines, are all earthquake resistant. As a result of a previously implemented safety improvement measure, the pumps and control valves of the system were moved from the turbine hall to the reactor building, where they are well protected from external effects. The system was then re-designed in compliance with the single failure criterion.

The electrical power to the auxiliary emergency feedwater system is supplied from the Category II safety system, thus it -restarts automatically after the loss of electrical power.

With the consideration of the previously carried out system reliability analyses, it can be concluded that the redundancy of the auxiliary emergency feedwater system and the independence of its redundant lines are sufficient to guarantee that single failure will not cause the loss of the feedwater function in the case of design basis accidents.

Cooling system of the spent fuel pool

The task of the cooling system of the spent fuel pool is to remove the residual heat of service and spent fuel elements from the spent fuel pool. Cooling of the spent fuel pool is performed by two independent redundant cooling circuits, each capable of individually performing the function to a full extent and each contains a heat exchanger and a pump. The cooling circuit leads the water of the pool to the heat exchangers, the secondary sides of which are supplied by the essential service water system. Schematic arrangement of the cooling system is shown in Figure 2-4.

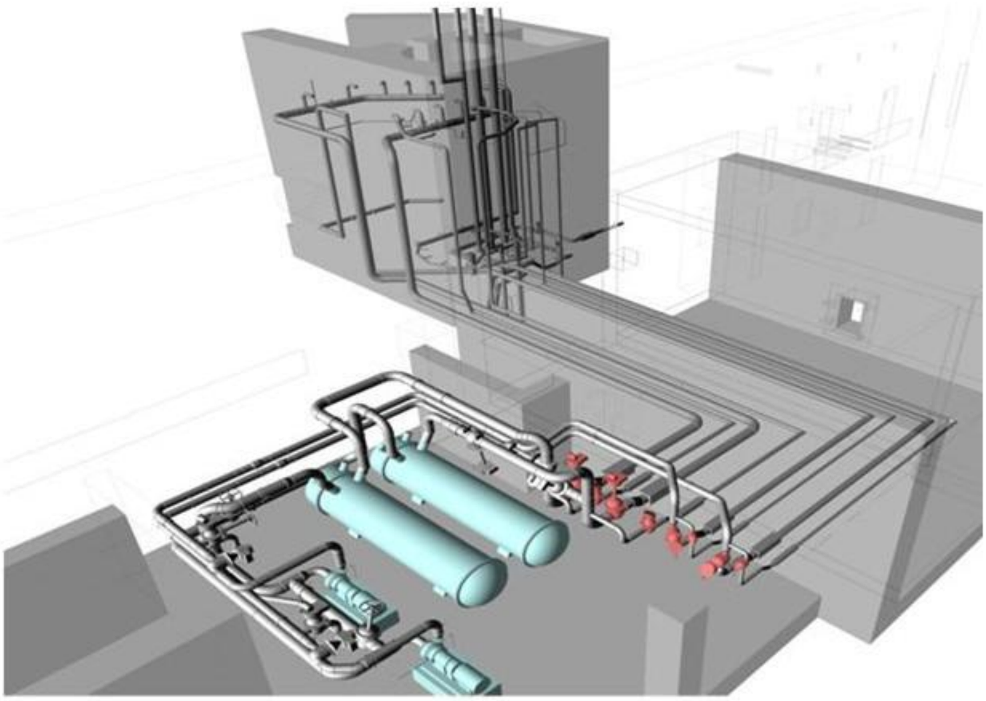

Figure 2-4: Spent fuel pool cooling circuit with pumps and heat exchangers

The cooling circuits can be connected together both on the suction and delivery legs. The required level of cooling can thereby be ensured; the failure of a pump or a heat exchanger in any combination could not impair the cooling function.

Robustness of the ultimate heat sink against external effects

The design basis of the plant practically excludes the loss of the ultimate heat sink induced by internal causes, so this chapter will focus on the discussion of external natural phenomena. Since the flooding of the Danube is not required to be considered in the design basis of the ultimate heat sink, only the resistance against earthquakes, low cooling water level and extreme weather conditions shall be discussed below.

Seismic resistance

In the initial phase of cooling down following an earthquake, cooling takes place by steam generation from demineralised water supplied into the steam generators and then by release of the steam to the atmosphere. Review of seismic qualification of the demineralised water system was completed. The operator could demonstrate the seismic load bearing capability of the pipelines of the system after the necessary reinforcements.

Three demineralised water tanks of Installation II were placed in the close vicinity of the medical and laboratory building. It is a reinforced concrete structure building of significant robustness, but formally is not qualified for design basis earthquakes, and the tanks therefore are not protected against the collapse of panels from the building. The potential damage to one of the tanks that provide back up to each other during an earthquake of larger intensity was taken into account in the hazard analysis.

Transmission from open circuit cooling to closed circuit steam-water cooling can be implemented with emergency feedwater pumps and the normal cooling down system; these systems were therefore qualified and reinforced as appropriate. The two circuits of the cooling down system were designed to be full backup to each other.

The auxiliary emergency feedwater system is able to supply the steam generators with demineralised water as a backup tool during the open secondary circuit cooling phase. As a result of a previously implemented safety improvement measure the pumps and control valves of the system were moved from the turbine hall to the reactor building, where they are well protected from external effects. The system was then re-designed in compliance with the single failure criterion and seismic protection requirements.

In acceleration ranges greater than the design basis the soil liquefaction causing building settlement may lead to more severe damage. The connection points of the underground pipelines and cables leading to the main building would be critical with regard to different extent of settlement and relative movements of the buildings and the cables. A connection point of such a pipeline can be seen in Figure 2-6.

Figure 2-6: Underground connection point of the essential cooling water system to the main service building

The cooling circuit of the spent fuel pool is qualified and reinforced to design basis earthquake. Analyses demonstrated that the reinforced concrete block of the reinforced reactor building maintains its structural integrity under loads induced by a design basis earthquake; it means that the integrity of the spent fuel pool being part of the reinforced concrete block is also maintained.

The main condenser cooling water system has no function during and after an earthquake, thus the components of the system and its steel pipelines of 3600 mm in diameter are placed in a trench (Figure 2-7), and they are not formally qualified for earthquake. The potential damage to the pipeline therefore cannot be excluded even for events being smaller than a design basis earthquake. The pipelines contain a significant volume of water. If it is discharged, it fills up the pipeline trenches. Theoretically there is enough space available to accommodate the discharged amount of water, but if the condenser pumps do not stop, the uniform filling up of the trenches is not guaranteed, local flooding might occur. An improvement measure was decided upon to prevent this potential hazard.

Figure 2-7: Courtyard pipelines of the main condenser cooling water system

Low water level of the Danube

The low water level of the Danube means a requirement only for the design basis of the essential service water pumps among the ultimate heat sink systems. As it was discussed in Section 1.1.3, the drive shafts of the rotating wheels of the essential service water pumps were extended, the suction elbows were replaced; and thus the pumps were moved to a lower level. Accordingly, the pumps can be started and operated without cavitation at 83.50 m water level above the level of the Baltic Sea, as lowest, while the lowest level of the Danube considered in the design basis is 84.07 m.

Extreme wind load

The systems of the ultimate heat sink are placed in a building providing sufficient protection against any wind load. The systems, structures and components are not susceptible to other wind induced effects (e.g. sand, dust).

Extreme temperatures

The essential service water system is well protected against extreme external air temperatures, because its components are underground cables or elements placed in closed reinforced concrete shafts. A significant portion of the cooling systems is located in the turbine hall. The process equipment placed in the turbine hall is originally designed for the environmental conditions of the turbine hall, their operation is ensured under the conditions of the hall even if prolonged high, or extremely high, outside temperatures occur.

The turbine hall is susceptible to external cold weather due to the large glass surfaces (one layer iron frame glass windows). Danger of freezing might occur in the turbine building due to prolonged extremely cold temperature, which would challenge the small diameter non-insulated piping near the windows. The original boiling water heating systems were replaced by a much more effective heating system supplied from the in-house service steam system. As an alternative solution, 10 electric heating units are available to cope with prolonged or extremely cold external temperature in order to avoid having cold locations in the turbine hall.

Extreme rain, snow and lightning

Design of buildings enveloping the safety systems for these effects was assessed during the last periodic safety review and it was concluded that they are in compliance with the respective standards. Probabilistic safety assessments in relation to weather effects are in progress, they are expected to be completed by the end of 2012.

Possible actions following loss of the ultimate heat sink

If stoppage of water intake from the cold water canal branched from the Danube is assumed, the cooling water supply of the systems terminates.

In the case of loss of essential service water supply, the units will shut down, the primary circuit pumps will stop, and thus the primary circuit will be cooled in natural circulation service mode. The loss of the cooling water also means that the steam generated in the steam generator can be removed to the atmosphere only, and thus the water inventory will soon run out. The emergency feedwater pumps supply the steam generators from the feedwater tanks, which are made up from the demineralised water tanks. If the emergency feedwater pumps are not capable stabilizing the water level in the steam generators, or the water runs out from the feedwater tanks, then this function has to be performed by the auxiliary emergency feedwater pumps that draw directly from the main pipeline of the demineralised water tanks.

The total shutdown of the water intake plant entails termination of the make-up of the demineralised water, and only the demineralised water inventory stored in the tanks can be used. With reference to normal state, the inventory is enough for 3 days to cool the units.

It is not anticipated to lose the total system from internal causes, but if the system is lost due to a common cause failure, then the loss of electric supply may also be assumed. Considering that the essential service water supply, which terminates due to loss of ultimate heat sink, is required for the operation of the Diesel generators providing safety electric supply, the event will lead to total loss of electric power supply as well.

In the case of simultaneous total loss of ultimate heat sink and electric supply, the success of interventions and the prevention of a severe accident situation are the matter of timely implementation of the appropriate measures and boration of the coolant as a pre-condition for cooling. The period of several hours that is available before the start of fuel damage shall be used by the operators to carry out all those interventions, by which the alternative cooling or coolant supply opportunities described below are actuated.

Alternative coolant sources

The essential service water system can be supplied from the fire water systems of the plant, but their applicability is currently limited to provide alternative cooling water. The primary water source of the fire water system is the bank filtered well plant consisting of 9 large diameter wells of 30 m depth; such plant is capable providing water flow rate of 810 m^3/h at a pressure of 8 bars. This well plant can provide a practically unlimited quantity of water independently of the water level of the Danube. A connection system is installed from the well plant to the essential service water system. Despite, the well plant is currently not applicable to avoid the prolonged loss of the ultimate heat sink, because the pumps are powered from the normal electric grid.

Additionally, the fire water pump station of the plant having water inventory of 4,000 m^3 is available; it is supplied from the discharge water canal of Installation I. The pumps of this station start automatically, should the need for fire water exceed the flow rate provided by the wells.

If the pressure of the fire water system decreases below the lower service value, then the earthquake resistant Diesel fire water pumps (Figure 2-8) that draw from the outlet line of the essential service water system of Installation II start automatically. The current arrangement makes it possible to provide 100 m^3 cooling water without the operation of the essential service water system of Installation II.

Figure 2-8: Diesel-driven fire water pump station

A further alternative solution is the mobile water intake directly from the Danube, the cold water canal of the Danube, or from the fishing lakes located at the perimeter of the site as shown in Figure 2-9. Those lakes contain about one million cubic meters of water. The mobile water intake can be performed by the plant fire fighters with the available equipment; this solution was justified on an exercise carried out by the fire fighters. A photo taken during the exercise can be seen in Figure 2-10.

Figure 2-9: Discharge water canal and the fishing lakes

Figure 2-10: Installation of the mobile water intake system

The cooling water obtained accordingly can be supplied in due amount and at appropriate pressure to the already installed outside collectors of the delivery leg of the auxiliary emergency feedwater systems of both of the units of the installation.

Currently, the cooling water of the Diesel generators can be supplied from the fire water systems as well. The operation of the Diesel generators with a cooling system supplied from the fire water systems is an accepted and well tested practice during the maintenance of the units. The Diesel generators can be started accordingly even in accident conditions, and they can be kept in service until the restoration of the essential service water system. The fire water system is to be connected by disassembly of the essential service water system of the Diesel generators and assembly of a connection element. Currently only one assembly set is available per installation.

Alternative cooling water supply to the containment

Following the loss of the ultimate heat sink, an external water source may be necessary if the water inventory available in the containment is totally exhausted. For example, the significant water inventory stored in the localization tower within the containment can be used to prevent damage to the reactor pressure vessel, as well as to flood the reactor cavity and to provide alternative supply for the spent fuel pool. In the long term, in order to limit the containment pressure, the release of the medium from the containment would be necessary, which causes further loss of coolant. Such a loss of coolant reserve shall be supplemented from external resources.

The modification including the installation of the feedwater side relief valves of steam generators was completed on each unit to manage primary to secondary leakages. These relief valves can let water flow to the floor of the hermetic compartments from the secondary side of the steam generators. The external (low pressure) feedwater, supplied from an alternative source, can be supplied to the containment via the opening of these relief valves. The relief valves can be powered from the existing severe accident Diesel generators (described in Section 3.1.1), and can be remotely opened.

The water supplied to the containment as described above can be used for the external cooling of the reactor cavity without any limitation, even if it dilutes the boric acid concentration of the fluid within the containment. If the external electrical power supply is successfully restored, then the emergency core cooling systems supplying water to the reactor pressure vessel will be restarted according to operating procedures, and they circulate the water available in the containment through the reactor. In the unknown state of the reactor core, it is not permitted to supply water of lower boric acid concentration than that leaking from the primary circuit, since it may bring the core to a critical state again. The boron concentration of the water supplied to the containment therefore shall be increased and the boron concentration shall be at least at the level required in the tanks of the emergency core cooling system.

Alternative cooling of the spent fuel pool

Cooling of the spent fuel pool is ensured by the essential service water system; currently there is no alternative cooling system available if it is lost. Based on conservative assumptions applied in the loss of coolant analysis of the spent fuel pool the damage to the cladding of the fuels will commence after about 19 hours. Accordingly, in the case of loss of spent fuel pool cooling, sufficient time is available for the personnel to implement the procedures established in the emergency operating procedures to cope with the situation by periodic use of the coolant stored in the tanks of the emergency core cooling system and other cooling systems until the normal cooling of the spent fuel pools are restored. These operations need electric power.

The spent fuel pools have no existing dedicated, external, independent water supply opportunities. According to the valid emergency operating instructions, the water make-up (without energy source) can be provided by gravity forced discharge of water to the spent fuel pool from the upper trays of the localization tower. The water inventory stored in the trays of the localization tower might be required for other purposes if an accident occurs in the reactor simultaneously. The feasibility of manual operation of valves being on the discharge route depends on the local radiological conditions.

The water can be reasonably supplied by the use of mobile equipment, similar to the alternative supply to the containment, even from identical water sources. Since the issue of criticality may appear depending on the state of the fuel stored in the spent fuel pool, thus the boron concentration of the water shall be set as of that supplied to the containment.

2.2 Activities of the operator

2.2.a Actions of Paks NPP

Seismic safety improvement measures

The safety battery sets located in the ground floor compartments of the electric galleries were changed to new ones that are seismically qualified and meet the earthquake safety requirements.

Taking account of floor spectra characterizing their place of installation, the Diesel generators and the connecting systems and distributors are all qualified.

All the buildings that house the systems of electric power supply were also qualified or reinforced.

The rigidity of the longitudinal and transversal steel structures of the turbine hall against seismically induced horizontal forces was improved by significant civil engineering interventions (i.e. bracing elements, anchoring and reinforcement of nodal joints).

The brick walls of electronic, instrumentation and control rooms, where the batteries, distributor cabinets, panels and boards are located, as well as the walls having potential hazard to these pieces of equipment were verified or reinforced to withstand a design basis earthquake.

Due to the differences between the buildings housing the Diesel stations, separate seismic resistance evaluation and reinforcement were performed for both. Today the Diesel generators and their buildings can withstand the design basis earthquake without loss of function.

