PERSPEKTIVEN FÜR UMWELT & GESELLSCHAFT umweltbundesamt

Expert Opinion on Environmental Impact Assessment Report NPP PAKS II

MINISTERIUM FÜR EIN LEBENSWERTES ÖSTERREICH

enco
Provider of independent Nuclear Safety expertise

ENVIRONMENT AGENCY AUSTRIA umweltbundesamt

EXPERT STATEMENT ON THE ENVIRONMENTAL IMPACT STUDY ON NPP PAKS II

ENCO

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Project management

Franz Meister, Umweltbundesamt

Prepared/Revised by

O. Velicu, ENCO

T. Szikszai, ENCO

Reviewed by

I. Svyetlov, ENCO

Approved by

B. Tomic, ENCO

Layout and typesetting

Elisabeth Riss, Umweltbundesamt

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EXECUTIVE SUMMARY

Introduction

In the district of Tolna, close to the city of Paks, approximately 100 km south of Budapest, the only Hungarian Nuclear Power Plant (Paks NPP) is located on the right bank on the Danube. On the site of Paks NPP, two additional reactor units are planned to be built, which would generate 1,200 MWe each, for 60 years. The commercial operation of the new units is scheduled for 2025 and 2030 respectively.

In March 2013 the Republic of Hungary notified Austria in line with Article 7 of the Directive 2011/92/EU and Article 3 of the Espoo Convention on transboundary environmental impact assessment (Espoo Convention) the intent of constructing two new reactors at the Paks site ("Paks II"). The competent Hungarian authority is Dél-dunántúli Környezetvédelmi, Természetvédelmi és Vízügyi Felügyelőség (Authority for the Protection of the Environment, Nature and Water Management of South Danubia).

The Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW) replied that the Republic of Austria will take part in the transboundary Environmental Impact Assessment (EIA) since the proposed project could have significant transboundary impacts.

Within the EIA, a Scoping Report was prepared in order to identify which data the project applicant – MVM Hungarian Electricity Group – needs to present in the next step of the EIA procedure, the Environmental Impact Study (EIS). MVM Hungarian Electricity Group commissioned the PÖYRY ERÖTERV plc. and subcontractors to prepare the Scoping Report. The Scoping Report was made publicly available in Austria. The comments received including an Expert Statement which was commissioned by the Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW) and several provinces was sent to Hungary for further consideration.

This Expert Statement assessed the EIA Scoping Report presented by the Hungarian side, in order to evaluate whether the content suggested by the EIA Scoping Report for the Environmental Impact Assessment (EIA) is sufficient to determine the safety of the project and the potential risk for Austria. The topics required for the Environmental Impact Study for the project were submitted to the Hungarian side, in order to be considered for the development of the EIS,

In April 2015 Hungary submitted the Environmental Impact Study (EIS), which was prepared in order to identify and evaluate the impact of the planned nuclear power plant technology on the environment. The Study was prepared by MVM ERBE ENERGETIKA Engineering Company Limited by Shares and its subcontractors, for the project company MVM Paks II. Zrt.

ENCONET Consulting Ges.m.b.H. was commissioned to prepare an Expert Statement on the assessment of the EIS presented by the Hungarian side. The objective of the assessment was to investigate whether the information presented in the EIS are reliable and sufficient to determine the safety of the proposed project and the potential risks for Austria, as well as to review if and to which extent the Austrian Expert Statement assessing the EIA Scoping Report has been considered. The present Expert Statement on the Environmental Impact Study presents the results of the assessment of the EIS submitted by the project developer to the authority. This Study has to be in conformity with the technical requirements based on the EU EIA Directive. Due to the technical nature of the project, the EIS has to present aspects related to nuclear safety too. This Expert Statement on EIS contains the topics to be considered in future bilateral consultations within the Espoo procedure, with a view to enable the formulation of well-founded recommendations to minimize potential adverse transboundary impacts.

Environmental Impact Study

The alternatives to the Paks II development project are not presented in the EIS, neither regarding alternative reactor designs, as contained in the Scoping Report, or regarding non-nuclear alternatives. According to the information given in the EIS Study, from the versions taken into consideration in the Scoping Report, the Russian NPP technology was selected. The Hungarian Government already signed an agreement with the Government of the Russian Federation for the construction of two VVER-1200 units at Paks. There is no indication on the reasons for this selection, as requested by the EIA Directive (art.5 paragraph 3(d)). Therefore, it is recommended to clarify during the bilateral consultations the following aspects:

a) How this selection was done and in particular if the environmental impact aspects were considered;
b) Why has the bidding procedure been cancelled.

The content of the EIS was found only partially in line with the EIA Directive general requirements and IAEA specific recommendations for the content of EIA reports[1] for new NPP. Therefore, it is recommended to consider the following aspects for the bilateral consultations:

c) A detailed presentation of how the nuclear safety requirements are going to be implemented during the design, construction and operation of Paks II;
d) The cumulative impact of all nuclear installations existing at the site and planned to be built on the site, not only for normal operation, but also for accident conditions, including the impact of one installation on the others, and the cumulative impact of accidents affecting more than one unit in the same time;
e) Consideration of beyond design basis accidents (including severe accidents) for estimation of all possible impact factors in accident conditions;
f) Necessary preventive and mitigation measures;
g) Justification of the selection of a 30 km radius area for the general surveys and of the purpose of the “deliveries area” indicated in Table 1.3.2-2 (section 1.3.2.3).

In addition to these, it is suggested to address also the following issues, although they are not important from a transboundary point of view:

h) The radiological impact on the workers;
i) Impacts on soil, landscape, cultural values and traffic.

[1] IAEA (2014b): Managing Environmental Impact Assessment for Construction and Operation in New Nuclear Power Programmes.

The description of the environmental radioactivity monitoring performed by Paks NPP was found fully in line with the relevant international standards and recommendations and in full compliance with the EC requirements and recommendations. The doses to the members of the critical group due to the operation of Paks NPP reported in the EIS were found in compliance with the doses calculated by EC based on the radioactive discharge data reported by Paks NPP. Also, following the verification performed in 2004 EC concluded that "*the facilities necessary to carry out continuous monitoring of levels of radioactivity in the air, water and soil around the Paks site are adequate*". Having in mind that the most significant impact that a NPP might have on the environment is the radiological one, and this is usually quantified through monitoring the radioactivity levels in environmental samples, based on these findings it can be stated that, if Paks II will be operated by Paks NPP operator, there are reasons to believe that the new plant will be operated safely.

j) However, this aspect needs to be clarified during the bilateral consultations, since there is no information in EIS regarding the future operator of the plant;

k) In addition to this, it is suggested to correct the 90 Sv value of the dose constraint indicated in section 4.4.2.3 (page 97).

Consideration of Austrian comments to EIA Scoping Document

The findings of the evaluation of the EIS show that: 3 direct answers were provided in the International Chapter, while 18 of them were considered by including the requested information in EIS. 7 questions were not considered, while another 7 are not applicable anymore (since part of them were related with the selection of the reactor type which was already done, and the rest were related with the costs which are not considered in EIS, as it is clearly stated in section 1.3.2.3). 2 questions were only partially answered. From the questions not considered, or inadequately/incompletely answered, the following ones should be followed up during the bilateral consultations:

a) The indication of the reference plant and its certification;

b) A detailed description of the measures for control of severe accidents and the mitigation of accident consequences;

c) Results of PSA, if available – although a negative answer is already included in the International Chapter;

d) Information about the status of implementation of stress test recommendations for Paks II.

Nuclear safety aspects

Selected nuclear technology

The project developer claims that the selected technology corresponds to the requirements of a Generation 3+ state-of-the-art NPP design. However, one of the specific safety features of the selected units (namely, the emergency heat removal spray pools) does not appear to be included in Chapter 6 of the EIS.

a) Therefore, it is suggested to clarify, during the bilateral consultation, if this is just an omission, or – if not – what is the reason that this safety feature is not included.

Transboundary impact

Regarding the transboundary impact assessment presented in the International Chapter, this was found incomplete. In case of incidents or accidents occurring at Paks site, the Austrian state territory could be affected as a result of an airborne release of radioactive substances. Therefore, a detailed identification and evaluation of all possible incidents and accidents which may occur at Paks site is of great importance for the EIA procedure. Due to the proximity to the Austrian state territory and to the level of the radioactive inventory, the existing as well as the planned nuclear power plants possess a potential threat. Even if the probability for Beyond Design Basis Accidents is very low, they should be assessed in the framework of the EIA procedure very carefully. For the assessment of a potential impact on Austria, the evaluation of possibly severe accidents including the maximum source term and the most unfavourable weather conditions, which could lead to radioactive fall outs on Austrian territory are of highest interest.

Therefore, the following clarifications and additional information are recommended to be addressed during the bilateral consultations and/or under the nuclear licensing procedure:

b) More information and, if available, documented proofs of the validation of the TREX (Euler-model) code used for modelling of the dispersion of accidental airborne releases;
c) Clarification of the information presented in Tables 2 and 3 (columns “1 day”, “10 day”, “30 days” for DEC1 and respectively “0-1 days”, “1-7 days”, “7-30 days” for DEC2) in section 2.3.5 of the International Chapter;
d) Calculation and presentation of the doses on all exposure pathways, as well as of total doses;
e) Clarification of the scope of the revision of the Hungarian NSR, and in particular if this revision will also include the modification of the requirement to analyze only design base accidents for the purposes of environmental impact assessment in accident conditions.