The seismic resistance of the cable tunnels and cables of electrical safety systems were reviewed. According to the results, technical solutions were applied to limit the movement of cables and cable bunches under seismic events, or the supplementary supports of the cable tunnels or the elements of the environment potentially jeopardizing the integrity of the cable tunnels (typically brick walls) were reinforced. Qualification of hermetic cable penetrations was also performed.

The subsequent seismic qualification of cable channels between Diesel buildings, the water intake structure and the main service building demonstrated the required level of robustness. Measures to prevent the degradation of the physical condition and to recover the water sealed condition took place after the seismic review.

Seismic safety of the electric, instrumentation and control equipment were assessed in the scope of equipment and device types, such as the relays susceptible for contact-bouncing and such complex equipment that includes such elements, the reliable operation of which is disturbed by the vibration induced by the quake. The operability of all of such devices was verified through vibration table testing according to the respective standards. Based on the results of the assessments, most of the device types applied in the plant are able to perform the required functions even during, and after, a design basis earthquake. The non-compliant relay types were replaced.

Improvement measures related to the ultimate heat sink

During cooling down following an earthquake, the essential service water system transfers the heat from the cooling down system to the ultimate heat sink. Those parts of the cooling systems, which are required for the management of a post-earthquake situation were qualified and reinforced. The separation of those parts that are not required by the cooling technology is performed by the installation of isolating valves.

The cooling down and permanent cooling procedure developed for earthquakes, and the respective systems, ensure the heat removal from the reactor and the spent fuel pool to the ultimate heat sink. The cooling circuit of the spent fuel pool is qualified and reinforced to the design basis earthquake, since these were qualified and reinforced for seismic resistance. Moreover, all the buildings of these systems are reinforced for earthquake. The rigidity of the longitudinal and transversal steel structures of the turbine hall against seismically induced horizontal forces was improved by significant civil engineering interventions (i.e. bracing elements, anchoring and reinforcement of nodal joints). Figure 2-5 shows an external reinforcement of the main service building.

Figure 2-5: One of the reinforcements of the main service building

The cooling circuit of the spent fuel pool was qualified and reinforced to design basis earthquake.

Prolonged loss of the Diesel generators is not assumed in the design basis. If it occurs, sufficient cooling of the spent fuel pool cannot be guaranteed in the long term. The cooling of at least one of the Diesel generator on each unit from the fire water system shall be implemented to ensure its start-up and alternative cooling. The respective operating procedures shall be developed.

2.2.b Implementation of planned activities

Seismic safety improvement measures

As it was described at the beginning of the Section on Design Issues, the high voltage substations, although being not safety systems and thus not reinforced for earthquakes, might provide many alternative electric power supply opportunities for the units. It is also a significant advantage during a post-earthquake recovery phase, if the substations are applicable to receive external supply, if they remain undamaged. An important circumstance from this aspect is that for the total collapse of the external power grid, as a result of a recent improvement, dedicated supply routes were established from gas turbines of the plants located in Százhalombatta at 120 kV voltage level and in Litér at 400 kV voltage level. An improvement measure is in progress to install a Diesel generator to improve the reliable start-up and decrease of the running-up time of the Litér gas turbine. A further improvement measure is the seismic review and evaluation of the automatism that switches the units to island service mode. It shall be reinforced if necessary.

Improvement measures related to the ultimate heat sink

The safety electrical power supply of band screens shall be solved in order to prevent the blockage of the screens of the essential service water system.

As an improvement measure, the quantity of demineralised water stored in the tanks shall be increased, and by the modification of the respective procedures the demineralised water quantity shall be maximized. The walls of the health and laboratory building shall be reinforced as necessary to prevent the collapse of its panels onto the demineralised water tanks.

Measures to manage failures originating from building settlement caused by an earthquake shall be identified. Further analysis shall be performed for the proper assessment of the building settlement and soil liquefaction phenomena. Based on assessment results, the affected underground lines and connections shall be re-qualified or modified to allow for a relative displacement.

Flooding protection of certain service compartments shall be improved. Adequate protection shall be installed to stop the main condenser coolant pumps when the main condenser coolant pipeline fails. It shall be ensured that the pipeline trenches are applicable to receive and drain the discharged water. If necessary, the slope shall be elevated or a protective dam shall be constructed to avoid the flooding of the turbine hall or the cable tunnels. In the machine room of the essential service water system pumps the penetrations of the machine room wall to water sealed design shall be modified.

The electrical power supply of the submersible pumps of the bank filtered well plant shall be established by a well protected fix or mobile Diesel generator in order to guarantee their applicability in severe accident situations.

The accessibility of the 2x2,000 m^3 water reserve available in the closed segment of the discharge water canal shall be solved.

The inter-connection opportunity between the two installations shall be uniformed. Similar to the connection existing on Installation I, the water supply in Installation II shall be solved from the fire water system to the essential service water system through the technology cooling water system.

Arrangements shall be made for the direct intake from the Danube, cold water canal of the Danube and from the water source of almost one million cubic meters of water in the fishing lakes located near the perimeter of the plant site. As water stored in the demineralised water tanks can be used as an alternative water source of independent source during an accident, appropriate connection points on these tanks shall be installed for providing water to the auxiliary emergency feedwater system using mobile pumps.

Periodic inspection and maintenance of the equipment designed to manage the low water level of the Danube shall be regulated.

The equipment needed for connecting mobile aggregators and pumps, brought from outside to process equipment, shall be provided. Plant procedures shall be prepared for the utilization of these external sources.

The method to feed cooling water directly into the containment through the auxiliary emergency feedwater system connection point and the secondary side blow-down valves of the steam generators shall be specified in procedures. Using the existing tank park, the method to borate and store borated water shall be provided.

An alternative way of supplying external cooling water to the spent fuel pools shall be implemented. The new water supply route connected in the courtyard by flexible means shall be protected from external hazards such as earthquake. In an accident situation, in the case of lack of other possibilities, the spent fuel pool shall be filled from the borated water reserve specified above. The required operations shall be specified in procedures.

Other measures based on design issues

As an improvement measure, by the modification of the operating procedures and handling instructions, the amount of the fuel of Diesel generators to be stored at the plant shall be increased to ensure that the Diesel generators providing the safety electric supply can operate for longer than 120 hours.

Operating procedures shall be developed for the utilization of alternative, previously unused, on-site cross-connections between the normal, backup and safety bus-bars.

Independent severe accident Diesel generators shall be installed for the power supply of safety consumers having a role in preventing severe accidents and/or managing an accident in the long term. The number and capacity of these independent severe accident Diesel generators shall be adjusted so that they are capable of supplying consumers, pumps and isolation valves of all reactors and spent fuel pools at the same time even in the case of loss of power supply at all units. The independent severe accident Diesel generators shall have appropriate protection against beyond design basis external hazards (i.e. earthquakes, natural hazards, flooding) to the installed emergency Diesel generators and they shall be totally independent of other systems (such as the cooling or electric supply systems) of the plant.

Possible cross-links shall be developed for providing safety electrical power supply at 6 kV from any operable emergency Diesel generator in any unit to the safety consumers of any other unit without using the off-site electricity grid. The review identified previously unused opportunities to arrange routes to supply power for alternating 6 kV voltage route, which means additional opportunities to those specified in the operating procedures.

The, previously decided upon, assessment to verify and document the protection against extreme environmental impacts is still in progress. Its results may imply the need for further measures.

2.2.c Results, further actions

Successful tests demonstrated the possibility of supplying power through dedicated supply routes from two gas turbine plants (Litér Plant and Százhalombatta Thermal Power Plant); however a suitable Diesel generator shall be made available to provide the black-start of the Litér Plant.

Connection possibility of accident diesel generators and the respective procedures were constructed and developed at all of the four units. The generators are stored at an appropriately protected location.

The further measures considered to be necessary can be found in the previous chapter. The planned schedule for the implementation of measures will be finalized by June, 2012.

2.3 Activities of the regulator

2.3.a Actions of the regulator

Section 2.1 of the Resolution HA5444 of the Authority requires that: In order to increase the protection against earthquakes some formerly not seismically qualified, non safety related reinforced concrete structured buildings shall be qualified and reinforced if necessary. In the frame of that, the seismic protection of the 400 kV and 120 kV substations, the fire brigade barrack, the shelters and the equipment housed there shall be increased. Protection of the demineralised water tanks in Installation II against collapse of the panels from the wall of the health building shall be ensured. In the frame of the refurbishment of the seismic instrumentation project currently under preparation, the issue of automatic shutdown of the reactor shall be reviewed. Proper fixing of the tools and appliances used during outages and stored at the units shall be ensured during non outage periods.

2.3.b Implementation of planned activities

The nuclear power plant shall submit an action plant by June 30th, 2012 which will be a matter of regulatory consideration.

2.3.c Results, further actions

Following the summary of results and experiences of the international review the HAEA will decide on the specification of further improvement measures and as to whether the scope of measures currently in progress shall be extended as well as on the schedule of their implementation.

3. On-site severe accident management and recovery

3.1 Overview

3.1.1 Severe accident management

Development of the concept of severe accident management

The analysis and technical activity aiming to improve the safety level of the nuclear power plant has further continued since 2002; the implementation of the design safety enhancement measures described in previous National Reports was completed. The focus of this activity moved towards low probability events having more significant consequences (i.e. beyond design basis accident and severe accidents). The evaluation of the plant safety from the aspect of large discharges was completed by the end of 2004. Essentially, this evaluation was an extended Level 2 Probabilistic Safety Analysis, which covered all such accidents initiated from either power operation or shutdown states of the unit that could lead, due to an adjunctive failure, to the damage to the core or the fuel, having more serious consequences than those allowed for design basis accidents. The scope of the analysis included those ex-vessel systems that include significant radioactivity; thus e.g., events of the spent fuel pool were also analyzed.

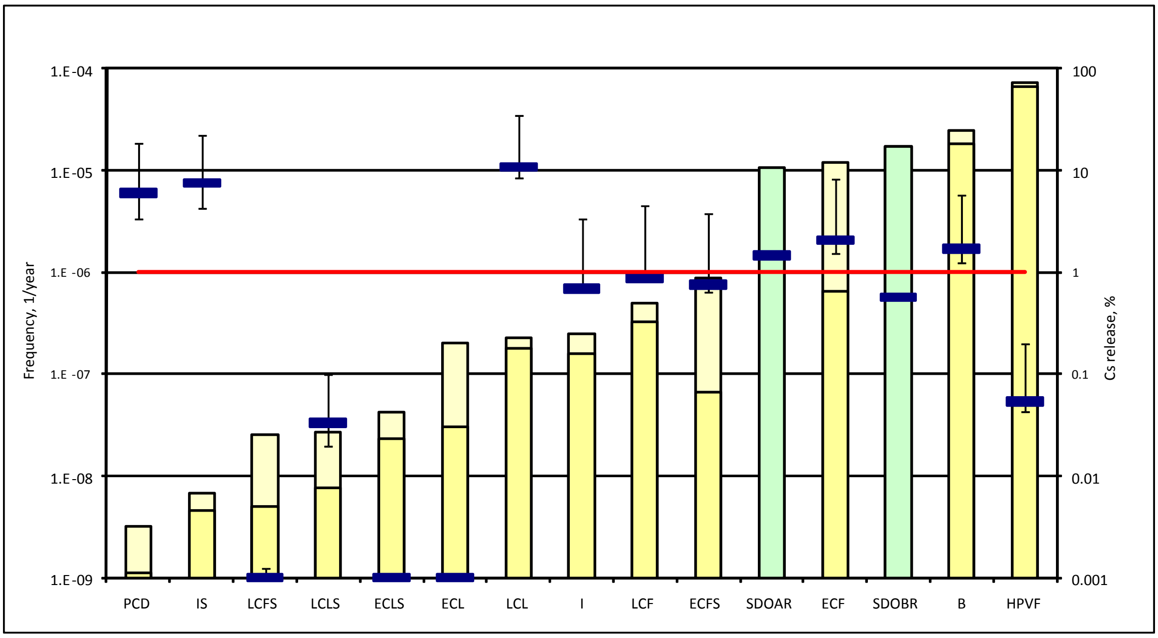

Figure 3-1: Source term categories and frequencies*

**the columns show the maximum and minimum relative release for the categories, while the lines show the occurrence frequencies and uncertainty ranges*

The analysis quantified the risk implied by the nuclear power plant, and additionally it facilitates the development of such accident consequence mitigating processes such as:

– cooling of the debris;
– reduction of radioactive discharges;
– maintenance of the structural integrity of the hermetic zone.

The analyzed event sequences terminate with various damage states of the containment (as final events).
In order to characterize the radioactive releases, the source term from the containment, the duration and location (release route) of containment damage, and the availability of the sprinkler systems having the most influence have been taken into account.

Atmospheric release and discharge towards the soil and ground water were differentiated among the discharges. 13 source term classes were set for atmospheric release from closed reactor and two source term classes for open reactor.

The symbols and names of the source term categories are summarized in Table 3-1.

Table 3-1: Source term categories

Source term category / containment state	
1	High pressure reactor pressure vessel rupture (HPVF/HPME)
2	Release bypassing the containment (by-pass) (B)
3	Early containment failure (ECF)
4	Early containment leakage increase (ECL)
5	Late containment failure (LCF)
6	Late containment leakage increase (LCL)
7	Early containment rupture with sprinkle (ECFS)
8	Early containment leakage increase with sprinkler (ECLS)
9	Late containment rupture with sprinkler (LCFS)
10	Late containment leakage increase with sprinkler (LCLS)
11	Intact containment (I)
12	Intact containment with sprinkler (IS)
13	Partial core damage (PCD)
14	Open containment, severe core damage before refueling (SDOBR)
15	Open containment, severe core damage after refueling (SDOAR)

The magnitude of ^{137}Cs release, which is the most important isotope for the health effects, and the probabilistic parameters of the release were determined by calculations for each event sequence representing the dominant plant damage states.

According to the concept of severe accident management modifications, the scope of the corrective actions was identified in such a way that the radioactive discharge caused by events in source term categories having relatively higher frequency and more significant discharged activity (i.e. SDOBR, SDOAR, ECF és B) or the frequency of events belonging to more dangerous categories have to be reduced.

The modifications implemented at Paks NPP with regard to severe accident management are aimed to stop any assumed severe accident event sequence and to bring the unit to a safe cold sate. The principal elements are as follows:

- prevention of high pressure damage to the reactor pressure vessel by reliable and effective pressure reduction;
- prevention of the damage to the reactor pressure vessel by its external cooling;
- maintenance of containment integrity by management of the generating hydrogen.

Two key elements of the practical execution of severe accident management are the execution of the technical modifications belonging to SAM and the introduction of Severe Accident Management Guidelines.

Accident management strategies for the loss of core cooling

Primary pressure reduction

In the case of certain severe accidents, the primary circuit pressure is high in the initial phase of the process; therefore the reduction of the pressure is the most important task. The pressure reduction is performed before the evolution of extended core damage, by way of the application of actions described in the Symptom-based Operating Procedures. Pursuant to the currently effective instructions, the pressure reduction is started if the restoration of core cooling is unsuccessful, at 550 °C core outlet temperature.

If the core outlet temperature further increases during the application of the Symptom-based Operating Procedures and then exceeds 800 °C in the case of total blackout, or 1100 °C in any other case, then the SAMGs have to be applied, and pressure reduction shall be implemented pursuant to the "Primary pressure reduction" instruction.

In this case the most important tools of pressure reduction are the valves of the pressurizer (i.e. safety and relief valves); however the valves of the emergency gas removal system or the primary circuit blow-down system can also be deployed. Boric acid water from the hydro-accumulators can be fed into the primary circuit, when the primary circuit pressure decreases below 35 bar and thus the core can be recovered. This action can delay melting of the core and prevent the occurrence of a high pressure process. Accordingly, the pressure reduction required by the operating procedure for such cases can be realized with great reliability, and thus the high pressure damage to the reactor pressure vessel can be avoided.

External cooling of the reactor pressure vessel

At first, the external cooling of the reactor pressure vessel requires water discharge from the localization tower (from the bubble trays) to the floor of the containment, and then the water can be drained to the reactor cavity there from by gravity. The approximate 1,180 m^3 water and the coolant from the primary circuit can be used to fill up the 270 m^3 reactor cavity.

The passive process of the external cooling of the reactor pressure vessel starts to work, when the reactor cavity is flooded according to the principle scheme displayed in Figure 3-2. The water transfers the heat from the wall of the reactor pressure vessel (by way of boiling and condensation) to the containment through natural circulation, and thus the reactor pressure vessel is protected and the core debris and molten parts are cooled within the reactor pressure vessel.

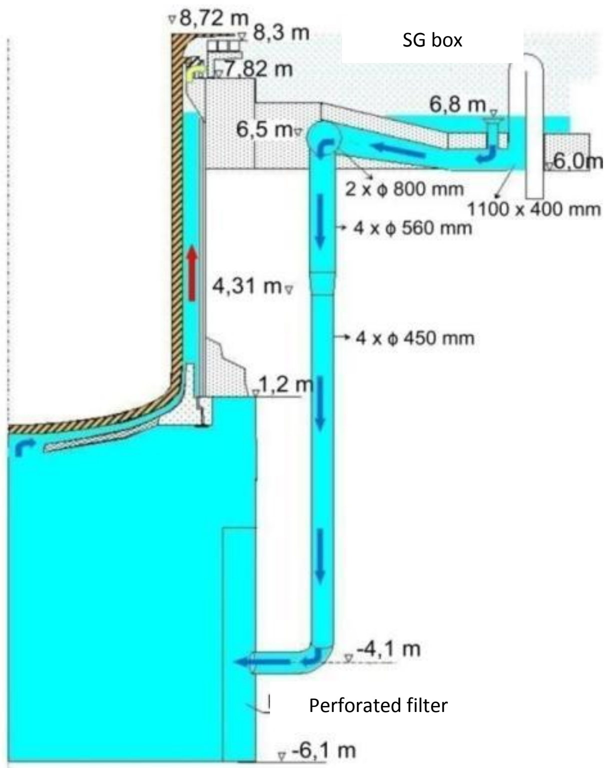

Figure 3-2: Scheme in principle of the external cooling of the reactor pressure vessel

According to calculations made in relation to the external cooling of the reactor pressure vessel, the stable cooling is assured based on the natural circulation of the coolant; consequently, the intactness of the reactor pressure vessel can be maintained. The conclusions drawn from the calculations were justified by the modeling of the heat flux occurring during the accident and the actual geometry of the reactor cavity in the frame of CERES experimental analyses conducted in Hungary.

Measurement system for severe accident management

Certain primary circuit and secondary circuit parameters are required to be known for the execution of interventions defined in the Severe Accident Management Guidelines; thus the severe accident measurement system is an important element of the severe accident modifications.

Figure 3-3: Measurement system for severe accident management

The principal parameters of the measurement system are as follows:
- primary pressure and core outlet temperature,
- containment pressure, temperature, oxygen and hydrogen concentrations,
- water levels in the containment, reactor cavity and spent fuel pool,
- dose-rates inside and outside the containment.

The construction of the measurement system guarantees its operability under severe accident conditions (temperature, radiation, humidity). Batteries can supply electrical power to the measurement system for 3.5 hours. This period is sufficient to put the severe accident Diesel generators into operation and then to start them; these Diesel generators will then supply electrical power to the system. The central unit and one of its display monitors can be seen in Figure 3-3.

Severe accident Diesel generators

The severe accident management requires the operation of the measurement system and the actuation of certain valves. Among them the most important ones are the pressurizer valves, the discharge valves of the localization tower and the valves discharging the water collected on the floor within the hermetic zone.

Figure 3-4: A severe accident Diesel generator

After the batteries are exhausted, the energy supply to the valves, not having other supply sources, is provided by a severe accident Diesel generator that is available at each unit (four in total). A severe accident Diesel generator can be seen in Figure 3-4.

Accident management strategies for the protection of containment integrity, after core damage

The potential severe accident processes challenging the containment of Paks Nuclear Power Plant are:

- hydrogen combustion induced rapid pressure increase that may cause damage to the containment;
- high pressure damage to the reactor pressure vessel and sudden pressure peak in the reactor cavity that may cause significant damage to the containment;

- ex-vessel steam explosion after vessel failure that may cause damage to the containment;
- interaction between the core debris and the concrete after vessel failure that causes burn through of the base plate and damage to the containment, then the rupture of the containment due to slow over pressurization.

The high pressure damage to the reactor pressure vessel is prevented by pressure reduction in the primary circuit. If the vessel is damaged at low pressure, then steam explosion or core-concrete interaction may occur. These sudden cliff edge effects entailing extended damage can be avoided by appropriate accident management. The accident management strategy applied to prevent such damage to the reactor pressure vessel is the external cooling of the vessel by flooding the reactor cavity (see "Accident management strategies for the loss of core cooling" section).

Hydrogen management with severe accident recombiners

Sixty (30 pairs) NIS type passive autocatalytic severe accident recombiners were installed for hydrogen management in the containment of each unit.

These recombiners significantly reduce the quantity of hydrogen generated during the analysed severe accident processes. Even if the hydrogen generation due to zirconium water reaction can be so intensive in certain processes that, in spite of the recombiners, the hydrogen may burn during an initial short period of time. The concentration of hydrogen is low enough that the hydrogen burning cannot jeopardize the integrity of the containment. In a later phase of the severe accident process the hydrogen concentration further decreases, and thus the gas mixture no longer remains flammable. The operation of the hydrogen recombiners is based on physical and chemical principles, thus intervention is not required. Consequently, the relevant instructions of the SAMGs primarily focus on the monitoring of the hydrogen concentration.

The hydrogen leaks to the reactor hall and the process building through the permissible leakage of the containment. Burnable gas composition cannot develop in these rooms, the hydrogen concentration remains below 1 vol%.

Prevention of containment over-pressurization

The process of slow over-pressurization is caused by steam produced during external cooling of the reactor pressure vessel. Consequently, the relevant accident management guideline requires the reduction of the pressure in the containment. The pressure reduction can be achieved by the cooling of the air volume or, by relieving the containment pressure through the venting system. If the electrical power supply is totally lost, then the air volume cannot be cooled by design tools; the only possibility is to discharge air through the venting system of the containment; thus damage to the containment can be avoided. Based on the analyses, the reduction of the pressure in the containment becomes necessary after 3-8 days. At that time the fission products (with the exemption of the noble gases) deposit themselves onto the walls of the containment or settle to the water on the floor of the hermetic compartments.

Nevertheless, unfiltered release can only be executed after the evacuation of the people from the area around the nuclear power plant; thus further corrective measures are identified to manage the prevention of containment overpressure, which will be realized in the next phase of severe accident management modifications.

Management of long-term accident processes

The external cooling of the reactor pressure vessel, deploying the water reserve of the localization tower, is applicable to accident management. During the process, the residual heat generated in the reactor core boils the coolant in the reactor cavity. A part of the steam, after condensation on the internal surfaces of the containment, flows back to the sump; the rest of the steam leaves the system through the leakage of the containment or its potential bleeding. If the coolant cannot be made up in the containment, then the cooling process of the reactor pressure vessel will stop after a certain period of time, and consequently the reactor pressure vessel would be damaged. The water from the bubble trays can provide a sufficient quantity for accomplishing external cooling of the reactor pressure vessel and the core debris for a period of one week. Afterwards, fire water can be supplied to the containment through the steam generator in order to keep the core debris within the reactor pressure vessel. The various valves and systems required for the implementation of the strategy are available at the plant.

Management of multi-unit severe accidents

The resources required for accident management and the accident electrical energy supply of the dedicated accident management system were installed individually in each unit; thus severe accidents occurring in different units are managed independently of each other; the management of multi-unit accidents is solved from a technical point of view. On the other hand the simultaneous accident management in more than one unit means increased organizational tasks that the personnel have to perform.

3.1.2 On-site emergency response

Design basis of on-site emergency response

Table 3-2 summarizes the major specifics of emergency response; i.e. initiating events, types of expected evolution of scenario (DBA - Design Basis Accident at a unit, SA - Severe Accident at a unit, 4 DBA - simultaneous Design Basis Accident at four units, 4 SA - simultaneous Severe Accident at four units), the tasks to be completed by emergency response as well as the most important specific conditions hindering the implementation of the emergency response tasks.

Table 3-2: Major characteristics of emergency response activities

Initiating event	Evolved event	Task	Specific condition
Internal cause	DBA	basic emergency response	-
	SA	emergency management	high radiation level long-lasting
Permanent loss of electric supply	4 DBA	basic emergency response + restoration of electric supply	-
Permanent loss of electric supply	SA	emergency response + restoration of electric supply	high radiation level, long-lasting, loss of communication and IT network
	4 SA	emergency response beyond the design basis	as above + insufficient resources
Permanent loss of ultimate heat sink	4 DBA	basic emergency response + restoration of cooling water supply	limited in time

Initiating event	Evolved event	Task	Specific condition
	SA	emergency management + restoration of cooling water supply	high radiation long-lasting
	4 SA	emergency response beyond the design basis	as above + insufficient resources
Earthquake, external events	4 DBA	basic emergency response + fire fighting, restorations	
	4 SA	fire fighting, restorations + emergency response beyond the design basis	limited external resources (24/72 hours), high radiation level, long-lasting, insufficient resources

The original task of the Emergency Response Organization of Paks NPP was the implementation and direction of emergency response activities required by design basis accidents. Later the scope of this activity was extended to cover activities required by a severe accident occurring at one unit. The scope of emergency response activities includes the majority of those on-site recovery tasks, which are to be implemented if a design basis accident occurs at one or more units, or a severe accident occurs at one of the units as a result of the loss of electric supply, loss of the ultimate heat sink, earthquake or other external event, further if these events require emergency response on their own. All of these tasks compose the design basis of emergency response. The design basis considers such disturbance factors potentially occurring during the implementation of emergency response and on-site restoration tasks, such as

- high radiation level;
- long-lasting nature;
- need for implementation within a limited period of time;
- unsatisfied request for external resources.

In principle, such severe accidents may occur which are beyond the design basis of the on-site emergency response. Such events are those severe accidents that occur simultaneously. The response to multi-unit severe accidents requires a greater number of qualified on-site personnel potentially participating in the emergency response than those available; thus the response to such severe accident requires the involvement of external resources, which are to be provided at national level. The external support does not mean the transfer of the licensee's responsibility; the management of the situation and the coordination of the response remain the task of the nuclear power plant.

The design basis of the on-site emergency response was used as basis for the establishment of the on-site emergency organization and the planning of resources.

Emergency management resources, emergency preparedness of the organization

Emergency Response Organization

Paks NPP established an Emergency Response Organization (ERO) for the management of extraordinary events or emergencies, the mitigation of accident consequences, and for the implementation of recovery actions.

The ERO is activated after the declaration of an emergency; it works according to an individually controlled direction and management method. The ERO is directed by the ERO manager in accordance with the prescribed shift schedule; he/she is solely responsible for each action taken during response to emergencies. The personnel of the ERO are selected from amongst the employees of Paks NPP Ltd and its assigned contracted partners working in special fields of expertise and having adequate competencies. The ERO members have to comply with physical, psychological and professional requirements. Moreover, in case of need, any employees at the NPP can be involved in the work of the ERO.

The ERO is capable of continuously performing its tasks even under adverse conditions defined in its design basis. The ERO can adjust its work to a long-lasting emergency and harsh radiation conditions.

The organizational structure of the ERO was established in accordance with traditional civil protection regulations, taking account of the special response tasks at the nuclear power plant. The staff numbers of the various organizational units were determined with significant margin. The structure and the staff numbers were determined based on the basic requirement to be met, namely that the ERO shall be capable of providing response to the most severe accident postulated in its design basis. The organizational structure of the ERO is shown in Figure 3-5.

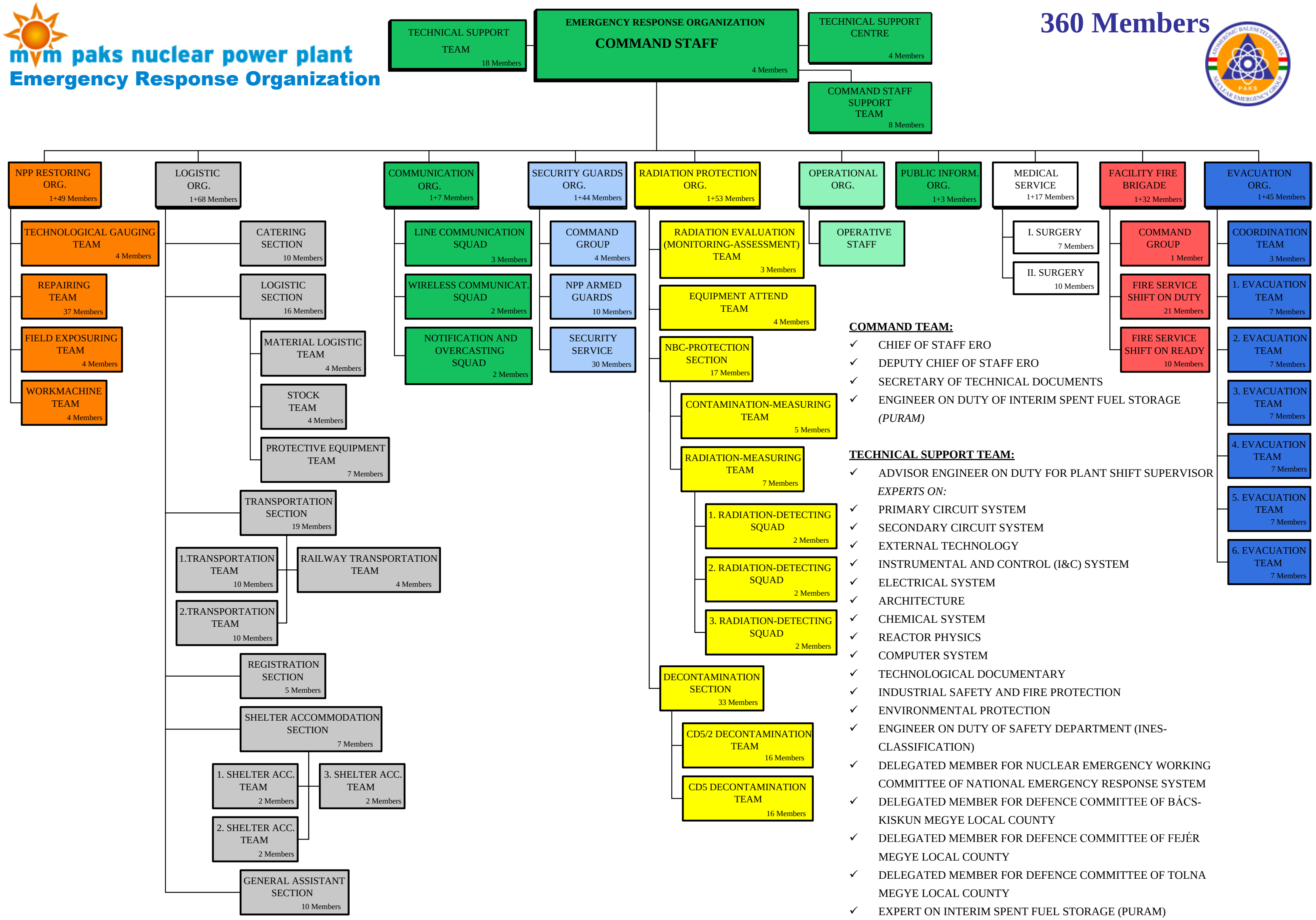

Figure 3-5: Organizational structure and staff numbers of the ERO

The operation of the ERO is regulated by the relevant national regulations and the internal procedures developed on the basis thereof.