Radioactive waste and spent fuel

The activities foreseen for the management of radioactive waste (RW) and spent fuel (SF) at Paks II are generally in line with the international standards and practices, but the impact of RW and SF generation and in particular of the planned management operations to be performed at Paks II are insufficiently analysed. Therefore, the following clarifications and additional information are recommended to be addressed during the bilateral consultations:

a) It is not clear if a national strategy and/or program for the management of RW and SF do exist in Hungary, as requested by the Council Directive 2011/70/EURATOM establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste;
b) To specify who is the owner of the prime responsibility for the safe management of RW and SF according to the Hungarian legislation;
c) During the construction of Paks II, no RW or SF will be generated; however, the already existing RW and SF stored on Paks NPP site should be considered;

d) Presentation of the total estimated quantities of RW and SF at the site, when all units will be in operation, and of the existing quantities on Paks NPP site;

e) Interim storage of High Level Waste (other than SF) inside the auxiliary building is improper; therefore, it is necessary to clarify how the removal of residual heat will be ensured;

f) The impact of RW and SF management operations planned to be performed at Paks II during normal operation was evaluated based on engineering judgement only; doses to the workers and members of the public due to these operations, based on the quantities and characteristics of the RW and SF which will be generated by Paks II should to be calculated;

g) Generation of RW and SF following severe accidents (and not only design-basis accidents) should be estimated and presented;

h) Accidents affecting the RW and in particular SF management facilities to be established on Paks II site should also be evaluated and their impact on the environment considered;

i) To clarify the information given in section 8.1.2.1.5 in relation with the temporary storage of spent fuel on site for several decades “perhaps even beyond the plant’s operation time” which contradicts the information given in Chapter 19;

j) It is suggested to replace all the references to the IAEA Safety Series No.115 in Chapter 19 with references to Directive 96/29/Euratom and to correct the information relative to international and EU legislation given in section 19.1.

ZUSAMMENFASSUNG

Einführung

Im Bezirk Tolna, in der Nähe der Stadt Paks, etwa 100 km südlich von Budapest, befindet sich auf dem rechten Ufer der Donau das einzige ungarische Kernkraftwerk (KKW Paks). Auf dem Betriebsgelände des KKW Paks ist der Bau von zwei zusätzlichen Reaktoreinheiten geplant, die 60 Jahre lang jeweils 1.200 MWe erzeugen sollen. Der kommerzielle Betrieb der neuen Einheiten ist ab 2025 beziehungsweise 2030 geplant.

Im März 2013 hat die Republik Ungarn gemäß Art. 7 der Richtlinie 2011/92/EU bzw. Art. 3 der Espoo-Konvention über die grenzüberschreitende Umweltverträglichkeitsprüfung (ESPOO-KONVENTION 1991) das Vorhaben der Errichtung von zwei neuen Reaktoren am Standort Paks („Paks II“) an Österreich notifiziert. Zuständige ungarische UVP Behörde ist Dél-dunántúli Környezetvédelmi, Természetvédelmi és Vízügyi Felügyelőség (Aufsichtsbehörde für Umweltschutz, Naturschutz und Wasserwirtschaft Süd-Transdanubien).

Das Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft (BMLFUW) hat erklärt, dass die Republik Österreich aufgrund möglicher erheblicher grenzüberschreitender Auswirkungen des Vorhabens auf seine Umwelt an einem grenzüberschreitenden Umweltverträglichkeitsprüfungsverfahren (UVP-Verfahren) teilnimmt.

Innerhalb der UVP wurde ein Scoping-Bericht erstellt, um festzustellen, welche Daten der Antragsteller – die MVM Ungarische Elektrizitätswerke AG – im nächsten Schritt des UVP-Verfahrens, der Umweltverträglichkeitsstudie (UVS), vorzulegen hat. Die MVM Ungarische Elektrizitätswerke AG beauftragten die PÖYRY ERÖTERV AG und deren Subunternehmer mit der Erstellung des Scoping-Berichts. Der Scoping-Bericht wurde in Österreich der Öffentlichkeit zugänglich gemacht. Die eingegangenen Stellungnahmen, einschließlich einer vom Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft (BMLFUW) und mehreren Landesregierungen in Auftrag gegebenen Fachstellungnahme, wurden zur weiteren Berücksichtigung nach Ungarn gesandt.

Diese Fachstellungnahme bewertete den von ungarischer Seite vorgelegten UVP-Scoping-Bericht dahingehend, ob der im UVP Scoping-Bericht für die Umweltverträglichkeitsprüfung (UVP) vorgeschlagene Inhalt ausreicht, um die Sicherheit des Vorhabens und das potenzielle Risiko für Österreich zu bewerten.

Die für die Umweltverträglichkeitsstudie des Projektes erforderlichen Themen wurden der ungarischen Seite zur Berücksichtigung bei der Entwicklung der UVS übermittelt.

Im April 2015 hat Ungarn die Umweltverträglichkeitsstudie (UVS) vorgelegt, die zur Identifikation und Bewertung der Auswirkungen der geplanten Kernkraftwerks-Technologie auf die Umwelt erstellt wurde. Die Studie wurde von MVM ERBE ENERGETIKA Engineering Co., Ltd und deren Zulieferern für die Projektgesellschaft MVM Paks II. Zrt. erstellt.

Die Enconet Consulting Ges.m.b.H. wurde beauftragt, eine Fachstellungnahme zur Bewertung der von der ungarischen Seite vorgelegten UVS zu erstellen. Das Ziel der Bewertung war es zu untersuchen, ob die in der UVS enthaltenen Informationen zuverlässig und ausreichend sind, um die Sicherheit des beabsichtigten Projekts und die möglichen Risiken für Österreich zu beurteilen, und auch um festzustellen, ob und in welchem Ausmaß die österreichische Fachstellungnahme zum UVP Scoping-Bericht berücksichtigt wurde. Die vorliegende Fachstellungnahme präsentiert die Ergebnisse der Bewertung der durch den Projektentwickler bei der Behörde eingereichten UVS. Diese Studie muss in Übereinstimmung mit den technischen Vorschriften auf Grundlage der EU-UVP-Richtlinie sein. Aufgrund der technischen Natur des Projekts hat die UVS auch Aspekte mit Bezug auf nukleare Sicherheit zu präsentieren. Diese Fachstellungnahme zur UVS enthält jene Themen, die in künftigen bilateralen Konsultationen im Espoo-Verfahren berücksichtigt werden sollen, mit dem Augenmerk auf die Formulierung fundierter Empfehlungen zur Minimierung möglicher nachteiliger grenzüberschreitender Auswirkungen.

Umweltverträglichkeitsstudie (UVS)

Es werden in der UVS keine Alternativen zum Paks II Entwicklungsprojekt vorgestellt, weder in Hinblick auf alternative Reaktortypen, wie sie im Scoping-Bericht enthalten sind, noch in Hinblick auf nicht-nukleare Alternativen. Nach den Angaben in der UVS, und nach den Versionen, die im Scoping-Bericht in Betracht gezogen wurden, wurde die russische KKW-Technologie gewählt. Die ungarische Regierung hat bereits ein Abkommen mit der Regierung der Russischen Föderation für den Bau von zwei WWER-1200-Einheiten in Paks unterzeichnet. Es gibt keinen Hinweis auf die Gründe für diese Wahl, wie dies in der UVP-Richtlinie (Artikel 5 Absatz 3 (d)) gefordert wird. Daher wird empfohlen, in den bilateralen Konsultationen folgende Punkte zu klären:

a) Wie wurde diese Wahl getroffen, und wurde insbesondere der Aspekt eventueller Umweltauswirkungen berücksichtigt;
b) Warum wurde das Bieterverfahren abgebrochen.

Es wurde festgestellt, dass der Inhalt der UVS sich nur teilweise mit den allgemeinen Anforderungen der UVP-Richtlinie und der IAEO-spezifischen Empfehlungen[2] für den Inhalt von UVP Berichten für neue KKW übereinstimmt. Daher wird empfohlen, bei den bilateralen Konsultationen auch die folgenden Aspekte zu berücksichtigen:

c) Eine detaillierte Darstellung, wie die nuklearen Sicherheitsanforderungen beim Design, der Planung, dem Bau und dem Betrieb von Paks II umgesetzt werden;
d) Die kumulative Wirkung aller am Betriebsgelände vorhandenen und geplanten Kernanlagen, nicht nur für den Normalbetrieb, sondern auch unter Störfallbedingungen, einschließlich der Auswirkungen einer jeden Installation auf alle anderen, und die kumulative Wirkung von Unfällen die mehr als eine Einheit zugleich betreffen;
e) Die Berücksichtigung von auslegungsüberschreitenden Unfällen (einschließlich schwerer Unfälle) zur Abschätzung aller möglichen Einflussfaktoren unter Unfallbedingungen;
f) Die erforderlichen Vorsorge- und Minderungsmaßnahmen;

[2] IAEA (2014b): Managing Environmental Impact Assessment for Construction and Operation in New Nuclear Power Programmes.

g) Die Begründung für die Auswahl eines Bereiches mit 30 km Radius für die allgemeine Überprüfung und den Zweck der "deliveries area" in der Tabelle 1.3.2-2 (Abschnitt 1.3.2.3).