Documentation

The General Emergency Response Plan is a document written in agreement with, and approved by, the authorities and special authorities concerned. It summarizes the tasks to be performed and requirements to be met by the ERO. It has modular structure, thus it provides general information as well as information and procedures specific to certain events.

The tasks to be implemented are regulated in detail by operating instructions; these documents specify the practical tasks in connection with preparation and inspection activities, as well as the response to a concrete emergency.

The documents including information supporting the activities of the ERO, along with recommendations on the operation of the ERO, are primarily based on guidelines provided by international and national professional organizations. Paks NPP Ltd, with the consideration of the recognized good practices, improves the effectiveness of the ERO; however new ideas are adapted only after careful testing. Corrective measures are identified based on lessons learned from inspections and exercises, as well as from other information exchange forums (e.g. conferences, trainings and consultations).

Collective protection

The fundamental objective of emergency response is to evacuate those personnel who are not involved in the interventions within the shortest possible time; thus sheltering has to be provided only for those participating in the implementation of emergency related actions.

Paks NPP has three qualified shelters for the protection of the personnel, which are capable of accommodating 1,200 people (i.e. 450, 300, 450 people). Each of the three shelters obtained regulatory qualification. The operating modes and the rules of operation are regulated in a specific operating instruction. Each shelter is provided with an individual electrical supply by way of a Diesel generator, filtered venting equipment, reserve filter sets and water reserves. The Diesel generators are able to operate for 72 hours, at a minimum, without additional fuel supply. The breakthroughs of filters are indicated by iodine measurement systems. The shelters are protected against flooding; the pump systems are duplicated and supplied by the Diesel generators.

Should the operation of the Protected Command Centre be hindered, Paks NPP has a Backup Command Centre having limited capabilities that was established for the performance of emergency tasks required by design basis accidents. The Backup Command Centre is located, in the town of Paks, at a linear distance of 5 km northward from the plant. The building has Diesel generator electrical supply that is capable of supplying electricity for 72 hours at a minimum without additional fuel supply. The building is equipped with an individual climate system and water reserve.

Individual protection

The individual protection tools of those not involved in the work of the ERO are:

- If the evacuation can be implemented only after radioactive materials have been released, then the personnel to be evacuated shall be provided with protective hoods ensuring protection against contamination for a limited period of time (i.e. 30 minutes). The protective hoods are stored close to muster points and in the storage shelter. Depending on the number of those staying on the site of the plant, the number of stored protective hoods has to be regularly reviewed.

The individual protection tools of those participating in the performance of emergency actions:
- gas mask + iodine filter;
- civil protection filter type protective clothing + rubber boots + protective gloves + helmet;
- visibility vest;
- supplementary protective tools (protective clothing, shoe protection, etc.);
- thermal underwear and upper clothing, if appropriate;
- electronic dosimeter;
- iodine tablet.

Protective tools of those performing special interventions:
- compressed air breathing device;
- fire resistant clothing (for fire fighting);
- isolation type protective clothing.

Certain stocks of the individual protective tools are stored at operative work places; they are immediately accessible. 20,000 iodine tablets are available for those participating in the performance of emergency interventions in the emergency protection warehouses. The radiation dose suffered by those participating in emergency actions is measured by electronic dosimeters that are also used during normal operation. The dosimeters have to be collected and adjusted to accident limit value in the controlled zone, and then brought to the place of usage. The regulatory film dosimeters are stored in the main building.

Facilities and equipment available for decontamination

Paks NPP is well prepared for the decontamination of personnel and tools both on and off the site. If feasible, the decontamination activity has to be conducted at a designated and installed decontamination location that is the closest to the contaminated area. If infeasible, then mobile decontamination equipment has to be applied. A complex decontamination system is on hand for mobile decontamination, which is sufficient to establish three parallel decontamination lines, even at different locations.

The decontamination stations are capable of cleansing contaminated personnel wearing protective clothing or the body surface of the contaminated personnel being either in ambulant or injured condition. Protective clothing and personal breathing protectors belong to the stations for the operating personnel. Measuring instruments are available for the measurement of the contamination level. The decontamination stations, after arrival to the selected location, can start to operate within a short time. The water needed for decontamination can be supplied from an inflatable water tank, a motorised tanker or from the normal water network. The generated sewage water has to be handled in accordance with the regulations in effect. The decontamination stations can be heated; thus they can be deployed even in cold weather.

Equipment available for fire fighting and technical rescue

Paks NPP Ltd operates a Facility Fire Fighter Service to make first response and to perform various technical rescue and decontamination activities. The equipment needed for the performance of the above listed tasks are at the disposal of the Facility Fire Fighter Service; a part thereof is stored in the fire fighter barrack on the site, while the rest (i.e. mobile technical rescue equipment) is held in the storage building. A large heavy vehicle with off-road capabilities is also available for hauling the heavy weight Diesel generators. The Facility Fire Fighter Service, with its currently available equipment, is capable of performing the tasks identified in the General Emergency Response Plan.

If the barrack of the fire fighters becomes uninhabitable (i.e. due to degrading radiation conditions or damage to the building), then the personnel have to move to the designated shelter, where the reserve communication centre of the fire fighters is installed.

Transport vehicles

Ten wagons and two engines are on standby at Paks NPP to evacuate the personnel and to perform certain emergency response tasks if a design basis event occurs. Additionally five land-rovers are available to provide support in emergency situations. Should the rails become damaged in the case of an earthquake, then the evacuation has to be accomplished by alternate transport vehicles; which have to be obtained from external sources.

Communication means

Wired communication systems

The phone sub-boards providing the basis for the external and internal wire communication links are located in physically well separated buildings; one sub-board is installed in the Protected Command Centre.

The foundation of internal communication is the Digital Dispatcher Centre installed at the control nodal points, which are connected with loudspeaker lines, phone board extensions and direct lines. A direct communication line to the external cooperating organizations is also at the disposal of the ERO. These provisions guarantee the possibility of immediate communication in the case of an emergency.

Access to the process IT network from the Backup Command Centre is only possible through a web-based interface, but this is adequate to substantiate the emergency response measures.

Wireless communication systems

The following wireless communication systems operate on the site of the nuclear power plant:

- UHF radio system,
- Unified Digital Radio System,
- mobile phones.

In accident situations belonging to the design basis, the UHF radio system is the primary communication tool within a 30 km radius of the nuclear power plant. Portable radio sets are provided to the management staff of the plant, the fire fighter service of the plant, the security service, the operating and maintenance organizations and the ERO, as well as other authorized external cooperating organizations.

The Unified Digital Radio System is aimed to be used for communication with governmental organizations (i.e. disaster management organizations, security service, defense management organizations, defense forces, fire fighters and the national ambulance service). The operability of the system is guaranteed at state level.

The personnel of the ERO, including the positions of section commanders, are equipped with mobile phones. The applicability of GSM mobile phones provided to the staff of the ERO can be limited in a severe accident situation or after an earthquake, but it is expected that the alerting process can be completed subsequent to the occurrence of the event. Their permanent use is not considered during accidents.

Alarm and information systems

The following alarm and information systems are available at Paks NPP:

- Acoustic Alarm and Information System,
- Public Information and Alarm System,
- Pannon Messenger System,
- Automatic Calling and Fax-transmission system,
- MARATHON Terra Mailing System,
- Governmental Communication and IT System.

The Acoustic Alarm and Information System operates on wire network; its operability is dependent on the intactness of the network. The system has an uninterruptible power supply that ensures 4 hours service as a minimum. The system basically aims at providing alarms.

The Public Information and Alarm System is an alarm and communication system installed within a 30 km radius of the nuclear power plant. The control centers of the system are installed at the Protected Command Centre, Plant Control Centre and at the Tolna County Disaster Management Directorate; additionally, a mobile control unit is also available. The system consists of 227 sirens, which are capable of communicating alarm signals, as well as recorded or live speeches. The siren terminals are network independent and can be operated in local mode; thus alarming and informing the public is possible even in the case of a severe accident entailing loss of power supply or if the external electric power network collapses.

The Pannon Messenger system is operated on the GSM network, thus its capability is limited.

The Automatic Calling and Fax-transmission System, through ISDN lines, is applicable to provide groups and individuals with alert messages, as well as to send faxes. The system consists of alerting terminals at the Protected Command Centre and the Plant Control Centre.

The primary tool of information transmission of written documents within the frame of the National Nuclear Emergency Response System is the MARATHON system. This mailing system is applicable to send electronic mail and data to external organizations having proper licenses. The terminals of the plant dedicated for communication are at the Plant Control Centre, Protected Command Centre and at the Backup Command Centre.

The Governmental Communication and Information System is a closed governmental electronic mailing system for the transmission of electronic messages and data to external organizations. The terminal of the plant dedicated for communication is installed at the Protected Command Centre.

Information Technology systems

The emergency response required IT instruments, which transmit data on the technological conditions of the nuclear power plant units and the radiological situation, also satisfy general purposes.

Off-site forces and equipment

Pursuant to the effective legislation, the licensee (i.e. Paks NPP Ltd) is responsible for the recovery of the occurred event, the mitigation of consequences and for the direction of the emergency response activities. The management of effects and implementation of recovery actions off the site are the task of the national competent authorities. After the declaration of a nuclear emergency situation, the Hungarian Nuclear Emergency Response System will be activated. Its task is to direct and organize any such activity, which is aimed at recovering damage and mitigating the effects of the occurred event. If the management of the occurred emergency requires resources exceeding the potentials of Paks NPP Ltd, then the plant can request support and resources from the National Nuclear Emergency Response System. The direction and coordination of response activities on the site remain under the competence of the nuclear power plant, even if external forces contribute to the implementation of response tasks.

External resources and equipment that can be involved in emergency response activity

The initiating specific operating instructions give proposal on the involvement of external forces required for the response. The manager of the ERO may request additional resources for the response. In the case of those events, when prepared scenarios are not available, the ERO manager, under his/her competence identifies the external resources needed for the response and then initiates their involvement. At the same time, if the chairperson of the organization leading the national level emergency response activities judges that the nuclear power plant cannot manage the situation on its own, then he/she may send rescue forces to support the plant in the response.

The nuclear power plant is obliged to provide dosimeters and personal protective tools to those participating in the response activity on the site, should they not possess such means.

The practical issues of the involvement of external resources (e.g. their effective activation) are stipulated in cooperation agreements concluded by Paks NPP Ltd. These agreements identify the preparatory and response tasks, and the rules of cooperation. The agreements do not affect the legally defined tasks, competencies, authorities and obligations.

<u>External human resources</u>

The involvement of external forces in fire fighting and technical rescue activities is implemented depending on the severity of the event which has occurred, based on the decision of the commander. The external forces are activated in line with the Alarm and Rescue Plan. The arrival time of the rescue forces is dependent on the time of the alarm, the distance of fire fighting barracks from the plant as well as on traffic conditions. The average speed of marching is 1 km/minute.

The Security Service of the ERO, if appropriate, cooperates with the police and other external organizations concerned in law enforcement. The required forces are available within an hour subsequent to alerting them, if the traffic conditions make it feasible.

At national level, the Disaster Management Organizations, the Hungarian Defence Forces, the personnel of those organizations that are assigned based on civil defence service obligation, as well as the voluntary ambulances can be involved in nuclear emergency response. The activation times of these organizations are listed in the National Nuclear Emergency Response Plan.

Equipment

Detailed data on available mobile equipment is included in the survey conducted by the Directorate General for National Disaster Management. These pieces of data primarily refer to the capacity, number, location and activation time (i.e. taking them to transportable condition, their transportation and put into service) of the available Diesel generators, pumps and fuel transportation vehicle. It can be assumed that the generators and pumps arrive without operators, thus generators and pumps requiring special operatory skills cannot be utilized.

The mobile generators, depending on their capacity, can be haulable or transportable. The vehicles for the transportation or hauling of the generators are selected by the competent disaster management organizations. The equipment can be air transported by helicopters of the Hungarian Defence Forces; however air transportation requires further clarification on how the air ban around the plant can be lifted. The time needed for putting into operation varies regarding the equipment; nevertheless a sufficient number of generators and pumps can be put into operation within a few hours.

Training of the Emergency Response Organization

The emergency response personnel of Paks NPP are regularly trained and exercised; while the personnel not participating in the performance of emergency interventions are provided with a basic and then annual refresher trainings on emergency preparedness and response.

The basic trainings having examination obligations regard the proper way in which the emergency interventions have to be implemented (i.e. alarm signals, sheltering, meeting and mustering, evacuation and decontamination). The employees get annual refresher training; the technical, administrative and the management personnel are obliged to attend. The employees of contractors of the plant are obliged to receive training once a year from their employer.

The special preparedness of those units of the ERO, whose tasks are in close connection with the tasks to be performed in various service states, is integrated into their regular training system. The operative personnel are trained on emergency response tasks during refresher trainings, simulator trainings and special courses. The refresher training and the training on new issues are jointly provided to the maintenance personnel.

The emergency response training of plant fire fighters, medical units and security units is performed in the frame of their professional refresher training programmes, in compliance with other legal professional requirements.

Exercising of the Emergency Response Organization

The aim of the exercises is to methodically practice the tasks, and to check the time required for their performance as well as the quality thereof. The exercises, depending on their objectives, have various types (practicing exercise, verification exercise, complex/comprehensive exercise with the implementation of real field actions, table top exercise); they can be either announced or unannounced.

Conduct and evaluation plan has to be prepared for each exercise. The exercises have to be evaluated in line with aspects defined in advance in the conduct and evaluation plan. Based on the evaluation of the exercise, an action plan is prepared for the elimination of non-compliances and defects; the implementation of the plan has to be monitored.

Preparation of external contributors for emergency response activities

The external organizations participating in the interventions have to be regularly involved into the preparation of exercises; they have to get theoretical trainings and attend on site walk-downs.

Implementation of emergency response actions

Emergency response

The emergency response tasks of the ERO can be basically divided to two parts from the aspect of resources that can be involved. In the first period the operative personnel starts the emergency response with the available systems according to the effective procedures and operating instructions, paying special attention to the prevention and mitigation of consequences. After the activation of the ERO, in the second period, the ERO performs the emergency response tasks by integrating the operative organization, paying special attention to the mitigation of off-site consequences.

The ERO is activated by the declaration of the emergency situation. In the case of situations belonging to the design basis, the operating states of the ERO cover the entire period from the occurrence of the emergency through the mitigation of consequences, until the recovery of the damage caused:

- in duty operating state the ERO is only partially operated based on a specific decision;
- in emergency operating state the ERO is always activated entailing its partial or full operation;
- in recovery operating state the ERO is partially operated. A recovery plan is made in accordance with the specific situation, which includes in detail the tasks to be completed.

The partial or full alerting, convening and activation of the ERO are implemented after the occurrence of an extraordinary or emergency event or the potential occurrence thereof. In any case (either during working hours or outside thereof) the arrival of the personnel and the commencement of the activity shall be implemented within the defined time limit.

Time limits for activation of ERO units are as follows:

- the operating staff, the facility fire fighters, the armed security guards and the security service fulfils continuous duty operation;
- the personnel on duty shall arrive to the site within an hour;
- the mobile environmental monitoring vehicle has two hour arrival time at weekends.

It can be assumed, based on alerting drills that only 40% of those being not on duty can arrive to the site within the time limit; therefore the staff number of the ERO is highly oversized.

Response to design basis accidents

Paks NPP prevents the evolution of severe accidents from design basis accidents by way of safety systems and operating instructions provided to the operating personnel.

Radioactive materials may be discharged in the case of certain design basis accidents. Even if these discharges are much below the emergency limit values, the ERO shall implement the necessary protective measures and perform the communication tasks required by such situations.

In cases belonging to the design basis of emergency response, the stabilization of the technological conditions and reduction of radioactive discharges are parallel tasks. It is essential to monitor the discharge by remote measurement systems and to provide samples for measurements. In the case of a design basis accident the airborne radioactive materials are released through the stacks, where remote measurement and sampling systems are operated. In severe accident situations the radioactive materials may be released through non-monitored pathways; estimations shall be provided for such cases. The liquid discharges are monitored by installed automatic samplers and remote measurement systems; if they are out of operation, then the source term can be determined by local sampling or estimation.

The dispersion calculation software applied at the plant is applicable to estimate the source term caused by the event and the doses expectable within the 30 km environment of the plant, based on the information obtained from process, meteorological and environmental radiation measurement data.

The most important tasks of the ERO in the case of a long-lasting emergency situation are to fulfill the logistics tasks, as well as to provide rest and catering to the emergency personnel. The ERO manager is to decide on the completion and shift-change of the operative personnel, depending on the situation evolved. The operating personnel can rest in the shelters (i.e. those for 300 or for 450 personnel).

Duty service, replacement and shift changing solutions are applied in key positions identified by regulations and international recommendations. If appropriate, volunteers can be involved; additionally, own employees can be obliged to perform emergency response tasks according to law.

Operation of the ERO if a severe accident occurs at one unit

The operating staff members perform their activity according to operating instructions. In the case of a severe accident, subsequent to the activation of the ERO, the structure of operative control remains unchanged until the Severe Accident Management Guidelines have to be applied. During the implementation of Severe Accident Management Guidelines the operative control over the personnel of the affected unit is taken by the ERO Technical Support Centre from the plant shift supervisor, who remains the leader of the operative staff. In such a situation the personnel of the damaged unit performs the activity based on purpose oriented instructions, which are directly announced to the control room staff by the Technical Support Personnel working in the Protected Command Centre. The staff members concerned are informed of the actions to be implemented in the main or other control rooms by the unit shift supervisor or the operators.

The further operation of the intact units, if an accident occurs at another one, is regulated by operating instructions. The operation of the intact units is furthermore directed by the plant shift supervisor. Of course, the activities of the operating personnel are influenced by the accident conditions of the neighbouring unit, basically through the degradation of work conditions and the inaccessibility of certain equipment and rooms. These effects hinder the emergency response activity, but the necessary measures can only be determined being aware of the actual situation. In line with the evolved conditions, the ERO can make decision on regrouping of the personnel between units in order to ensure sufficient resources for the mitigation of accident consequences.

If the control room is uninhabitable, then the reserve control room is at the disposal of the staff, where the actions required for shutting down and cooling down the unit, as well as those required for the maintenance of the cold state can be executed. If none of the control rooms can be inhabited, then the control room personnel keep contact with the Technical Support Personnel from another appropriate location. Only such limited interventions can be performed in this case, which can be initiated on the scene.

The operative staff members remain at their workplaces during the management of a severe accident while those places can be kept safe. The ERO makes the decision on the evacuation of the workplaces, operative areas and other areas, if the work conditions severely degrade, and decide on the designation of places applicable for long-term stay (e.g. moving to an emergency shelter). Later on, the closed areas can/must be accessed only to execute the necessary interventions for the time needed for the execution.

3.2 Activities of the operator

3.2.a Actions of Paks NPP

Severe accident management

The principal elements of severe accident management modifications are as follows:

- external cooling of the reactor pressure vessel by discharging water from the localization tower and flooding the reactor cavity;
- hydrogen management under severe accident conditions by passive autocatalytic recombiners;
- prevention of coolant loss from the spent fuel pool due to pipeline rupture;
- establishment of the severe accident management measuring system;
- provision of severe accident Diesel generators for supplying electrical power to SAM instruments.

Based on the Severe Accident Management Guidelines the processes entailing significant radioactive releases (from the reactor or the spent fuel pool) during severe accidents occurring in any service state of the unit can be managed. The strategy is aimed to bring the unit to a controlled and stable state and to avoid the release of fission products. Accordingly, the main strategic points of the Severe Accident Management Guidelines are as follows:

- water supply to the steam generators,
- reduction of the primary pressure,
- water supply to the main circuit,
- water supply to the hermetic zone,
- reduction of radioactive discharges,
- control of hermetic zone conditions,
- hydrogen management within the hermetic zone,
- mitigation of the consequences induced by the accident of the spent fuel pool.

Direct Emergency Guidelines aim at reducing the direct risk to barriers preventing the discharge of radioactive materials; therefore, because of more severe consequences, they get greater priority. These are:

- reduction of radioactive discharges,
- pressure reduction within the hermetic zone,
- control of hydrogen combustion,
- control of vacuum within the hermetic zone.

As a result of the recently accomplished modifications, the long term electric supply to the relief and safety valves of the pressurizer can be guaranteed from the batteries, and after they run down from the severe accident Diesel generators, in any case.

Special discharge valves were installed in the hermetic zone for the external cooling of the reactor pressure vessel; the schedule of the venting line of the reactor cavity was changed and the modifications required for streaming the water to the reactor pressure vessel within the reactor cavity were performed. The discharge valves can be supplied by electrical energy from the normal, safety and severe accident electric power supplies.

The installation of the severe accident measuring system was completed. The principal elements of the measuring system are as follows:

- primary pressure and core outlet temperature,
- containment pressure, temperature, oxygen and hydrogen concentrations,
- water levels in the containment, reactor cavity and spent fuel pool,
- dose-rates inside and outside the containment.

Batteries can supply electrical power to the measurement system for 3.5 hours; this period is sufficient to put the severe accident Diesel generators into operation.

Severe accident Diesel generators were installed at each unit.

The containment was equipped with 60 (30 pairs) NIS type passive auto-catalytic severe accident recombiners for hydrogen management.

Two concepts were assessed in order to prevent the severe accident induced internal over-pressurization of the containment. The first concept regards filtered discharge: the radioactive material is released to the environment through a filter having adequate efficiency. The second concept regards the long term cooling of the containment, which in addition makes the filtered or unfiltered discharge unnecessary.

In addition to the point model calculations, less conservative three-dimensional analyses have to be made to determine the quantity and dispersion of the hydrogen generated during simultaneous accidents of two spent fuel pools, a closed reactor and of a reactor opened for refueling at a single installation.

The long term (i.e. after a week) processes shall be analysed in order to mitigate the severe accident consequences. Accordingly, the system preventing the slow over-pressurization of the containment (i.e. filtered discharge or internal cooling of the containment) shall be developed and established.

On-site emergency response

The existing symptom oriented operating procedures shall be reviewed, as to whether they support the optimal recovery subsequent to simultaneous occurrence of an earthquake and the rupture of primary coolant circuits.

The potential hazard of discharging radioactive materials to waters, its potential routes, the tools and methods of its monitoring, as well as the scope of necessary and possible measures shall be assessed.

Currently, a time limit for the service state of the closed reactor below 150 °C primary circuit temperature does not exist; the establishment of a time limit value is reasonable to be assessed, since the cooling necessary for an extended period also means some hazard.

3.2.b Implementation of planned activities

Status of modifications planned in connection with severe accident management

Several process modifications required for the introduction of severe accident management measures have been already implemented to various extents at the units of Paks NPP. The status of each measure at the units is compiled in Table 3-2.

Table 3-2: Status of severe accident management modification, date of planned completion

Modification	Unit 1	Unit 2	Unit 3	Unit 4
Construction of reactor cavity flooding system	Implemented	2012 main outage	2013 main outage	2014 main outage
Construction of autonomous power supply to designated consumers	Implemented	Implemented	Implemented	Implemented
Installation of passive hydrogen recombiners	Implemented	Implemented	Implemented	Implemented
Reinforcement of cooling circuit of spent fuel pool against loss of coolant	Implemented	Nov-Dec, 2012	Feb-Mar, 2013	Jan-Feb, 2012
Installation of severe accident measurement system	Implemented	Jun-Aug, 2012	Sept-Oct, 2013	May-June, 2013
Introduction of severe accident management guidelines	Dec 31, 2011	Dec 31, 2012	Dec 31, 2013	Dec 31, 2014

3.2.c Results, further actions

Table 3.2 includes the measures to be implemented in the future.

3.3 Activities of the regulator

3.3.a Actions of the regulator

Measures required by the Authority

Section 1.2.5 of Resolution HA5444 of the Authority requires that: The operability, under harsh situations evolving during an earthquake and total loss of power, of installed equipment measuring the environmental radiation on the site and in its vicinity that is required to substantiate the emergency response activity shall be assessed.

Section 2.4 of Resolution HA5444 of the Authority requires that: The operating procedures shall be modified in order to increase the available margins and more efficient deployment of available recovery options. The modifications shall include the increase of the fuel stored on the site, and the maximization of the desalted water quantity stored in the desalted water tanks. The inservice inspection and maintenance of stored equipment shall be procedurized in order to manage the low water level of the Danube. Operating instructions shall be developed for the establishment of potential links between the as yet unused normal, reserve and safety AC trains. The available symptom oriented operating procedures shall be revised, as to whether they support the optimal restoration after the simultaneous occurrence of an earthquake and the break of the primary cooling circuits. Procedures shall be developed for the management of liquid radioactive wastes in severe accident situations. Additionally, an accident management guideline shall be developed for the management of a situation when a severe accident occurs simultaneously in the reactor and the spent fuel pool. The hazard of the discharge of radioactive materials to water, its potential route, the means and methods for its monitoring as well as the scope of the necessary and possible measures responding to such situations shall be assessed.

Section 2.5 of Resolution HA5444 of the Authority requires that: Independent severe accident Diesel generators shall be installed to support the power supply of safety consumers that have a role in preventing severe accidents and/or managing an accident in the long term. The number and capacity of these independent severe accident Diesel generators shall be adjusted so that they are capable of supplying consumers, pumps and isolation valves of all reactors and spent fuel pools at the same time even during the loss of power supply in all units. The independent severe accident Diesel generators shall have appropriate protection against beyond design basis external hazards (earthquake, natural hazards, flooding) of the installed emergency Diesel generators and they shall be totally independent of other systems (such as the cooling or electric supply systems) of the plant.

Section 2.6 of Resolution HA5444 of the Authority requires that: Black-start capability (start-up from own Diesel generator) shall be created for the Litér gas turbine, which can provide external electrical power via a dedicated alternative transmission line.

Section 2.7 of Resolution HA5444 of the Authority requires that: Possible cross-links shall be developed for providing safety electrical power supply at 6 kV from any operable emergency Diesel generator in any unit to the safety consumers of any other unit when off-site power is lost, without the use of the external network.

Section 2.8 of Resolution HA5444 of the Authority requires that: In order to avoid clogging of the intake filters of the essential service water system, the electric power supply of the filters shall be changed to safety electric supply.

Section 2.9 of Resolution HA5444 of the Authority requires that: In order to provide long-term heat removal through the steam generators, the possibility shall be established for feeding external cooling water from the already existing connection points in the courtyard area via existing injection lines to the auxiliary emergency feedwater system. Accessibility of the external connection points under accident circumstances shall be improved. The connection points may need to be relocated. As water stored in the demineralised water tanks can be used as an alternative water source during an accident, appropriate connection points on these tanks have to be installed for providing water to the auxiliary emergency feedwater system using mobile pumps. Arrangements have to be made for the utilisation of additional water sources such as the Danube and the fishing lakes near the plant. The equipment needed for connecting the mobile aggregators and pumps brought from outside the site to the process equipment has to be provided. Plant procedures have to be prepared for the utilisation of the external sources.

Section 2.10 of Resolution HA5444 of the Authority requires that: The opportunity to feed cooling water directly into the containment through the auxiliary emergency feedwater system and the newly installed secondary side blow-down valves of the steam generators is given, but only borated water can be used for that purpose. Using the existing tank park, the method to borate and storage of borated water shall be provided. The method of water supply into the containment from external sources shall be specified in procedures.

Section 2.11 of Resolution HA5444 of the Authority requires that: An alternative way of supplying external cooling water to the spent fuel pools shall be implemented. The new water supply route connected in the courtyard by flexible means has to be protected from external hazards (such as earthquake). In an accident situation, in case of lack of another possibility, the spent fuel pool shall be filled from the borated water reserve specified above. The required operations shall be specified in operating instructions.

Section 2.12 of Resolution HA5444 of the Authority requires that: Direct electric power supply shall be provided from a new, duly protected fixed or mobile Diesel generator to supply, in case of an emergency, the submersible pumps of the nine large-diameter wells drilled into the pebble bed of the Danube bank.

Section 2.13 of Resolution HA5444 of the Authority requires that: An additional cooling water source of 2x2,000 m3 shall be made available from the closed section of the discharge water canals of Installation II for the nearby Diesel-driven fire water pump station that can remain in service for approximately 8 hours.

3.3.b Implementation of planned activities

Paks NPP Ltd shall submit an action plan by June 30, 2012; the plan will be assessed and approved by the nuclear safety authority.

3.3.c Results, further actions

Based on the results of the international review and the summary of the experiences, the HAEA makes decisions on the development of the details of potential additional measures, and on the extension of measures in progress and the schedule thereof.

4. National organizations

4.1 Overview

4.1.1 Regulatory regime supervising nuclear facilities

In Hungary the following nuclear facilities being under regulatory supervision operated in 2010:

- Paks NPP (Paks NPP Ltd),
- Spent Fuel Interim Storage Facility (Public Ltd Company for Radioactive Waste Management),
- Budapest Research Reactor (KFKI Atomic Energy Research Institute),
- Training Reactor (Institute of Nuclear Techniques of the Budapest University of Technology and Economics).

An essential condition of the peaceful use of atomic energy is the operation of such a regulatory system, which has all the authorization, professional knowledge and financial resources that are required to perform its tasks in order to enforce the effective regulations, and which is independent of organizations having either interest or disinterest in the use of atomic energy.

In accordance with this Act, the control and supervision over the safety of applications are in the hands of the Government. The implementation of the governmental tasks is fulfilled by the Hungarian Atomic Energy Authority (HAEA) and the ministries concerned. The legal framework divides the basic regulatory tasks between the director general of the Hungarian Atomic Energy Authority (HAEA) and the minister of health.

The minister of health performs the tasks regarding radiation protection, safety of radioactive materials and equipment housing them, equipment and facilities generating ionizing radiation (hereinafter referred to as radiation hazardous equipment and facilities), as well as radioactive wastes and repositories via the Office of the National Chief Medical Officer.

The ministries concerned and central administration bodies are involved in the execution of regulatory tasks defined in the Act on Atomic Energy (Atomic Act) according to their own field of profession: the Ministry of the Interior, Ministry of National Resources, Ministry of Rural Development, Ministry of Public Administration and Justice, and the Ministry of National Development. The Govt. Decree 320/2010. (XII. 27.) Korm. on the Hungarian Trade Licensing Office and territorial metrology and technical safety procedures, designates the HAEA as having special authority in the procedures aimed at granting the license for trading of dual use goods and technologies. The conditions of special authority consent are determined in the Govt. Decree 144/2011. (VII.27.) Korm. on the rules of international trading of nuclear and nuclear dual use goods. The Ministry of National Defence performs licensing and inspection tasks regarding the use of atomic energy by the Hungarian Defence Forces according to a specific law.

4.1.2 Hungarian Atomic Energy Authority

The Atomic Act identifies the Hungarian Atomic Energy Authority as the body performing regulatory control over the nuclear facilities in Hungary. The HAEA is a public administration body acting under the control of the government in the field of peaceful applications of atomic energy with individual scope of tasks and authority, being independent from both organizational and financial points of view. The HAEA is supervised by a minister designated by the prime minister, independently of his/her portfolio. The HAEA cannot be directed in its field of competence defined in act.