Zusätzlich zu diesen Punkten wird vorgeschlagen, auch folgende Themen zu behandeln, obwohl sie aus grenzüberschreitender Sicht nicht bedeutsam sind:

h) Die radiologischen Auswirkungen auf die Arbeiter;
i) Die Auswirkungen auf Boden, Landschaft, Kulturgüter und Verkehr.

Die Beschreibung der vom KKW Paks durchgeführten Überwachung der Umweltradioaktivität steht völlig im Einklang mit den einschlägigen internationalen Normen und Empfehlungen und stimmt mit den EU-Anforderungen und Empfehlungen vollständig überein. Die Dosen an die Mitglieder der kritischen Gruppe durch den Betrieb des KKW Paks, die in der UVS angegeben werden, stehen in Übereinstimmung mit jenen Werten, die von der EU basierend auf den Daten über radioaktive Freisetzung durch das KKW Paks berechnet wurden. Auch hat die EU nach der im Jahr 2004 durchgeführten Überprüfung festgestellt, dass „die notwendigen Einrichtungen zur ständigen Überwachung der Radioaktivitätswerte in Luft, Wasser und Boden rund um den Standort Paks angemessen sind“. In Anbetracht der Tatsache, dass die größten Auswirkungen, die ein KKW auf die Umwelt haben könnte, radiologischer Natur sind, und diese in der Regel durch Überwachung der Radioaktivität in Umweltproben quantifiziert werden, kann basierend auf diesen Ergebnissen festgestellt werden, dass, wenn Paks II vom Betreiber des KKW Paks betrieben wird, es Grund zur Annahme gibt, dass die neue Anlage sicher betrieben werden kann.

j) Allerdings muss dieser Aspekt in den bilateralen Konsultationen geklärt werden, da es in der UVS keine Angaben in Bezug auf den künftigen Betreiber der Anlage gibt.
k) Darüber hinaus wird vorgeschlagen, den 90 Sv Wert der Dosisbeschränkung in Abschnitt 4.4.2.3 (Seite 97) zu korrigieren.

Berücksichtigung der österreichischen Kommentare zum UVP Scoping-Bericht

Die Ergebnisse der Auswertung der UVS zeigen folgendes: 3 direkte Antworten wurden in dem Internationalen Kapitel gegeben, während 18 Fragen berücksichtigt wurden, indem die erforderlichen Informationen in der UVS aufscheinen. 7 Fragen wurden nicht berücksichtigt, während weitere 7 nicht mehr zutreffend sind (da ein Teil von ihnen sich auf die Auswahl des Reaktortyps bezogen, die bereits erfolgt ist, und die übrigen in Zusammenhang mit den Kosten standen, die nicht in der UVS betrachtet werden, wie in Abschnitt 1.3.2.3 eindeutig festgestellt wird). 2 Fragen wurden nur teilweise beantwortet. Aus den Fragen die nicht berücksichtigt oder unzureichend/unvollständig beantwortet wurden, sollten die folgenden in den bilateralen Konsultationen verfolgt werden:

a) Die Angabe der Referenzanlage und deren Zertifizierung;
b) Eine detaillierte Beschreibung der Maßnahmen zur Beherrschung schwerer Unfälle und zur Minderung von Unfallfolgen;
c) Die Ergebnisse der probabilistischen Sicherheitsbewertung, soweit verfügbar – obwohl eine negative Antwort bereits im Internationalen Kapitel enthalten ist;
d) Informationen über den Stand der Umsetzung der Stresstest-Empfehlungen für Paks II.

Nukleare Sicherheitsaspekte

Ausgewählte Kerntechnologie

Der Projektentwickler behauptet, dass die gewählte Technologie den Anforderungen eines Generation 3+ state-of-the-art-KKW-Designs entspricht. Doch eines der besonderen Sicherheitsmerkmale der ausgewählten Einheiten (nämlich die Notfallwärmeabfuhr-Sprühbecken) scheint nicht in Kapitel 6 der UVS enthalten zu sein.

a) Daher wird vorgeschlagen, während der bilateralen Beratungen zu klären, ob dies nur ein Versehen ist oder – falls nicht – was der Grund dafür ist, dass diese Sicherheitsfunktion nicht enthalten ist.

Grenzüberschreitende Auswirkungen

Die Abschätzung grenzüberschreitender Folgen im Internationalen Kapitel wird für unvollständig befunden. Im Falle von Ereignissen oder Unfällen, die am Standort von Paks auftreten, könnte das österreichische Staatsgebiet infolge einer Freisetzung radioaktiver Stoffe in die Luft betroffen sein. Daher ist eine detaillierte Ermittlung und Bewertung aller möglichen Zwischenfälle und Unfälle, die am Standort Paks auftreten können, von großer Bedeutung für das UVP-Verfahren. Aufgrund der Nähe zum österreichischen Staatsgebiet und des Ausmaßes des radioaktiven Inventars stellen die bestehenden sowie die geplanten Kernkraftwerke eine potenzielle Gefährdung dar. Auch wenn die Wahrscheinlichkeit für auslegungsüberschreitende Unfälle sehr niedrig ist, sollten sie im Rahmen des UVP-Verfahrens sehr sorgfältig untersucht werden. Für die Beurteilung von möglichen Auswirkungen auf Österreich ist die Bewertung von möglichen schweren Unfällen, einschließlich eines maximalen Quellterms und der ungünstigsten Wetterbedingungen, die zu radioaktiven Fallouts auf österreichischem Gebiet führen könnten, von höchstem Interesse.

Daher wird empfohlen, die folgenden Klarstellungen und zusätzlichen Informationen während der bilateralen Konsultationen und/oder unter dem atomrechtlichen Genehmigungsverfahren anzusprechen:

b) Weitere Informationen über, und falls vorhanden, dokumentierte Beweise für die Validierung des TREX (Euler-Modell) Codes, der für die Modellierung der Verteilung der zufälligen Emissionen in die Luft verwendet wurde;

c) Erklärung der in den Tabellen 2 und 3 präsentierten Informationen (Spalten „1 Tag“, „10 Tage“, „30 Tage“ für DEC1 bzw. „0–1 Tage“, „1–7 Tage“, „7–30 Tage“ für DEC2) in Abschnitt 2.3.5 des Internationalen Kapitels;

d) Berechnung und Darstellung der Dosen für alle Expositionswege sowie der Gesamtdosen;

Eine Klarstellung des Umfangs der Revision der ungarischen NSR, insbesondere ob diese Revision auch eine Änderung der Anforderungen enthält, nur Auslegungsstörfälle für die Zwecke der Umweltverträglichkeitsprüfung unter Unfallbedingungen zu betrachten;

Radioaktive Abfälle und abgebrannte Brennelemente

Die für die Entsorgung radioaktiver Abfälle (RA) und abgebrannter Brennelemente (AB) in Paks II vorgesehenen Aktivitäten stehen generell in Einklang mit den internationalen Normen und Praktiken. Jedoch sind aber die Auswirkungen der Erzeugung von RA und AB, und insbesondere der geplanten Verwaltungsvorgänge die bei Paks II durchgeführt werden sollen, nicht ausreichend untersucht. Daher wird empfohlen, die folgenden Klarstellungen und zusätzlichen Informationen in den bilateralen Konsultationen anzusprechen:

a) Es ist nicht klar, ob eine nationale Strategie und/oder ein Programm für die Behandlung von RA und AB in Ungarn besteht, wie sie in der Richtlinie 2011/70/EURATOM über die Errichtung eines Gemeinschaftsrahmens für die verantwortungsvolle und sichere Entsorgung abgebrannter Brennelemente und radioaktiver Abfälle gefordert wird;

b) Es ist anzugeben, wer nach den ungarischen Rechtsvorschriften hauptverantwortlich für die sichere Entsorgung von RA und AB ist;

c) Während der Errichtung von Paks II werden keine RA oder AB erzeugt; jedoch sollten die bereits auf dem Gelände des Paks KKW vorhandenen RA und AB betrachtet werden;

d) Die Angabe der geschätzten Gesamtmengen von RA und AB auf dem Gelände, wenn alle Einheiten in Betrieb sind, und die bereits auf dem Gelände des KKW Paks vorhandenen Mengen;

e) Die Zwischenlagerung hochaktiver Abfälle (außer AB) in Nebengebäuden ist unzulässig; daher ist es notwendig zu klären, wie die Ableitung von Restwärme gewährleistet werden kann;

f) Die Auswirkungen von RA und AB-Management-Vorgängen, die in Paks II im Normalbetrieb planmäßig durchgeführt werden, wurden nur auf der Grundlage von technischen Gesichtspunkten untersucht; Dosen für die Arbeiter und Mitglieder der Öffentlichkeit aufgrund dieser Vorgänge, basierend auf der Menge und den Eigenschaften der RA und AB, die durch Paks II erzeugt werden, sollten berechnet werden;

g) Die Erzeugung von RA und AB nach schweren Unfällen (und nicht nur nach Auslegungsstörfällen) sollte abgeschätzt und vorgelegt werden;

h) Unfälle, die die Abfallbehandlungsanlagen von RA und insbesondere AB am Standort Paks II betreffen, sollten auch bewertet und deren Auswirkungen auf die Umwelt berücksichtigt werden;

i) Die Aussage, die in Abschnitt 8.1.2.1.5 in Bezug auf die Zwischenlagerung von abgebrannten Brennelementen vor Ort für mehrere Jahrzehnte „möglicherweise auch über die Betriebsdauer der Anlage hinaus“ gemacht wird, ist zu klären, da sie den in Kapitel 19 gemachten Aussagen widerspricht;

j) Es wird vorgeschlagen, alle Verweise auf die IAEA Safety Series No.115 in Kapitel 19 mit Verweisen auf die Richtlinie 96/29/Euratom zu ersetzen, und die Informationen in Bezug auf internationale und EU-Rechtsvorschriften in Abschnitt 19.1 zu korrigieren.

VEZETŐI ÖSSZEFOGLALÓ

Bevezetés

Tolna megyében, Paks városhoz közel, kb. 100 km-re déli irányban Budapesttől a Duna jobb partján található az egyetlen magyar atomerőmű (Paksi Atomerőmű). A Paksi Atomerőmű telephelyén két új atomerőművi blokk építését tervezték, amely 1,200 MW teljesítménnyel villamos energiát fog termelni 60 éven keresztül. Az új blokkok kereskedelmi üzemének a kezdetét 2025-re és 2030-ra ütemezik.

2013 márciusában a Magyar Köztársaság értesítette Ausztriát a 2011/92/EU Direktíva 7. cikkelyének és a határokon átterjedő környezeti hatásvizsgálatról szóló Espoo Egyezmény 3. cikkelyének megfelelően két új atomerőművi blokk építési szándékáról a paksi telephelyen (“Paks II”). A kompetens magyar hatóság a Dél-dunántúli Környezetvédelmi, Természetvédelmi és Vízügyi Felügyelőség.

A Szövetségi Mezőgazdasági, Erdészeti, Környezetvédelmi és Vízügyi Minisztérium (BMLFUW) válasza szerint az Osztrák Köztársaság részt vesz a határokon átterjedő környezeti hatás vizsgálatban, mivel a javasolt projektnek jelentős határokon átterjedő hatásai lehetnek.

A környezeti hatásvizsgálat (KHV) keretein belül a tartalmi követelmények meghatározására jelentés készült annak érdekében, hogy meghatározzák azokat az adatokat, amelyeket a pályázónak – az MVM Magyar Villamos Művek Csoportnak – a környezeti hatásvizsgálat következő lépésében a környezeti hatástanulmányban be kell mutatni. Az MVM Magyar Villamos Művek Csoport megbízta a PÖYRI ERŐTERV Zrt. és alvállalkozóit a tartalmi követelmény jelentés összeállítására. A tartalmi követelmény jelentést nyilvánosan hozzáférhetővé tették Ausztriában. A beérkezett észrevételeket, köztük a Szövetségi Mezőgazdasági, Erdészeti, Környezetvédelmi és Vízügyi (BMLFUW) Minisztérium és több tartomány által megrendelt szakértői nyilatkozatot, elküldték Magyarországra további megfontolásra.

Ez a szakértői nyilatkozat elemezte a magyar oldal által bemutatott környezeti hatásvizsgálat tartalmi követelmény jelentését értékelve, hogy a jelentés által javasolt tartalom elégséges-e a projekt biztonságának és az Ausztriát érintő kockázatok meghatározására. A környezeti hatástanulmányhoz szükséges témákat elküldték a magyar félnek a környezeti hatástanulmány kidolgozása során való megfontolásra, mint a környezeti hatásvizsgálati folyamat átfogó szakértői megbeszéléseinek előfeltételét.

2015 áprilisában Magyarország benyújtotta a környezeti hatástanulmányt (KHT), amely azzal a céllal készült, hogy meghatározzák, és értékeljék az új atomerőművi blokkok környezetre gyakorolt hatásait. A tanulmányt az MVM Paks II. Zrt projekt vállalat részére az MVM ERBE ENERGETIKA Mérnökiroda Zrt. és annak alvállalkozói készítették el.

Az ENCONET Consulting Ges.m.b.h megbízást kapott a magyar fél által bemutatott KHT szakértői értékelésére. Az értékelés célja az volt, hogy megvizsgálják, hogy a KHT által bemutatott információ megbízható-e és elégséges-e a javasolt projekt biztonságának és az Ausztriára vonatkozó kockázatok meghatározására, valamint annak a vizsgálata, hogy a KHV tartalmi követelmény jelentését értékelő osztrák szakértői nyilatkozatban foglaltakat milyen mértékben vették figyelembe. A KHT-re vonatkozó jelen szakértői jelentés tartalmazza a projekt fejlesztője által a hatóságnak benyújtott KHT vizsgálatának az eredményeit. Ennek a KHT-nak összhangban kell lennie az EU KHV Direktíván alapuló műszaki követelményekkel. A projekt műszaki természete miatt a KHT-nak tartalmaznia kell nukleáris biztonságra vonatkozó megfontolásokat is. Ez a KHT-ra vonatkozó szakértői nyilatkozat tartalmazza az Espoo eljárás jövőbeni kétoldalú konzultációinak a témáit is azzal a céllal, hogy lehetőség legyen a potenciális kedvezőtlen határokon átterjedő hatások minimalizálására jól megalapozott javaslatokat tenni.

Környezeti Hatásvizsgálati Jelentés

A Paks II fejlesztő projekt alternatíváit a KHT nem mutatja be, nem mutatja be továbbá az alternatív reaktor típusokat sem, pedig az benne volt a tartalmi követelmény jelentésben, és nem mutat be nem nukleáris alternatívákat sem. A KHT információja szerint a lehetséges verziók közül az orosz atomerőművi technológiát választották ki. A magyar kormány már aláírta az Orosz Föderáció kormányával az egyezményt két VVER-1200 típusú blokk építését Pakson. Nem indokolják ezt a választást, pedig az EU KHV Direktívája megköveteli azt (5. cikkely, 3(d) paragrafus). Ezért javasoljuk a kétoldalú tárgyalásokon a következők tisztázását:

a) hogyan ment végbe a kiválasztás, különös tekintettel a környezeti hatások figyelembe vételére;
b) miért törölték a beszerzés pályázati eljárását.

A KHT tartalma csak részben felel meg a KHT Direktíva általános követelményeinek és a NAÜ új atomerőmű KHT tartalmára vonatkozó speciális ajánlásainak[3]. Ezért javasoljuk, hogy a kétoldalú konzultáció során a konzultáció terjedjen ki a következő kérdésekre:

c) annak a részletes bemutatása, hogy a Paks II tervezése, építése és üzemeltetése során hogyan teljesülnek a nukleáris biztonságra vonatkozó követelmények;
d) a telephely összes nukleáris létesítményének a kumulatív hatásai, nem csak a normál üzemi hatások, hanem a baleseti hatások is, beleértve az egyik létesítmény hatását a másikra, és az egyidejűleg több blokkon bekövetkező balesetek kumulatív hatásai is.
e) tervezési baleseteken túli balesetek figyelembe vétele (beleértve a súlyos baleseteket is) a baleseti állapotok összes lehetséges hatásának a megbecsléséhez;
f) a szükséges megelőző és elhárító intézkedések;
g) az általános felmérések 30 km-es sugarú köre kiválasztásának, és az 1.3.2-2 táblázatban közölt (1.3.2.3 fejezet) “szállítási terület” céljának az indoklása

Ezeken kívül, javasoljuk a következő kérések tisztázását is, bár ezek nfontosak a határokon átterjedő folyamatok szempontjából:

h) foglalkoztatottakra való radiológiai hatások;
i) talajra, tájképre, kulturális értékekre és közlekedésre vonatkozó hatások.

[3] IAEA (2014b): Managing Environmental Impact Assessment for Construction and Operation in New Nuclear Power Programmes.

A Paksi Atomerőmű által végzett környezeti radiológiai monitorozás leírása teljes mértékben összhangban van a vonatkozó nemzetközi szabványokkal és ajánlásokkal és teljes mértékben megfelel az EB követelményeinek és ajánlásainak. A KHT-ban ismertetett Paksi Atomerőmű üzemeltetéséből eredő kritikus csoportra vonatkozó dózisok megfelelnek az EB által a Paksi Atomerőmű által a kibocsátási adatok jelentése alapján számolt dózisoknak. Továbbá, a 2004-ben végzett felülvizsgálatot követően az EB kijelentette, hogy "a paksi telephely környezetében a levegő, a víz és talaj radioaktivitási szintjének folyamatos monitorozásához szükséges létesítmények megfelelőek." Figyelembe véve azt, hogy egy atomerőmű leglényegesebb hatása a környezte a radioaktív hatás lehet, és ezt általában a környezetvédelmi minták radioaktivitás szintjének a monitorozása alapján számszerűsítik, ezek alapján kijelenthető, hogy ha a Paks II-t a Paksi Atomerőmű üzemeltetője üzemelteti, akkor van okunk hinni abban, hogy az atomerőművet biztonságosan fogják üzemeltetni. Ugyanakkor ezt a kétoldalú konzultációk alkalmával tisztázni kell, mert a KHT nem tartalmaz az erőmű jövőbeni üzemeltetőjére vonatkozó információt.