Licensing (at facility, system and component level) and inspection of the nuclear safety of nuclear facilities, registration of radioactive materials, as well as licensing of related shipments and package designs, evaluation and coordination of research and development, fulfillment of regulatory tasks in the field of nuclear emergency preparedness, approval of emergency response plans of nuclear facilities, and the related international relations all belong under the competence of the HAEA.

The HAEA is responsible for the implementation of the Treaty on the Non-Proliferation of Nuclear Weapons, fulfillment of duties originating from the safeguards agreement with the European Atomic Energy Community and the International Atomic Energy Agency, accountancy for and control of nuclear materials.

A very essential international expectation with regard to the safe application of atomic energy is that the authority responsible for nuclear safety shall be independent of the interests of producers, owners and service providers, as well as of the public administration bodies having interest or disinterest in this regard. In Hungary, the Atomic Act and its implementation decrees guarantee the enforcement of the international expectations regarding independence.

The authorization and competences required for the fulfillment of its tasks are at the disposal of the HAEA. If justified, then the HAEA is authorized to impose fines, revoke or suspend the license of a nuclear facility.

The majority of the budget of the HAEA is assured by its own incomes; the Atomic Act grounds the financing of the activities providing technical support to regulatory control from the state budget. The incomes of the HAEA, with the exception of incomes from fines, shall be used for its operation.

A Scientific Council that is made up of a maximum of 12 nationally acknowledged individual experts supports the work of the HAEA in order to provide scientific background for the governmental, regulatory and nuclear emergency response measures. The chairman and members of the Scientific Council are appointed by the minister supervising the HAEA. The Scientific Council, with the consideration of advance scientific results, provides statements on the most important theoretical and research and development issues in relation to nuclear safety, radiation protection and nuclear emergency preparedness and response.

Other public administration bodies also participate in nuclear safety related licensing procedures of the HAEA; the law provides the possibility to involve professional experts (both institutes and individuals) in the proceedings. Within the frame of its regulatory activity the HAEA takes into account the aspects of physical protection, fire protection and off-site emergency response.

4.1.3 Paks Nuclear Power Plant

Govt. decree 118/2011. (VII. 11.) Korm. and its annexes (i.e. the Nuclear Safety Code) include the safety requirements. The Nuclear Safety Code requires that the operators of nuclear power plants shall have sufficient resources (i.e. material, organization and administrative resources) to mitigate the consequences of events beyond the design basis of nuclear power plants.

The holder of the operational license, i.e. Paks Nuclear Power Plant Ltd, owned 100% by the state; it is a sister company of the Hungarian Electric Power Trust. The supervision by the owner is imposed through the General Assembly and the Board.

A functionally independent organizational unit, the Safety Directorate is responsible for the supervision of safety within the company. The Safety Directorate is the independent supervisory and control unit of Paks NPP Ltd in the field of nuclear safety, physical protection, radiation protection, labour safety and fire protection, environmental protection, regulatory relations, quality control and material testing, and quality management.

Paks NPP Ltd involves contractors to fulfill its tasks, being companies either within the MVM Group or outside of it. These companies are all qualified from a nuclear safety point of view. Paks NPP Ltd, in the field of engineering services, is supported by national engineering and research institutions.

The safe operation of the plant, in compliance with the effective operating limits, is the task of the operative personnel. The operative personnel perform the continuous service of the nuclear power plant units in the organizational structure defined in the so named Operative Scheme, through functions fulfilled by job positions indicated in the hierarchy associated with the structure. The operative personnel work in 3x8 hour shifts; the personnel are organized in 6 shifts.

The number of the personnel required for the performance of the tasks of the operative personnel (including the personnel of the unit control room), and the composition of the personnel being on duty at a given time are specified based on the service requirements of the potential operating states of the unit. The operative control and executive conditions required for the continuous service of the units are specified for the various design operating states of the nuclear power plant.

The operative leader of the shift personnel of all four units is the plant shift supervisor, who is the ultimate decision maker on essential safety issues and questions not regulated by instructions. The positions directly subordinated to the plant shift supervisor are: the unit shift supervisors, the leaders of primary circuit, secondary circuit, electrical, instrumentation and control, external process, chemistry and dosimetry services, the foreman of electrical external plants, the shift leader of refueling machine operators, the computer specialist on duty, the engineer leading the base, the shift leader of the radioactive waste management service, the shift supervisor of the Plant Control Centre, the shift commander, the commander of the fire fighters, phone centre manager, the dress room supervisor and the manager of the special buffet. The control room is permanently staffed by the unit shift supervisor, the reactor operator, the secondary circuit operator and the electrical operator.

The operating staff members perform their activity according to operating instructions. In the case of a severe accident, subsequent to the activation of the Emergency Response Organization, the structure of operative control remains unchanged until the Severe Accident Management Guidelines are to be applied.

4.1.4 Technical Support Organizations

The coordination and financing of technical support activities serving for the regulatory control over the safe application of atomic energy fall under the competence of the HAEA. On the grounds of regular technical support programmes over the recent years, a network of technical support organizations (TSO network) was established.

The most relevant institutes of the network are: the KFKI Energy Science Research Centre (including the former KFKI Atomic Energy Research institute), the NUBIKI Nuclear Safety Research Institute, the Institute of Nuclear Techniques of the Budapest University of Technology and Economics, the Radiochemistry Faculty of the Pannon University, the PÖYRY-ERŐTERV Ltd., the SOM SYSTEM Ltd., and the VEIKI Enregia+, the successor organization to the thermal energy division of the former Electrical Energy Research Institute.

In the field of radiation protection the Office of the Chief Medical Officer is supported by the National Frédéric Joliot-Curie Research Institute for Radiobiology and Radiohygiene.

The technical support organizations carry out expert and scientific activities not only for the Authority but also for the nuclear installations. These organizations may perform contractual work for several institutions, but a particular expert or scientist is allowed to provide expertise at a given time and for a particular issue exclusively for the operator or the Authority, but not for both simultaneously. The relatively comprehensive system of censure, the internal quality assurance system of the support organizations and the careful selection of reviewers guarantee the appropriate consideration of interests and independent decision-making of the Authority.

4.2 Activity of the operator

4.2.a Actions of Paks NPP

The technical parameters of Paks NPP are described in the previous chapters. After the Fukushima accident, Paks NPP Ltd immediately commenced and then completed by the required deadline the extraordinary review in accordance with the principles suggested by the European Council and the guidance developed by ENSREG. The technical results of this targeted safety reassessment are summarized in Chapters 1-3 of this report.

The organizational structure of the plant is in compliance with the legal and regulatory requirements, and it is in agreement with the international expectations. The operator of the nuclear power plant has sufficient resources (material, organizational and administrative) to mitigate the consequences of events beyond the design basis of the plant.

4.2.b Implementation of planned activities

The schedule of the implementation of the planned measures and their status at the moment of closure of this report are described in Chapters 1-3.

The organizational structure shall not be modified based on the recent assessments.

4.2.c Results, further actions

Subsequent to the completion of the international review, based on their results and after the summarization of the experiences, the plant will implement additional safety improvement measures, if appropriate.

4.3 Activity of the regulator

4.3.a Actions of the regulator

After the Fukushima accident, in line with the principles suggested by the European Council and the guidance developed by ENSREG, the nuclear safety authority (i.e. Hungarian Atomic Energy Authority) urgently requested Paks NPP Ltd to conduct the extraordinary reassessment. After the completion of the reassessment, subsequent to the receipt of the report prepared by the plant, the HAEA reviewed the analyses made by the plant and made its own analyses. The results of the review and these own analyses were submitted to ENSREG by the stipulated deadline.

The HAEA is supported by its TSO institutes during the analysis of the Fukushima events. In 2011, the HAEA concluded a contract for the contribution to the evaluation of the review report made by OECD NEA after the Fukushima reactor accident.

The HAEA performed the analysis of its own legal status and organizational structure. The regulatory framework and the legal structure are adequate, they are in agreement with the international expectations; the independence of the regulator is guaranteed.

4.3.b Implementation of planned activities

On the basis of the action plan proposed by Paks NPP Ltd, the HAEA ordered the implementation of the approved safety improvement measures; the HAEA continuously monitors, controls and evaluates the progress of implementation.

The Targeted Safety Reassessment has not revealed any such deficiency which requires the modification of the effective nuclear safety regulations or the regulatory system.

4.3.c Results, further actions

After the completion of the international review, based on the results, and after the summarization of its experience, the HAEA will assess the necessity of the potential modification and be ready to execute the appropriate measures whether the modification needs affect the legal basis, the regulatory system or the technical solutions of the nuclear power plant.

5. Off-site Emergency Preparedness & Response and Post-Accident Management

5.1 Overview

5.1.1 Emergency measures

Legal background

The organizational structure of the national disaster management system, the tasks of ministers and governmental bodies concerned in disaster management regarding prevention, preparation and response, and the tasks of the disaster management organization are regulated by Act CXXVIII of 2011 on disaster management and the amendment of certain related acts, as well as by the implementation of Govt. decree 234/2011. (XI. 10.) Korm.

The organizational structure and tasks of the Hungarian Nuclear Emergency Response System (HNERS) are regulated by Govt. decree 167/2010. (V. 11.) Korm.

The Hungarian Nuclear Emergency Response System

The HNERS is established to prepare for the response to radiological or nuclear events occurring during the peaceful use of atomic energy, to mitigate and then eliminate the consequences. The HNERS is a complex system of central, sectoral, regional and local bodies and organizations that are all concerned in the prevention of events entailing unplanned radiation exposure to the population and the mitigation and elimination of the consequences of such events.

The Disaster Management Coordination Governmental Committee, as a governmental coordination body, fulfills the tasks associated with the direction of the HNERS. This Committee makes the decisions on disaster management and coordinates the response related sectoral tasks. The ministries concerned provide contribution to HNERS on a sectoral level.

The county defence committees and their working bodies operate at a regional level. The disaster management and nuclear emergency response working committees are chaired by the presidents of the County Defence Committees. Their tasks are the development of defence plans, county level direction of preparation, response and recovery, providing professional recommendations on response and recovery in the case of a potential or real emergency. Further submitting proposals, planning and organization of rescues from any aspect, as well as the direction of rescue work according to the decisions made by the County Defence Committees. Their working units are the Operative Staffs and the Public Communication Working Groups.

Operating states of the HNERS

The HNERS operated in normal, or in other cases in an elevated operating state; the elevated state includes alert, emergency and recovery operation levels.

In a normal operating state the HNERS performs the following tasks: continuous monitoring of the nation-wide radiological situation; collection, verification, analysis of radiological data, and alarm issuing; operation and maintenance of the HNERS alerting system; updating of nuclear emergency response plans; preparation and exercising of organizations concerned in nuclear emergency response; provision of material and technical resources required for the performance of nuclear emergency response tasks.

Tasks to be fulfilled in addition to those listed above in alert operating state are: strengthened monitoring; forecasting of unplanned radiation exposure to the population; provision of reliable and timely information to the public on the event occurred and the nation-wide radiological situation; preparation for the commencement of the emergency operation if it becomes necessary.

In emergency operating state, the HNERS performs: the assessment, mitigation and termination of the consequences of the extraordinary event inducing the nuclear emergency; forecasting of the radiological consequences of nuclear accident occurring outside the borders of the country and in the space or of a national situation induced by an event entailing radiation hazard; the determination and implementation of the tasks required by the situation.

In recovery operating state the HNERS informs the organizations contributing to recovery, and provides scientific and technical support to them.

5.1.2 Radiation protection

The National Radiation Monitoring and Alarming System (NRMAS) is operated to provide decision making support to the governmental coordination body. The operation of the NRMAS and the direction of its professional work are performed by the minister responsible for disaster management. The tasks of the NRMAS are as follows:

- monitoring of the radiological situation in the country;
- providing support to alarm and notify according to the operating state of the HNERS;
- providing information to the organizations contributing to the HNERS;
- providing support to measures required for the maintenance of public life and labour conditions, protection of material assets and for emergency response activity;
- presentation of the nation-wide radiological situation, based on the measurement data of the NRMAS remote measuring system, according to the predefined levels;
- unless otherwise prescribed by law, provision of data characterizing the radioactive contamination for the fulfillment of the international notification obligations, based on measurement data of systems operated by HNERS organizations and users of the atomic energy, as well as on the evaluation of the Nuclear Accident Information and Evaluation Centre of the central body of the professional disaster management organization;
- verification of the validity of alert and alarm signals received from the stations of the remote measurement system, investigation of the inducing cause, and preparation of a report on the situation evolved to the leaders of HNERS organizations.

The leading organ of the NRMAS is the Nuclear Accident Information and Evaluation Centre, which performs the central tasks of early forecasting in the case of a nuclear emergency and of the international radiological monitoring data exchange system; additionally it provides contribution to public information, support to decisions made by the governmental coordination organization; forecasts the expected dispersion route of radioactive materials discharged from an event having adverse safety influence; operates the international real-time on-line nuclear emergency decision support system.

A sub-system of the NRMAS consists of the installed automatic remote measurements stations of the Radiological Remote Measurement Network, which is the early alarm system in the case of a nuclear emergency; the system continuously monitors the radiation dose-rate in the county and the more important meteorological parameters. Currently, gamma dose rate measurement data from 132 measuring stations of six sectors are collected in the national radiological monitoring centre. The network of mobile radiological laboratories, meaning the other sub-system of the NRMAS, identifies and analyses the radiation contamination in the case of a nuclear emergency. The third sub-system of the NRMAS is the network of fixed laboratories, which measure the radioactivity of the collected samples (i.e. food, milk, soil, water, etc.). These measurements provide basis for the implementation of long-term protective measures (i.e. grazing ban, limitation of food and water consumption, etc).

5.1.3 Protective actions

Three counties concerned with the Urgent Protection Action Zone that is within the 30 km radius around Paks NPP are: Bács-Kiskun, Fejér and Tolna. They fulfill their response tasks according to their regional and local emergency response plans.

Based on the decision of the County Defence Committees concerned, the settlements having a role in the evacuation and reception of the population prepared, as a part of their emergency response basic plans, the evacuation and reception sub-plans for tasks to be performed in the case of a nuclear emergency. The plan can be implemented to effectively mitigate the consequences of events having hazardous effects on the environment, population and material assets and entailing radioactive material discharges that are induced by an accident at Paks NPP, an accident occurring during the transport of nuclear materials, nuclear power plant accident occurring outside the border or by a failed satellite falling from space.

Iodine prophylaxis

The citizens of the settlements, being within a 30 km radius of Paks NPP, are provided with iodine tablets from the Medical Stock Management Institute. The tablets are stored in the offices of the local governments concerned in Bács-Kiskun and Fejér counties, in addition to those at the family doctors and the duty services of first responder organizations in Tolna county. Following a decision the iodine tablets are distributed in the settlements based on the distribution plans. The disaster management directorate plans, organizes and performs the iodine tablet provision to those working in civil defence organizations and to the disaster management officers.

Evacuation, reception

Only one village having residents of about 140 (i.e. Paks-Csámpapuszta, Tolna county) can be found within a 3 km radius of Paks NPP, which belongs to Paks from a public administration viewpoint. Three meeting points are designated for the evacuation of the population, where the people can be rapidly evacuated by transport vehicles.

The evacuation from 60 settlements being within a 3-30 km radius of Paks NPP in Tolna county concerns about 125,000 people. 26 settlements having a population of about 80,000 are in the 30 km urgent protective action zone of the plant. 8 settlements are concerned in Fejér county; the number of people to be evacuated is about 13,000. The bus service companies are involved in the evacuation process. The pass-through capacity of the routes selected in advance is sufficient for the implementation of the evacuation. The evacuation and reception are directed by the county defence committees. In general, the reception points are designated in the territory of the given county.

Evacuation of the employees of Paks NPP

The evacuation plan of the workers of Paks NPP is included in the General Emergency Response Plan of the plant. According to the plan, the employees should use their own vehicles, the train owned by Paks NPP and the buses put at the disposal of the plant by the regionally competent bus company.