Ezen kívül, javasoljuk, hogy korrigálják a 4.4.2.3 fejezetben (97. oldal) látható 90 Sv dózismegszorítás értéket.

A KHV tartalmi követelmény dokumentumra vonatkozó osztrák észrevételek figyelembe vétele

A KHT vizsgálata azt mutatja, hogy: a Nemzetközi Fejezetben 3 közvetlen válasz található, míg 18-at a kért információ KHT-ben való figyelembe vételével oldották meg. 7 kérdést nem kezeltek le, másik 7 kérdés pedig már nem aktuális (mert egy részük a reaktor típus kiválasztásával volt összefüggésbe, a többi pedig a költségekre vonatkozott, amit a KHT nem tárgyal, ahogy ezt az 1.3.2.3 fejezetben világosan kijelentették). 2 kérdésre csak részben volt válasz. Azokból a kérdésekből, amelyeket vagy nem kezeltek le, vagy nem megfelelő a válasz, a kétoldalú konzultációkon a következőket javasoljuk tisztázni:

a) a referencia erőmű megnevezése és annak a tanúsítványai;
b) a súlyos baleset kezelésre és a baleseti következmények elhárítására vonatkozó intézkedések részletes leírása;
c) PSA eredmények, ha vannak – bár a Nemzetközi Fejezetben a negatív válasz megtalálható;
d) a Paks II stressz teszt ajánlásainak bevezetésének az állapotára vonatkozó információ.

Nukleáris biztonsági kérdések

A kiválasztott nukleáris technológia

A projekt fejlesztője szerint a kiválasztott technológia megfelel a kor színvonalának megfelelő 3+ generációs atomerőművi technológiának. Ugyanakkor, a kiválasztott blokkok egyik speciális biztonsági tulajdonságát (nevezetesen az üzemzavari remanens hőelnyelő sprinkler medencék) a KHT 6. Fejezetében nem említik meg. Ezért javasoljuk, hogy a kétoldalú konzultációkon tisztázódjon, hogy ez csak valami miatt kimaradt, vagy ha nem, akkor mi az oka az említett biztonsági tulajdonság létesítményből való kimaradásának.

Határon átterjedő hatások

A Nemzetközi Fejezetben bemutatott határon átterjedő hatások elemzésére vonatkozóan azt lehet mondani, hogy az nem teljes körű. A paksi telephelyen bekövetkező üzemzavarok, vagy balesetek esetén az osztrák állam területe érintett lehet a légnemű radioaktív anyag kibocsátás következményeként. Ezért a KHV eljárásban nagyon fontos az összes a paksi telephelyen lehetséges üzemzavar és baleset beazonosítása és értékelése. Az osztrák állam területének a közelsége miatt és a radioaktív anyagok mennyisége miatt a létező és a tervezett atomerőművek potenciális veszélyt jelentenek. Még akkor is, ha tervezésin túli balesetek valószínűsége nagyon alacsony, azokat a KHV eljárásban elemezni kell nagy odafigyeléssel. Az Ausztriát érintő potenciális hatások elemzésé során a legnagyobb figyelemmel kísérik a lehetséges súlyos balesetek értékelését, beleértve a maximális forrástagot és a legkedvezőtlenebb időjárási viszonyokat, amelyek radioaktív kihullást eredményezhetnek Ausztria területén,

Ezért javasoljuk, hogy a kétoldalú konzultációkon és/vagy a nukleáris engedélyezési eljárás során tisztázzák a következő kérdéseket tisztázzák:

a) több információ, és ha hozzáférhető, a légnemű baleseti kibocsátások diszperziójának a modellezésére használt TREX (Euler modell) számítógépes program verifikációjának dokumentált bizonyítása;
b) a Nemzetközi Fejezet 2.3.5 fejezetében található 2 és 3 táblázatban lévő információ tisztázása (a TAK1 "1 nap", "10 nap" és "30 nap" oszlopai és a TAK2 "0–1 nap", "1–7 nap" és "7–30 nap" oszlopai);
c) az összes expozíciós útvonal dózisának számítása és bemutatása, beleértve a teljes dózisokat;
d) a magyar NBSZ felülvizsgálati terjedelmének a tisztázása, különös tekintettel arra, hogy a felülvizsgálat fogja-e tartalmazni annak a követelménynek a megváltoztatását, amely csak a tervezési üzemzavarok baleseti körülmények miatti környezeti hatásainak vizsgálatára vonatkozik.

Ezeken kívül, javasoljuk, hogy említsék meg a 3.5 fejezetben az EB és a szomszédos országok értesítését, amelyre Magyarország kétoldalú egyezményekben kötelezettséget vállalt a nukleáris balesetekről korai értesítésre vonatkozóan, mert ezt nem említik meg a KHT-ban.

Radioaktív hulladékok és kiégett üzemanyag

A Paks II-nél a radioaktív hulladék és kiégett üzemanyag kezelésére a tervezett tevékenységek általában megfelelnek a nemzetközi szabványoknak és gyakorlatnak, de a radioaktív hulladék és kiégett üzemanyag generálásának a hatásait, különös tekintettel a Paks II-nél tervezett kezelési műveletekre, nem elemezték teljes körűen. Ezért javasoljuk, hogy a kétoldalú konzultációkon a következő kérdéseket és szükséges információkat tárgyalják meg.

a) nem világos, hogy létezik-e Magyarországon a radioaktív hulladék és kiégett üzemanyag kezelésére nemzeti stratégia/program, mint ahogy azt a 2011/70/EURATOM Bizottsági Direktíva biztosítva a Közösségi keretet a kiégett üzemanyag és radioaktív hulladékok felelős és biztonságos kezelésére vonatkozóan;

b) meg kell nevezni a radioaktív hulladék és kiégett üzemanyag kezelés magyar szabályozás szerinti elsődleges felelősség tulajdonosát

c) a Paks II építése alatt nem keletkezik radioaktív hulladék és kiégett üzemanyag, ugyanakkor figyelembe kell venni a paksi telephelyen tárolt radioaktív hulladékot és kiégett üzemanyagot is;

d) a telephelyen az összes blokk üzemelése során a radioaktív hulladék és kiégett üzemanyag becsült teljes mennyiségének, és a Paksi Atomerőmű telephelyén már létező mennyiség bemutatása;

e) a nagyaktivitású hulladék (nem a kiégett üzemanyag) melléképületben való tárolása helytelen, ezért szükséges tisztázni, hogy a remanens hőt hogyan szállítják el;

f) a Paks II-nél a radioaktív hulladék és kiégett üzemanyag tervezett normál üzemi kezelési műveleteinek a hatásait mérnöki becsléssel értékelték csak; ezen műveletek miatti dolgozói és lakossági dózisokat a Paks II-nél keletkező radioaktív hulladék és kiégett üzemanyag radioaktív hulladék és kiégett üzemanyag mennyisége és jellemzői alapján számolni kell;

g) a súlyos balesetekből keletkező (nem csak a tervezési üzemzavarokból) radioaktív hulladék és kiégett üzemanyag mennyiségét és jellemzőit meg kell becsülni és be kell mutatni;

h) a Paks II-nél létesülő radioaktív hulladék és különösen a kiégett üzemanyag kezelés létesítményeit érintő baleseteket is elemezni kell a környezetre gyakorolt hatás vonatkozásában;

i) tisztázni kell a 8.1.2.1.5 fejezetben közölt információt, amely a kiégett üzemanyag több évtizedig tartó "és esetleg az erőmű élettartamán túli" telephelyen történő ideiglenes tárolására vonatkozik, mert az ellentmond a 19. Fejezetben közöltekkel;

j) javasoljuk, hogy a 19. Fejezet irodalomjegyzékében cseréljék ki az összes IAEA Safety Series No. 115 hivatkozást a 96/29/Euratom-ra való hivatkozásra, és javítsák ki a 19.1 fejezet nemzetközi és EU szabályozásra vonatkozó információkat.

1 EVALUATION OF THE SELECTED NUCLEAR TECHNOLOGY

While not specifically mentioned in EIS, it seems that the selected technology is AES 2006 – a WWER 1200 with two V-491 reactors. There are several NPPs under construction with such reactor (V-491) and with the same designed safety features. The WWER-1200 (V-491) design was developed by "Atomenergoproekt" St. Petersburg (SPbAEP). As compared to the reference design, some specific design features with safety improvements according to the BIS requirements can be forecasted, however they are not stated in the EIS, and likely will not be known before the commissioning, as the Hungarian government qualified all the new NPP relevant information as state secret. In the following part we focus on the design safety features of the new Russian WWER technology.

Regarding the selected technology, based on the available information from the EIS and other open sources the following can be stated:

1) The coverage of design basis conditions (DBC) and the design extension conditions (DEC) (beyond design basis conditions in the AES-2006 design) in the Paks II design is in line with the requirements of EUR version D and with the IAEA requirements. The design extension conditions are categorised to Complex Sequences (DEC 1) and Severe Accidents (DEC 2). They are called somewhat differently in the EIS, but they mean essentially the same as specified here. The EUR (version D) requires, in line with the IAEA Safety Standards, that the internal and external hazards be part of the design basis conditions. This is also applied in the Paks II design as these requirements are adopted in the Hungarian NSR, and will be obligatorily verified during the licensing process.
2) The following active and passive safety systems are implemented in the standard V-491 design:
   - **Low pressure emergency injection system** is designed for boric acid solution supply to the reactor coolant system in case of loss-of-coolant accidents including the reactor coolant system break with a maximum D nom 850 when the pressure in the system goes below the working parameters of the given low pressure emergency injection system;
   - **High pressure emergency injection system** is designed for boric acid solution supply to the reactor coolant system in case of loss-of-coolant accidents that exceed the compensatory capability of the normal make-up system at the pressure in the reactor coolant system below the working pressure of the high pressure emergency injection system (below 7.9 MPa);
   - **Residual heat removal system** is designed for the decay heat removal and reactor plant cool down during a normal NPP trip, under the conditions of anticipated operational occurrences and under design basis accidents on condition of retaining the primary-side integrity together with the low-pressure emergency injection system;
   - **Emergency core cooling system**, passive part is designed for boric acid solution supply with a concentration not less than 16 g/kg at primary pressure below 5.9 MPa in the amount sufficient for reactor core cooling before the low-pressure emergency injection pumps actuate in design-basis loss-of-coolant accidents;

- **Quick boron injection system** is designed for boric acid injection into the pressurizer in case of a primary-to-secondary leak to reduce the primary pressure and to create the necessary concentration of boric acid in the primary coolant under a BDBA without scram;
- **Emergency gas removal system** is designed to remove the steam-gas mixture out of the reactor plant primary side (reactor, pressurizer and steam generators' collectors) and to reduce the primary circuit pressure in order to mitigate the consequences of design basis and beyond design basis accidents;
- **Primary overpressure protection system** is designed to protect the reactor plant equipment and pipelines from the gauge pressure on the primary side under the design basis conditions of Category 2–4 and beyond-design basis accidents due to the operation of the pressurizer pilot-operated relief valves installed on the line for steam discharge out of the pressurizer's steam space into the relief tank;
- **Secondary overpressure protection system** is designed to protect the reactor plant equipment and pipelines from the gauge pressure on the secondary side under the design basis conditions of Category 2–4 and beyond-design basis accidents due to the operation of the steam generators pilot-operated relief valves installed on the steam line sections between the steam generators as far as shut-off electric motor-operated gate valves, considering the advance actuation of the steam dump to the atmosphere and reactor trip system;
- **Passive heat removal system via steam generators** is designed for long-time residual heat removal from the core to the ultimate heat sink via the secondary side at beyond design basis accidents. The system of passive heat removal through the steam generators backs up the appropriate active system of heat removal to the ultimate sink in case it is impossible for it to perform its design functions.
- **Emergency feed water system** is designed to supply the steam generators with feed water under the conditions of anticipated operational occurrences and design basis accidents when feed water supply by the standard system and auxiliary systems is impossible;

- **System of passive heat removal from the containment** refers to the engineered safety features for coping with BDBA and is designed for long-time heat removal from containment at beyond design basis accidents;
- **Main steam line isolation system** is designed for quick and reliable steam generator isolation from a leaky section:
  - at pipeline breaks downstream of the SGs as far as the turbine stop valves in the pipeline sections that either can be isolated or cannot be isolated from the SG;
  - at feed water pipeline breaks downstream of the SGs as far as the check valves;
  - at primary-to-secondary leak;
- **Double-envelope containment and core catcher** are designed to retain the radioactive substances and ionizing radiation within the limits envisaged in the design.

3) Regarding the specific safety features, it can be stated that this design has lots of innovative and in some cases unique safety features like the following ones:

- **The safety systems** have 4x100% redundancy for most of the safety functions. In addition, the AES-2006 have several different systems that can provide the same safety function (”diverse” systems).
- **The reactivity control** and ensuring the needed subcriticality of the reactor under all conditions following a postulated initiating event are provided by two totally diverse systems, namely by the control rods that can ensure deep subcriticallity even under cold moderator temperatures, and by the fast boron injection system that can serve as a redundancy to the control rod system with a speed that would prevent the damage of the fuel cladding following all possible initiating events. This feature is somewhat unique in the Generation 3+ reactor population.
- **Emergency heat removal spray pools** are to provide heat sink in case all other active heat sink possibilities are lost. There are four such spray pools, that are effective even in high ambient temperature (hot summer) conditions, and each of them is enough to take the residual heat from the system. In cold weather there is no need for the spray function. In very cold weather) the cooling water from the condenser would be driven to heat up the pools to avoid total freezing. One observation to be made here is that that in the EIS there is no mention about such spray pools, and they are also not indicated on the layout drawings, therefore a clarification of this aspect might be useful, though it may happen that in the final design such safety feature will be included.
- **Passive emergency heat removal system** that can remove the residual heat from the reactor even in cases, when the active secondary heat removal fails.
- **Passive emergency cooling of the containment** that can provide cooling even in case of full core melt down. This system can provide passive cooling through the steam condensers in the containment till the water in the EHRT evaporates. In the worst case it is estimated to be 72 hours. After this time it is necessary to add supplementary water in the tanks.
- **Molten core catcher** is a complicated construction that is to catch the molten core if it melts through the reactor vessel. The construction is such that it can survive even high pressure melt through event, and prevent the corium concrete interaction and therefore the production of combustible and explosive gases. This feature is unique to the WWER design.
- **Emergency AC power supply** is provided by protected diesel generators in case of total loss of external power supply. Onsite power sources are: one onsite diesel generator plus four backup diesel generators. In total each unit has five diesel generators. In addition, a mobile diesel generator is installed on the site that can replace any of the other diesel generators.

In conclusion, it can be stated that the Paks AES-2006 design involves innovative safety solutions that can effectively cover a wide range of accidents preventing the core damage and, even if core damage occurs, preventing the large radioactive releases into the environment. The built-in safety features are satisfying the current international safety requirements including those of the IAEA and EUR.

Moreover, in general terms the AES-2006 design seems to correspond to the requirements of a Generation 3+ state-of-the-art NPP design. Given the above mentioned strict BIS requirements are fulfilled, the expected Paks II specific features will further improve the safety of the new Paks units, though concrete information about this is not available at the moment. On the other hand, the available information shows that in comparison with the other Generation 3+ reactor types, similar design safety features can be observed in the Russian AES-2006, and in most of the cases the same design safety issues are covered, therefore it is difficult to indicate major safety differences.

2 EVALUATION OF COMPLETENESS OF INFORMATION PRESENTED IN EIS

According to the EIA Directive (2011/92/EU on the assessment of the effects of certain public and private projects on the environment), the developer of any project subject to environmental impact assessment shall supply, in an appropriate form, the following information:

1) A description of the project, including in particular:
   a) a description of the physical characteristics of the whole project and the land-use requirements during the construction and operational phases;
   b) a description of the main characteristics of the production processes, for instance, the nature and quantity of the materials used;
   c) an estimate, by type and quantity, of expected residues and emissions (water, air and soil pollution, noise, vibration, light, heat, radiation, etc.) resulting from the operation of the proposed project.
2) An outline of the main alternatives studied by the developer and an indication of the main reasons for this choice, taking into account the environmental effects.
3) A description of the aspects of the environment likely to be significantly affected by the proposed project, including, in particular, population, fauna, flora, soil, water, air, climatic factors, material assets, including the architectural and archaeological heritage, landscape and the interrelationship between the above factors.
4) A description (covering the direct effects and any indirect, secondary, cumulative, short, medium and long-term, permanent and temporary, positive and negative effects of the project) of the likely significant effects of the proposed project on the environment resulting from:
   a) the existence of the project;
   b) the use of natural resources;
   c) the emission of pollutants, the creation of nuisances and the elimination of waste.
5) The description by the developer of the forecasting methods used to assess the effects on the environment referred to in point 4.
6) A description of the measures envisaged to prevent, reduce and where possible offset any significant adverse effects on the environment.
7) A non-technical summary of the information provided under headings 1 to 6.
8) An indication of any difficulties (technical deficiencies or lack of know-how) encountered by the developer in compiling the required information.

Thus, the completeness of the information provided in EIS was assessed against these requirements, but, due to the fact that this information is not organised following strictly the structure given in EIA directive, a table of compliance was difficult to be developed. Therefore, the findings of the evaluation are presented below following the points as above listed.

1) An adequate description of the project is provided, mainly in Chapter 4 and Chapter 6, including the characteristics of the plant and the land-use requirements, the characteristics of the nuclear power generation process, as well as the nature and the quantities of the nuclear fuel. Estimates of the ex-

pected quantities of conventional waste, radioactive waste, spent fuel, radioactive airborne and liquid emissions, and waste water are given, for both the construction and operation phase of the project. Noise and vibration loads, heat load on the Danube, air pollution, surface and ground water pollution are estimated too. Soil pollution is only marginally mentioned.