Provision of evacuation equipment to the population

109 meeting points are designated within the 30 km radius of Paks NPP, so in the Urgent Protective Action Zone, where the buses pick up the people to be evacuated, and then transport them to the reception points. Breathing protection tools (protective hoods) required for the rescue and evacuation are available for those living in settlements located in the dispersion route of the radioactive plume; the protective hoods are distributed at the meeting points.

The protective hoods are stored in the settlements' warehouses for those living within a 9 km radius of the plant; the rest of the stock is stored in the county warehouse (outside the 30 km zone); the latter are distributed based on the local effects of the nuclear emergency situation.

Should people living in the settlements located in other sectors need to be provided with protective hoods, the number required exceeding the county stock has to be requested from the central stock.

5.1.4 Information activity

Alerting the population

Within the 30 km radius of Paks NPP, the technical tool of alerting is the installed public information and alerting system. Altogether 227 modern public information and alerting devices alert about 225,000 people living in 74 settlements on 2,800 square kilometers.

The acoustic terminals are powered by uninterruptible power supplies, thus the public can be alerted and informed in the case of loss of the electrical power supply. The high capacity loud speakers, in addition to traditional siren signals, are capable of transmitting voice messages, thus the population can be provided with the essential information by way of a live broadcast.

The control centres of the system are installed at the Protected Command Centre, Plant Control Centre and at the Tolna County Disaster Management Directorate; additionally, a mobile control unit is available. The operability of the sirens is tested by humming signals (i.e. at reduced volume) on the first Monday of each month, and by transmitting full volume emergency hazard and end of emergency signals twice a year.

Altogether 70 sirens are installed in Bács-Kiskun county, which are capable of communicating alarm signals, as well as recorded or live speeches. An additional 11 sirens are installed in seven settlements in Fejér county, and 146 sirens in 40 settlements in Tolna county. Sirens capable of communicating alarm signals, as well as recorded or live speeches are installed in 25 settlements out of 40 in Tolna county within the 30 km radius of the plant.

Public information

As required by Govt. decree 165/2003. (X.18.) Korm. on the rules of public information in the case of a nuclear or radiological emergency, a public information plan shall be prepared at national, sectoral, county and facility level by the central bodies and organizations of the HNERS, as well as by those bodies and organizations that are obliged to prepare Emergency Response Action Plans. The public information plans are to be prepared for providing timely and reliable information to the public; the plans include those available information principles, methods and tools, which can be applied for effective communication. The objective of public information activity is to obtain and maintain public trust, substantiate effective information exchange, protection of the life, health and material assets of the population in the case of an emergency.

The media relationship is essential in every phase (i.e. both in the phase of preparation/prevention and during an emergency). In the prevention phase the fulfillment of the public information tasks requires the establishment of the infrastructure needed for public and media relations at each level of emergency response organizations, the compliance with the related human requirements. The maintenance of the relationship with the media, the regular training of media representatives and their involvement in exercises play an essential role in the phase of preparation; additionally, these are very important steps towards building public trust.

Taking account of the stipulations of the decree on public information, the planning of public information starts with the assessment of the information request at every level. Subsequently, the principal public information elements have to be identified, including:

- actual public groups;
- forms, tools and methods of public communication;
- basic knowledge of the preparation for an emergency;
- detailed description of potential forms of actions during an emergency (information leaflets);
- basic information on radioactivity, its effects on living organisms and the environment;
- potential media relationships (TV, radio, journals), their forms and rules;
- methods of regular preparation and training of media experts;
- subject, objectives and regularity of communication exercises, description of the functional activity.

5.2 Activity of the operator

5.2.a Actions of Paks NPP

In the field of emergency response, the role of the operator is limited to on-site activities. The contribution of the plant to off-site emergency response is the prognosis of the escalation of technology processes.

The relationship between on-site and off-site emergency response systems is adequate; this was demonstrated by several national level exercises.

5.2.b Implementation of planned activities

There is no need for any modification at the plant in the field of preparation for off-site emergency response.

5.2.c Results, additional measures

Subsequent to the completion of the international review, based on their results and after the summarization of the experiences, the plant will implement additional safety improvement measures if appropriate.

5.3 Activity of the regulator

5.3.a Actions of the regulator

The HAEA actively participated in the Targeted Safety Reassessment as described in the above chapters. As lessons learned from the reassessment, the Authority identified several issues; however, neither of these remarks is so critical that require immediate action.

The Hungarian Atomic Energy Authority is the international contact point towards both the IAEA and the EU; additionally, the HAEA fulfils its obligations expected within the HNERS. The Hungarian nuclear emergency response system is established in compliance with the relevant international norms, thus it is adequate even when in international comparison.

The National Nuclear Emergency Response Plan is maintained and regularly updated by the High-level Working Group consisting of representatives of central, sectoral and regional organizations. As a result of the regular revisions, several guidelines and technical aids were prepared during recent years, which can be downloaded from the website of the HAEA. The latest version of the National Nuclear Emergency Response Plan was published in November 2011.

5.3.b Implementation of planned activities

The Targeted Safety Reassessment did not reveal any such deficiency, which requires the modification of the national nuclear emergency response system. Nevertheless, the national collection and utilization of the lessons learned from the Fukushima accident is on the 2012 agenda of the Disaster Management Governmental Coordination Committee.

Hungary intends to further improve the national nuclear emergency response system as well as its own regulatory activity based on the international and national experience obtained from the Fukushima accident. The partial feedback of its own experience was completed during the revision of the regulatory procedures.

5.3.c Results, further actions

After the completion of the international review, based on its results, and after the summarization of its experience, the HAEA will assess the necessity of potential modifications and be ready to execute the appropriate measures in relation to the legal basis or the operation of the nuclear emergency response system.

6. International cooperation

6.1 Overview

Participation in the nuclear safety convention

Hungary was among the first states who signed the Convention on Nuclear Safety; the Convention was ratified in Hungary by Act I of 1997. Hungary has participated in each review conference, its national reports were submitted in due time; Hungary actively participated in the reassessment process and supported the initiative aiming at the revision of the Convention in light of the lessons learned from the Fukushima accident.

Communication with other states

The HAEA keeps close professional links to partner authorities of other states operating VVER type reactors (i.e. Czech Republic, Finland, Slovakia and Russia). Within the frame of conventions on mutual information exchange, Hungary cooperates with the authorities of the Czech Republic, Slovakia, the USA, Russia and Romania. A direct link was established with the German Federal Ministry of Environmental Protection in the frame of a scientific technical cooperation programme. Additionally, bilateral intergovernmental agreements were concluded in the field of safe application of atomic energy, and these agreements are also managed by the HAEA. In order to make these bilateral meetings more effective, the nuclear safety authorities of Czech Republic, Hungary, Slovenia and Slovakia discuss the actual, issues of mutual interest in quadrilateral meetings. Annual expert meetings are held in the frame of the Austrian-Hungarian bilateral agreement on nuclear safety and radiation protection.

Hungary, at an early stage, joined the early notification system of the IAEA and the urgent information exchange system of the EU. Hungary always participates in the fulfillment of tasks under the conventions, including the development, testing, introduction of communication tools, as well as their use in international communication drills having various scopes at various levels. In the frame of the above mentioned bilateral agreements, concluded on the basis of the IAEA convention, Hungary participates in the communication drills of the neighbouring states on mutual basis. The development of communication tools had been started before the Fukushima accident; the IAEA launched the introduction of the USIE website, while the EU worked on the development of WEBECURIE. The USIE website takes over the tasks of recent communication platforms (i.e. fax, ENAC website), while the WEBECURIE will start to operate in 2012 in a way that is compatible with USIE. Hungary was involved in the testing of these systems; currently the USIE system is in use.

International reviews carried out at the Authority

The following international reviews evaluated the activity of the Hungarian Atomic Energy Authority:

- May 21 - June 2, 2000 – IAEA International Regulatory Review Team Peer-review;
- February 9-18, 2003 – Follow-up of IAEA International Regulatory Review Team Peer-review;
- Prior to accession of Hungary to the EU, the HAEA activities in relation to nuclear facilities were assessed by the nuclear safety authorities of certain EU member states (Finland-STUK, Belgium-AVN, Spain-CSN);
- IAEA Safety Review Mission was conducted in relation to the serious incident entailing fuel damage that occurred in 2003;
- February-March, 2012 – In the frame of the European stress test peer review, an expert team of European nuclear safety authorities reviewed the related activity of the HAEA.

International reviews carried out at the operator

Paks Nuclear Power Plant Ltd has paid special attention to international reviews since the start of plant operation. This is reflected in the fact that Paks NPP was a "pioneer" of such review programmes, and it was ready to be first reviewed among the nuclear power plants.

International reviews have always been important and promoting elements of constant endeavours aimed at increasing the safety and improving productivity of the nuclear power plant. The preparation for the reviews obliges the operator to deal comprehensively with the routine practice. The action plans aimed at eliminating deficiencies discovered by way of assessments or known and confirmed by outside experts greatly contribute towards improving power plant processes.

International safety reviews carried out at Paks Nuclear Power Plant

Year	Objective or subject of the review	Reviewer organization
1984 - 1987	Operation, maintenance	Experts invited by the Soviet supplier
1988	OSART (full scope)	IAEA
1990	Operation, maintenance	Experts from 4 countries invited by the power plant
1991	Design for safety	IVO
1991	Post-OSART review	IAEA
1992	Peer Review	WANO
1992	ASSET	IAEA
1993-1996	Site seismicity - 6 occasions; seismic safety programme – 2 occasions	IAEA
1995	Post-ASSET review	IAEA
1995	Peer Review follow-up	WANO
1996	Assessment of the accomplishment of safety improvement measures	IAEA
1997	Nuclear Liability Insurance Engineering Inspection	International experts of the insurance pool
1997	Quality assurance audit	Blayais Nuclear Power Plant
1999	PSA analysis of low power states (IPERS) (VEIKI-Paks NPP joint studies)	IAEA
2000	Pre-OSART mission	IAEA, Paks NPP
2001	OSART mission	IAEA
2001	Nuclear Liability Insurance Engineering Inspection	International experts of the insurance pool
2003	Review of Unit 2 event	IAEA
2003	Review of Unit 2 event	WANO
2003	Expert mission concerning the development of organizational operation	IAEA

Year	Objective or subject of the review	Reviewer organization
2004	Expert mission on organizational development	*IAEA*
2004	Follow-up mission of the serious incident that took place at Unit 2	*WANO*
2005	Follow-up missions of OSART and expert missions	*IAEA*
2005	WANO peer review	*WANO*
2008	Follow-up of peer review	*WANO*
2008	WANO Peer Review follow-up	WANO
2011	Safety Aspects of Long Term Operation (SALTO) Peer Review Mission	IAEA
2012	WANO Peer Review	WANO

In November 1988 was the first OSART that was conducted in a COMECON country operating VVER type reactor. In 2001, at the request of Paks NPP Ltd, the second OSART review was conducted; its objectives were:

- independent assessment and evaluation of the operational practice and safety of Paks NPP reflecting the international good practices;
- conduction of an independent international review that contributes to the judgment process of the accession to the European Union.

The WANO Peer Review also has great importance; it is similar to the IAEA OSART, but it is carried out by experts of the operating companies. Based on the new long term strategy of WANO, WANO Peer Review shall be held in each nuclear power plant every six years. The last WANO review that started in 2011 has not finished by the deadline of the closure of this Extraordinary Report.

In summary, it can be stated that every safety review was concluded with a positive general evaluation; however recommendations and suggestions were formulated on further improvement of safety. The action plans for the implementation of the proposed measures played a relevant role in the improvement of the safety level of the nuclear power plant.

International operational experience and their feedback

Both Paks NPP Ltd and HAEA gather, and systematically assess, the national and international experience. The major sources of international experience are the IRS reports, the clearinghouse reports of the European Commission (quarterly reports, Fukushima reports), the reports of the IAEA and the US NRC, as well as the information provided by OECD NEA Working Groups. The VVER Forum plays a relevant role, where in addition to information exchange with authorities supervising similar nuclear power plant units certain benchmark tests can be performed. An essential part of regulatory supervision is the investigation of events and the review of the operational experience feedback process. The Authority continuously verifies the operational experience feedback system of the operator, including the processing of events, the lessons learned and the status of the implementation of the decided upon corrective measures.

International sharing of own operational experience

The membership principles of the IAEA and the WANO require each nuclear power plant, thus also the Paks NPP, to share its own operational experience with other members of the organizations.

Accordingly the plant prepares reports on each event occurring at the plant, as well as each significant lessons learned, and then submits the reports to the information system of these international organizations, to the event reports databases.

The documents regulating the operation of the event reporting systems of the international organizations (WANO, IAEA IRS) specify the criteria and formal requirements for event reporting.

Accordingly, based on the decision of the manager of the organization responsible for safety and with his/her approval, the company information officer prepares the event reports in English. The event reports are made on the basis of the company level event investigation reports. The WANO event reports are uploaded to the WANO database via its Moscow Centre, while the IAEA IRS reports are submitted, after verification, by the HAEA.

Utilization of the experience of other power plants

Being aware of, and learning from, operational and other experience of other facilities as originated from international information sources is a fundamental interest of Paks NPP.

Paks NPP Ltd, as a member of large international organizations (IAEA, WANO), participates in their programmes supporting continuous information exchange between nuclear power plants.

Paks NPP Ltd operates a well regulated procedure for the processing and utilization of operational experience received through these channels, which clearly defines the responsibilities and tasks of the involved organizations and roles.

The following reports are received by the plant via the electronic (web based) information systems of the IAEA and the WANO: WANO SER (Significant Event Report), SOER (Significant Operating Experience Report), ENR (Event Notification Report), EAR (Event Analysis Report), MER (Miscellaneous Event Report), JIT (Just-In-Time Report) and IAEA IRS (Incident Reporting System). Each report can be accessed on the company portal in its original form, in English. A list including the titles of every report is compiled every month.

In agreement with the WANO requirements, the WANO SER/SOER type reports are always processed and utilized. The Hungarian translation of each such event report is prepared within two weeks after its receipt, and then forwarded to the professional organizational units. The experts processing the reports evaluate the event reports and determine the lessons to be learned, the potential deficiencies of Paks NPP and those specific measures, which are needed to prevent the occurrence of similar events at Paks NPP. An evaluation report is made based on the opinion of professional organizational units, which is discussed at the subsequent meeting of the Operation Review Committee, who make a decision on the implementation of proposed measures, their deadlines and the persons responsible therefore.

The processing of this large number of event reports received via the WANO information channel is commenced by screening. The screened event reports, after their translation into Hungarian, are processed by the competent professional organizational units. The tasks derived from the processing of event reports are uploaded to the task monitoring system of the plant.

In addition to the processing of event reports, the operation of the WANO circular questions is also part of the feedback process of international experience (i.e. answering of questions received, forwarding of own questions towards other nuclear power plants).

The international operational information exchange is supervised by the Operational Review Committee. Annual reports are made on the recently performed activities. The statistics of processed event reports have to be presented in the annual report, as well as the lessons learned from WANO SER/SOER event reports, utilization of WNAO JIT reports, the own event reports submitted to international reporting systems, the participation of plant experts in meetings of international organizations, and the evaluation of the effectiveness of the process.

Adaptation of IAEA safety series

The structure and content of the IAEA Safety Standards, after the publication of the amended Atomic Act, provide a basis for the Hungarian nuclear safety regulations. The most important ones among the IAEA Safety Standards, as listed below, were used during the preparation of the nuclear safety regulations and periodic safety reviews:

- SF-1: Fundamental Safety Principles – the fundamental safety principles are included in the Atomic Act;
- Requirements for siting (NS-R-3) – requirements for the site selection process;
- Management systems (GS-R-3) – nuclear power plant management systems;
- Regulatory framework (GSR Part 1) – regulatory regime;
- Design (NS-R-1) – design requirements;
- Operation (NS-R-2) – operational requirements;
- Decommissioning (WS-R-5) – decommissioning of nuclear facilities.