2) The main alternatives studied by the developer are not presented in EIS, but only in PCD. Since the selection of the reactor type to be built was taken by the Government, the choice did not belong to the developer. Therefore, the reasons for this choice are not given.

3) A description of the environment elements possibly to be affected by the proposed project is given in summary in Chapter 8, and in details in each technical chapter (9-21). These include the population, fauna, flora, surface and ground water, air, climatic factors, architectural and archaeological heritage. Landscape is not considered, and soil is considered only indirectly. Only the population outside the construction site and future operation site was considered; the impact on the Paks NPP workers was not addressed, nor the impact of Paks NPP on Paks II workers. As such, the interrelationship between these factors was addressed only to a limited extent, during the evaluation performed (when indirect impact were analysed for the purposes of evaluation of the impact on a certain environment element).

4) The impacts on the environment of the proposed project are described in each technical chapter (9-21). Direct and indirect effects are considered, as well as – for some elements – short, medium and long-term. Positive and negative effects are mentioned, whenever the case. Cumulative effect of the simultaneous operation of the existing plant and the proposed new one are also addressed, but only for normal operation of both plants are described. The effects of one plant to the other one, especially in accident conditions, are not estimated. The spent fuel storage that at one moment should be built on Paks II site is not considered at all as a potential source of impact. The cumulative effect of more than one installation on Paks site (Paks NPP, Paks II and the 2 Interim Spent Fuel Storage facilities) being simultaneously affected by an accident is not considered at all.

5) The methods, the models and the codes used to evaluate the effects on the environment of the impact factors considered are described in each technical chapter (9-21).

6) Measures to mitigate the adverse effects on the environment, or to prevent the possible adverse effects are included in each technical chapter, whenever the case.

7) A non-technical summary of the information presented in the chapters included in EIS is provided in a separate document.

8) The difficulties encountered by the authors of the analyses performed, and sometimes the ways to avoid or to resolve such difficulties are indicated in the technical chapter, whenever the case.

Following this analysis, it can be stated that, in general terms, the EIS content covers the EIA Directive requirements. However, these requirements are rather general, since they are addressing all types of development projects. Specific content for an EIA report for development of new NPPs is given in the IAEA Publication No. NG-T-3.11. According to this, an environmental impact assessment report for a nuclear project development should address all environmental and socioeconomic impacts, with their nature, probability, duration, magnitude and significance, during the entire duration of the project (i.e. from construction to decommissioning of the NPP). A typical content for a NPP EIA report would be:

a) Summary
b) Introduction
c) Environmental impact assessment procedure and communication and participation
d) Description of the project
e) Description of the plant
f) Nuclear safety
g) Description of the environment
h) Environmental impact assessment for the project
i) Cumulative impact
j) Impact of irregular operation and accidents at the nuclear power plant
k) Transboundary impacts (depending on States)
l) Nuclear fuel production chain
m) Prevention and mitigation of adverse impacts
n) Environmental monitoring program

Apart from the general aspects (a–e) which should be described in a manner similar with the EU general requirements, some specific points require more attention.

Nuclear safety

This section should include a review of the nuclear safety aspects of the plant, describing the nuclear safety requirements and principles as well as their implementation in the design, construction and operation of the NPP. Nuclear safety principles and regulatory requirements are presented in EIS, but their implementation is rather only generally described.

Environmental impact assessment for the project

This section should describe the analyses performed in order to estimate the magnitude and important characteristics of the impact, for each of the construction, (normal) operation and decommissioning stage of the project.

For each development stage, the following impact factors should be addressed:

- air, soil and water quality due to nuclear and non-nuclear releases;
- aquatic flora, fauna and ecological values;
- terrestrial flora, fauna and ecological values;
- landscape and cultural environment;
- traffic;
- noise level;
- people and socioeconomic factors;
- RW and SF management.

While the construction of Paks II is adequately considered in EIS, the analysis of the normal operation of the plant does not address the impact on the workforce due to the operational activities. The impact during decommissioning of Paks NPP is considered only at a level of general description, but this is acceptable (since decommissioning in itself requires a separate EIA).

From the impact factors indicated by IAEA as important to be considered, EIS properly addresses most of them, except the soil, the landscape and possible cultural values, and the traffic.

Cumulative impact

This section should include a description of other projects in the area and the combined impacts resulting from the addition of the new NPP, including the cumulative impact (in time) on environmental resources that continue to be affected. While the latest is adequately analysed and presented in EIS, the cumulative impact of Paks NPP and Paks II is presented only for the population off site and only for normal operation. The impact of Paks NPP of the workers that will be involved in the construction of Paks II is not addressed. Nor the cumulative impact of both NPPs on the outside (external) workers during the joint operation.

Impact of irregular operation and accidents at the nuclear power plant

This section should describe the impacts on people and the environment due to design base accidents, beyond design basis accidents and severe accidents at the NPP, together with the impact area and the measures to address these impacts.

By far the most important comment to EIS is that the impact on people and the environment was analysed only for design base accident. Beyond design basis accident, including severe accidents, are presented only in the International Chapter, and that presentation is very short and incomplete (see Section 4 for more details).

Transboundary impacts

This section should describe the possible transboundary impacts (e.g. impacts of accident situations, socioeconomic impacts such as employment, and impacts on a shared watercourse). The International chapter provide a short description of the analysis of the transboundary impacts, however this is rather incomplete (see Section 4 for more details).

Nuclear fuel production chain

This section should include a general description (not an assessment) of the nuclear fuel chain, which requires a separate EIA report. EIS properly addresses this aspect.

Prevention and mitigation of adverse impacts

This section should describe the measures envisaged by the project developer to prevent and to diminish significant adverse impacts of the project, e.g.:

- engineering and planning alterations;
- practice alterations for construction and operation;

- habitat restoration;
- financial compensation, etc.

The selection criteria for the proposed mitigation measures, in terms of cost, technical feasibility, legal possibility or social acceptability, should also be clarified in this section.

While some of these are partially addressed in EIS (e.g. habitat restoration is mentioned in Chapter 18, but only as a diminishing factor of the impact on local flora and fauna), the prevention and mitigation measures are not clearly presented. This might be due to the fact that no significant adverse impacts are identified in EIS. However, financial compensation aspect should at least be mentioned in EIS.

Environmental monitoring programme

This section should describe the environmental monitoring programme for the construction and operation periods, which should address the environmental elements that might be affected (groundwater, surface water, soil or biota). All these aspects are adequately considered in EIS.

Consequently, it can be stated that the content of EIS follows only partially the EU general requirements, as well as the IAEA specific guidelines. For the gaps identified, if is recommended to obtain clarifications and additional information on the following aspects:

a) a justification of the selection made;
b) a more detailed presentation of the nuclear safety aspects related to the plant to be built (and in particular, how the nuclear safety requirements are going to be implemented during the design, construction and operation of Paks II);
c) the cumulative impact should be evaluated for all nuclear installations existing at the site and planned to be built on the site, not only for normal operation, but also for accident conditions; also, the impact of one installation on the other should be properly addressed; accidents affecting more than one unit in the same time should also be included;
d) beyond design basis accidents (including severe accident) should be considered in EIS too (and not only in the International Chapter) for estimation of all possible impact factors in accident conditions;
e) preventive and mitigation measures should be planned and presented in EIS.

In addition, it is suggested to consider also the following aspects, even they are not important for the radiological tranboundary impacts:

a) the radiological impact on the workers should also be assessed and presented, for normal operational activities;
b) soil, landscape, cultural values and traffic should also be considered for evaluation of impact.

3 EVALUATION OF ESTIMATED TRANSBOUNDARY IMPACTS OF ACCIDENTS AFFECTING PAKS II

The impact factors considered for the analyses performed under the scope of environmental impact assessment of the proposed Paks II development project are presented in Chapter 8 of EIS. These potential impact factors are grouped depending on the locations that may be affected, the time when they may appear and their nature. The typical impact factors considered in EIS are: the use of environmental elements, the generation of conventional waste, the emission of radioactive waste, the management of spent fuel. These impacts were analysed for each of the 3 different stages of the development of Paks II: construction, operation – in normal conditions and design-basis accident conditions – and decommissioning.

The most important comment related to this chapter – and in fact to all technical chapters of EIS – is that only design-basis conditions are considered for the evaluation of accident conditions, and it seems that this is due to the nuclear safety requirements currently in place in Hungary. According to the IAEA recommendations, the impact due to beyond design basis accidents and severe accidents at the nuclear power plant should also be evaluated for the purposes of assessment of environmental impact of new NPP. This aspect should be clarified since it might have an impact of the safety of the plant. However, this deficiency might have been already identified by the Hungarian regulators, since in section 3.4.3 of EIS it is mentioned that the Nuclear Safety Regulations are going to be revised, but only the modification of the definitions of plant states are explained; it is therefore necessary to find out if this revision will also address the requirement to analyse the impact of beyond design basis accidents too, in particular for safety assessment purposes.

Another comment refer to the information given in section 8.1.2.1.5 related with the spent fuel, for which it is stated that temporary storage on site for several decades “perhaps even beyond the plant’s operation time” is envisaged. Besides the fact that this is in contradiction with the information given in Chapter 19 of EIS, such a long-time storage would entail consideration of all the specific (enhanced) safety features to be addressed and it might also affect the planned immediate dismantling option for decommissioning of Paks II; therefore, it is suggested to correct this statement, for consistency with Chapter 19.