The requirements of the Western European Regulatory Association (i.e. reference levels) were established based on the IAEA safety standards and guidelines; these levels were taken into account in the Nuclear Safety Code during its revision in 2011.

Several Hungarian regulatory guidelines were prepared taking account of the IAEA guidelines; e.g. the NS-G-2.10, the GS-G-3.1 and the GS-G-3.5 can be highlighted based on their importance.

6.2 Activity of the operator

6.2.a Activity of Paks NPP

Both the Authority and Paks NPP strived for the collection of information on the Fukushima events from every available source; they actively participated in the adaptation of the stress test requirements, wide dispersion of results (i.e. list of requirements, preliminary and final reports) and further utilization of the international experience.
Paks NPP played an active role in the review process, provided significant contribution to the compilation of the National Report, provided support in answering the questions received, as well as it was represented in the review conference.

6.2.b Implementation of planned activities

The effective safety policy of Paks NPP states that the safety shall be regularly re-evaluated, inter alia by independent reviews. Accordingly, the company again invited the WANO Peer Review; its review has not yet finished at the date of the closure of this report.

6.2.c Results, further actions

Paks NPP wishes to utilize the lessons learned from the national reports submitted to the review conference and the experience gained in the conference during the identification of future safety improvement measures; additionally, it strives for sharing its own experience.

6.3 Activity of the regulator

6.3.a Actions of the regulator

Communication with other states

Hungary participated in the testing process of the USIE and WEBECURIE systems; the USIE system has already been operated at the Authority. Based on the lessons learned from the Fukushima accident, several developments are in progress regarding the EURDEP system providing the exchange of environmental radiation data; the developments, in addition to the completion of the scope of data to be exchanged, provide better reliability and more effective access to the member states. Hungary participated in the testing process of newly developed features; its data scope meets the new requirements.

The first meeting of the chairpersons of the Czech, Slovakian, Slovenian and Hungarian regulatory bodies in 2011 was held in Slovenia. The agenda of this meeting included the regulatory tasks derived from the experience of the Fukushima accident.

In 2011, the annual Hungarian-Austrian bilateral meeting was also used to discuss the post Fukushima situation and to share the related experience.

The peer review conducted in the frame of the stress test announced by the European Council became an important forum of the cooperation and communication of European regulators. The Hungarian nuclear safety authority deployed the potentials of this forum, and represented itself in each of the three tracks by delegated experts.

Public information activity

The HAEA continuously informed the public on the evolution of the Fukushima situation; more than 100 publications were released on its website between March 25 and April 21, 2011. These feeds described the evaluation of the Japanese situation, the potential Hungarian effects, the I-131 measurement results, background information, as well as such supporting data that were needed to better understand the information provided. The representatives of the HAEA gave 116 statements at the request of the media and gave answers to 17 public questions. Several statements were given to the media by the experts of the National Frédéric Joliot-Curie Research Institute of Radiobiology and Radiohygiene and the National Directorate General for Disaster Management.

Cooperation with international organizations

On the next day after the high-level conference convened by the European Council to manage the situation after the Fukushima accident, on March 16, 2011, the Hungarian presidency held an extraordinary meeting of the Working Party on Atomic Questions (WPAQ). The one and only point of the meeting agenda was the nuclear emergency induced by the Japanese earthquake and the subsequent tsunami. On the meeting of the WPAQ, the representatives of the European Union member states made a decision on offering and providing help necessary for the Japanese people and the Japanese nuclear sector. The importance of implementing a nuclear safety targeted re-assessment (i.e. stress test) and to develop the potential criteria system in advance were widely accepted by the meeting. The member states agreed that the European Council should be supported by the cumulated knowledge and the recommendations of the ENSREG during the development of the technical criteria. It was obvious that in addition to the implementation of the stress tests on a longer term, the provision of sufficient information to the public is an urgent (and continuous) task to be fulfilled by the member states.

The Ministerial Forum on Nuclear Energy was convened on June 7 in Paris at a French initiative. The Forum aimed at establishing common recommendation as reply to the Fukushima events and making decision on the further improvement of nuclear safety. The minister of national development represented Hungary in the Forum.

The IAEA Ministerial Conference was held in Vienna on June 20-24, 2011. The Conference aimed at comprehensively evaluating the lessons learned from the Fukushima nuclear accident and reviewing the global framework of nuclear safety. The Hungarian delegation, including the director general of the , was led by the minister for national development, who spoke on behalf of Hungary and as the current president of the EU Energy Council at the same time.

The Authority, through its delegates, actively participated in the implementation of the IAEA Action Plan; first of all as a member of the NUSSC and RASSC committees. The most important objective of the action plan is the revision of the IAEA safety standards on reflection of the Fukushima events.

International reviews at the Authority

In the field of nuclear emergency response the HAEA experts participate in the work of the following groups:

- NCACG - National Competent Authority Coordinating Group
- OECD NEA - WPNEM (Working Party on Nuclear Emergency Matters)
- ECURIE - EURDEP Working Group

The above working groups process the lessons learned from the Fukushima accident; the groups initiate or partly have already initiated developments to improve the emergency response capabilities.

Additionally, the Authority is a member of two public information working groups as follows:

NEA Working Group on Public Communication (WGPC)

The working group, after the Fukushima accident, carried out a survey on questions and issues of public information, the implemented or planned actions, and then submitted a report to the NEA CNRA. The WGPC will hold a workshop on crisis communication in May 2012, where the communication lessons learned from the Fukushima accident shall also be discussed.

ENSREG Transparency Working Group (TWG) Task Force on Peer Review Communication

The HAEA participates in the working group that was established by TWG in order to support the communication of the Peer Review Board and to improve the transparency of the process. The Working Group facilitates the efforts aiming at public involvement, the information on the ENSREG website and the organization of public meetings.

6.3.b Implementation of planned activities

The international reviews that are due in the next five years are as follows.

- 2012 – Preparation for International Atomic energy Agency "International Regulatory Review Team" invited for 2015; self assessment and implementation of measures judged to be necessary on the basis thereof, with the application of IRRS "Self-assessment tool" methodology" (The assessment includes the questions related to the Fukushima module).
- 2015 – Hosting the "International Regulatory Review Team" of the International Atomic Energy Agency
- 2017 – Hosting the Follow-up of the "International Regulatory Review Team" assessment

6.3.c Results, further actions

After the completion of the international review, based on its results and after the summarization of its experience, the HAEA will assess whether any additional measures are to be implemented in relation to international cooperation.

Activity Summary Table

Activity	Activities by the Operator			Activities by the Regulator		
	(Item 2.a) Activity - Taken? - Ongoing? - Planned?	(Item 2.b) Schedule Or Milestones for Planned Activities	(Item 2.c) Results Available - Yes? - No?	(Item 3.a) Activity - Taken? - Ongoing? - Planned?	(Item 3.b) Schedule Or Milestones for Planned Activities	(Item 3.c) Conclusion Available - Yes? - No?
Topic 1 – External Events						
It shall be verified whether the hazards of meteorological origin with considerable frequency are documented in the design basis of all systems for each operating mode.	Ongoing (initiated at the last PSR in 2008)	To be completed by the end of 2012. FSAR addition	Yes (Partially)	Planned	Review of updated FSAR	No
Full scope update of strength and static analyses of building structures ensuring protection for building engineering systems (venting, air conditioning, heating), taking into account environmental loads.	Taken	Action Plan June 2012. PSR 2017 the latest	Yes (Partially)	Planned	Inspection of necessary strengthen-ing	No
Performance of seismic protection qualification and, if necessary, implementation of reinforcement according to section 2.1 of Regulatory Resolution HA5444.	Ongoing	Action Plan June 2012. PSR 2017 the latest	Yes (Partially)	Taken: Reg.decision HA5444/ #2.1	Review of Action Plan June 2012. Review of PSR	No

Supplementary assessments to determine more accurately the building settlement following an earthquake.	Ongoing	Action Plan June 2012. PSR 2017 the latest	Yes (Partially)	Taken: Reg.decision HA5444/ #2.2	Review of Action Plan June 2012. Review of PSR	No
Seismic protection of machine racks and travelling water band screens providing Danube water meaning the ultimate heat sink function.	Ongoing	Action Plan June 2012.	No	Taken: Reg.decision HA5444/ #1.2.1	Review of Action Plan June 2012.	No
Improvement of flooding protection of certain process buildings.	Ongoing	Action Plan June 2012.	No	Taken: Reg.decision HA5444/ #2.3	Review of Action Plan June 2012.	No
Probability analysis based limitation of the operating mode of the closed reactor under 150 °C	Planned	Action Plan June 2012.	No	Taken: Reg.decision HA5444/ #1.2.4	Review of Action Plan June 2012.	No
Topic 2 – Design Issues						
Seismic qualification of the buildings housing the systems of electric power supply, diesel generators and battery sets.	Taken	---	Yes	Taken	---	Yes
Seismic reinforcement of the buildings housing the systems of electric power supply, diesel generators and battery sets, if necessary.	Taken	---	Yes	Taken	---	Yes
Qualification and reinforcement of essential service water system components for earthquake.	Taken	---	Yes	Taken	---	Yes
Qualification and reinforcement of spent fuel pool cooling circuit for earthquake, provision of borating.	Ongoing Taken Unit-1	2012-2014 Unit 2-4	Yes (partially)	Taken: Reg.decision HA5444/ #2.11	---	Yes

Vibration table testing of operability of electric devices to verify electromechanical contacts	Taken	---	Yes	Taken	---	Yes
Alternate cooling of diesel generators from fire water system	Planned	Action Plan June 2012.	Yes (partially)	Taken: Reg.decision HA5444/ #2.15	Review of Action Plan June 2012.	No
Increase of fuel stored for diesel generators	Ongoing	Action Plan June 2012.	Yes (partially)	Planned (needs license)	Review of Action Plan June 2012.	Needs fire safety analysis
Establishment of the possibility to create cross-connection between the essential electric systems of the various units	Ongoing	Action Plan June 2012.	Yes (partially)	Taken: Reg.decision HA5444/ #2.7	Review of Action Plan June 2012 + further licensing	No
Further development and improvement of reliability of external electric power supply at 120 kV and 400 kV	Ongoing	Action Plan June 2012.	Yes (partially)	Taken: Reg.decision HA5444/ #2.1- #2.6	Review of Action Plan June 2012.	Yes (partially)
Installation of independent diesel generators (~2-3 MWe) to supply alternate electric power (for each unit)	Planned	Action Plan June 2012.	No	Planned	---	No
Installation of alternate electric power supply for the screening of essential service water	Ongoing	Action Plan June 2012.	Yes (partially)	Taken: Reg.decision HA5444/ #2.8	Review of Action Plan June 2012.	No
Increase of stored amount of cooling water	Ongoing	Action Plan June 2012.	Yes (partially)	Planned (may need	Review of Action Plan	No

				license)	June 2012.	
Development of technical conditions and electric power supply to use new water resources and wells for cooling	Ongoing	Action Plan June 2012.	Yes (partially)	Taken: Reg.decision HA5444/ #2.9, #2.12	Review of Action Plan June 2012.	No
Implementation of possibility of cross-connection of component cooling water systems and fire water systems	Ongoing	Action Plan June 2012.	Yes (partially)	Taken: Reg.decision HA5444/ #2.9	Review of Action Plan June 2012 + further licensing	No
Topic 3 – Severe Accident Management and Recovery On-Site						
Implementation of severe accident management modifications • external cooling of reactor pressure vessel • hydrogen management by autocatalytic recombiners • prevention of loss of coolant of spent fuel pool (see at Topic-2, too) • installation of a severe accident measurement system • severe accident diesel generators for each unit (100 kWe)	**Ongoing** Taken Unit-1 Taken all Taken Unit-1 Taken Unit-1 Taken all	2012-2014 Unit 2-4	Yes (partially)	Taken Reg.decision HA5444 + Planned (if needs license)	Inspections + further licensing	Yes (partially)
Introduction of Severe Accident Management Guidelines (pressure decrease, maintenance of containment function)	Ongoing Taken Unit-1	2012-2014 Unit 2-4	Yes (partially)	Taken: Reg.decision HA5444/ #2.4	Inspections	Yes
Application of direct emergency guidelines (decrease of releases)	Ongoing Taken Unit-1	2012-2014 Unit 2-4	Yes (partially)	Taken: Reg.decision HA5444/ #2.4	Inspections	Yes

Review of Symptom-based Emergency Operating Procedures	Ongoing	Action Plan June 2012.	Yes (partially)	Taken: Reg.decision HA5444/ #2.4	Inspections	Yes
Further development and improvement of reliability of external electric power supplies at 120 kV and 400 kV (see at Topic-2, too)	Ongoing	Action Plan June 2012.	Yes (partially)	Taken: Reg.decision HA5444/ #2.1- #2.6	Review of Action Plan June 2012.	Yes (partially)
Establishment of the possibility to create cross-connection between the essential electric systems of the various units (see at Topic-2, too)	Ongoing	Action Plan June 2012.	Yes (partially)	Taken: Reg.decision HA5444/ #2.7	Review of Action Plan June 2012 + further licensing	No
Installation of alternate electric power supply for the screening of essential service water (see at Topic -2, too)	Ongoing	Action Plan June 2012.	Yes (partially)	Taken: Reg.decision HA5444/ #2.8	Review of Action Plan June 2012	No
Implementation of possibility of cross-connection of component cooling water systems and fire water systems (see at Topic-2, too)	Ongoing	Action Plan June 2012.	Yes (partially)	Taken: Reg.decision HA5444/ #2.9	Review of Action Plan June 2012 + further licensing	No
Application of the method of external cooling water supply to the containment	Ongoing	Action Plan June 2012.	No	Taken: Reg.decision HA5444/ #2.10	Review of Action Plan June 2012	No

Qualification and reinforcement of spent fuel pool cooling circuit for earthquake, provision of borating (see at Topic-2, too)	Ongoing Taken Unit-1	2012-2014 Unit 2-4	Yes (partially)	Taken: Reg.decision HA5444/ #2.11	Inspections	Yes
Development of technical conditions and electric power supply to use new water resources, wells for cooling (see at Topic-2, too)	Ongoing	Action Plan June 2012.	Yes (partially)	Taken: Reg.decision HA5444/ #2.9, #2.12	Review of Action Plan June 2012.	No
The water reserves of 2x2000 m^3 available in the discharge water canal shall be made accessible for the fire water pump station	Ongoing	Action Plan June 2012.	No	Taken: Reg.decision HA5444/ #2.13	Review of Action Plan June 2012.	No
Topic 4 – National Organizations						
European stress test - Targeted Safety Reassessment	Taken	2011	Yes	Taken: Review	2011	Yes
European stress test - International Peer Review	Taken: ENSREG Peer Review	2012	Yes	Planned IAEA IRRS	2015	No
Organizational changes	Not planned	---	---	Not planned now, but IRRS in 2015 may have suggestions	---	No
Topic 5 - Emergency Preparedness and Response and Post-Accident Management (Off-Site)						
Forecast as required for the accident management procedures	Taken	When needed	Yes	Taken	When needed	Yes

Topic 6 - International Cooperation						
International reviews (see at Topic-4, too)	Planned: WANO	Febr. 2012	Yes	Planned: IAEA IRRS follow up	2017	No
Introduction of the USIE system	---	---	---	Taken	2011	Yes
Annual meetings of the Czech, Slovakian, Slovenian and Hungarian chief regulators	---	---	---	Taken	every year	Yes
Austrian-Hungarian bilateral consultations	---	---	---	Taken	every year	Yes
Participation in the activity of international organizations • IAEA NUSSC, RASSC • ENSREG • EU Working Party on Atomic Questions • ECURIE - EURDEP Working Group • OECD NEA - Working Party on Nuclear Emergency Matters				Taken	regularly	Yes