The findings of the analyses performed for the purposes of environmental impact assessment of the proposed Paks II development project are summarized in Chapter 22 of EIS. This chapter presents in a tabular form, the results of the evaluations performed under the study for each impact identified as being relevant under Chapter 8 of EIS, both for normal operation and design-basis accident conditions during the construction, operation and decommissioning of Paks II. Information about the processes triggered by each impact factor, the affected environmental element, the dimensions of the impact areas and the nature of the impact (strength, duration and significance) are also included. None of the impacts summarized in this chapter and analysed under the EIS will have a cross-border character.

However, such impacts were analysed in the International Chapter of EIS, though the status of this chapter is not clear. It is not included in the Table of Content of the EIS, which might imply that it is not part of the main report. Thus, a clarification is needed in this respect.

Then, the conclusions summarized in this section are basically stating that "cross border impact are not anticipated even in the case of operating troubles". Due to the fact that "operating troubles" are not defined, it is assumed that this term refers to "operational occurrences", although in the technical chapters of EIS, all evaluations performed for accident situations were considering design-basis accidents. As defined in IAEA Safety Glossary (2007 edition), the (anticipated) operational occurrences are not considered accident conditions, while the event used to estimate the radiological impact in accident conditions of Paks II is a design-basis-accident – DBC4 (a design-basis condition with very low probability of occurrence, as explained in EIS section 3.4.3.2). In addition to these, severe accidents (or beyond-design-basis-accident, or DEC2 according to Hungarian classification of plant states) should have been analysed too. This type of event is considered and analysed only in this chapter.

For the purposes of estimating the transboundary radiological impact on the neighbouring countries in case of severe accident resulting in airborne releases, the TREX (Euler-model) code was used. The model is briefly described but no other information or reference is given regarding its validation except of the mention that all software programs are validated. Since based on a limited investigation done by the consultant this code seems to be developed in Hungary and used in Paks NPP only, there is a need for more data – and eventually a reference – regarding its validation.

A clarification is also needed in order to understand Tables 2 and 3 presenting the radioactive releases in case of beyond design basis accidents, and in particular the values given in the columns "1 day", "10 day", "30 days" for DEC1 and respectively "0–1 days", "1–7 days", "7–30 days" for DEC2. In the same sense, the fourth, fifth and sixth paragraphs in section 2.3.5 need to be verified and clarified (e.g. there is no column 0–10 days in Table 2).

The results presented in section 2.3.5 are incomplete. While it is recognized that inhalation doses might be the main contributor to the total dose, the presentation of the other doses, as well as of the total doses is needed. In order to allow the verification of the radiological cross-border impacts it is necessary to calculate and present all the doses on all exposure pathways (as specified in section 20.6.2.1.1), as well as the total doses.

4 EVALUATION OF PROPOSED RW MANAGEMENT SOLUTIONS FOR PAKS II

The radioactive waste ("RW") and spent fuel ("SF") management options and planned operations for Paks II are described in Chapter 19 "Management and disposal of radioactive wastes and spent fuel" of the EIS. This chapter presents the Hungarian regulatory framework governing the management of RW and SF, the quantities and types estimated to be generated by Paks II, the planned management operations, as well as the impact of RW and SF generation and management on the environment in normal operations and failure conditions at the planned power plant. Following the evaluation, it was found that in general lines, the activities foreseen for the management of RW/SF at Paks II are in line with the international standards and good practices, but some discrepancies were also found. A number of suggestions and recommendations are issued to correct these discrepancies, and also the need for further clarifications is explained in the following paragraphs.

The regulatory framework established in Hungary for the management of RW and SF follows the international standards and recommendations. However, the explanations given in section 19.2 of the EIS are slightly inadequate and therefore it is suggested to correct them: the EU Basic Safety Standards issued in 1996 (Directive 96/29/Euratom) are not based on the IAEA Basic Safety Standards published in the same year (IAEA Safety Series No.115) but on the ICRP recommendations from 1990 (ICRP Publication 60). Since ICRP revised its recommendations in 2007, both IAEA and EU revised their BSS in 2013. While IAEA BSS are not mandatory, the EC Directives shall be transposed by all EU MS. Considering the legislative effort that will be needed to transpose the new BSS, the transposition deadline for the new EU BSS (Directive 2013/59) is 6 February 2018; until then, all EU MS have to apply the provisions of Directive 96/29/Euratom, which should have been transposed by now into their national legislation. As such, it is suggested to replace all the references to the IAEA Safety Series No.115 with references to Directive 96/29/Euratom.

Another aspect observed is that in subsection 19.2.1 of EIS, the prime responsibility for the safe management of RW and SF belonging to the generator – as requested by both international and EU safety standards – is not mentioned. The whole discussion refers to the ultimate responsibility of the state, and the only responsibilities of the RW generator specified in this part refer to the minimization of RW generation. While from the descriptions given in the following sections of this chapter of EIS it is clear that the generator is also responsible for the management of RW, a clear statement of the party holding the prime responsibility for RW and SF management in Hungary is needed.

A more important comment refers to section 19.2.1.1, which is written at future tense. This might be due to incorrect translation of the original text, or it might refer to the legal procedure of Hungary to establish the national strategy and program for RW and SF management. However, there is no mention of any of such documents being actually in place in Hungary. Since both of them are requested to be developed by the Council Directive 2011/70/Euratom, there is a need to clarify if Hungary has at the moment a national strategy and/or program for the management of RW and SF.

The different options for closing the nuclear fuel cycle are adequately presented and analysed in subsection 19.4.3 of EIS. The existing disposal facility for short-lived LILW is specified in section 19.6 and taken into consideration in the analyses performed. The possible disposal options for HLW are also presented in this section of EIS, together with the current stage of the activities undergone in Hungary for developing an adequate repository (deep geological disposal facility).

The baseline conditions of the site are presented in section 19.5. According to EIS, there is no RW or SF present on the site where Paks II will be built. However, on Paks NPP site – which is adjacent to the site where Paks II will be built – it is stored the RW and SF generated by Paks NPP, which might have a local impact during the construction of Paks II (on the workers for instance). In addition, presenting the quantities of RW and SF stored on Paks NPP site is needed in order to check that indeed, the quantities of RW and SF to be generated by the new plant will be lower than the ones generated by the operating plant, as it is stated in EIS.

The impact of RW and SF generation by Paks II during normal operation is presented only in terms of the quantities of RW and SF expected to be generated. The RW and SF management operations, systems and facilities envisaged to be performed and installed at Paks II are also described. They are all in line with the international standards and good practices, except for the HLW. This type of waste will be managed, according to EIS, by collecting it in shielded containers that will be stored in the auxiliary building till the dismantling of the unit or the commissioning of a HLW repository. However, it is not mentioned how the residual heat generated by this waste will be removed. According to the international standards and practices, HLW has to be stored in a similar way like SF. This aspect is not properly addressed in EIS and it has to be clarified, since it may have an impact on the safety of the plant.

The impact of RW and SF management operations planned to be performed at Paks II during normal operation were evaluated based on engineering judgement only. The doses to the population living in the vicinity of the plant are not presented, and the only information given in this chapter sends to the chapter on environmental radioactivity. But in this chapter (21), the only results of calculation of doses to members of the public due to RW/SF management operations refer to the baseline conditions at the site, i.e. considers the activities and specific operations currently performed at Paks NPP. According to section 20.6.5.1, similar operations are going to be implemented at Paks II, and as such it is considered that the calculations performed for the operating plant show that the dose constraint established for the new plant will be observed. This might be true, and most probably such operations will have no detectable impact off the site, however, such statements should be substantiated with adequate calculations.

For the joint operation of all 6 units, the EIS states that the 2 new units will be at the beginning of their commercial operation and as such, all RW and SF management operations will be performed inside the units; no RW will leave the site and no SF will be handled outside the containment. Therefore, it is concluded that the impact of RW and SF will be dominated in this period by the management operations performed at Paks NPP.

The evaluation of the impact of RW and SF generation and management during accident conditions at Paks II was done in a similar manner like for the normal operation conditions. There are not enough data presented in section 19.8.5 to substantiate the statements of EIS Chapter 9. It seems that, like in the whole study, only the design-basis accidents were considered. From these, the only events kept for analysis are those ones generating RW or SF. For these, it is mentioned that they will be collected and stored in the auxiliary building before further treatment. Once again, since the list given in this section includes damaged fuel, storing in the auxiliary building is not adequate. The quantities of the RW/SF to be produced following the failure events are not given, the only information mentioned being that the respective quantity will not exceed the capacity of the temporary storage facility. Based on these and on the features of PWR reactors to contain the waste produced in design-basis accidents it is concluded in EIS that the impact area will not go beyond the safety zone to be established around Paks II, and due to this, an analysis of indirect impacts and transboundary impact is not considered justified. This might be true, and most probably this would be the case, but all these conclusions should be substantiated with adequate calculations. Generation of RW and SF following severe accidents (ant not only design-basis accidents) should be estimated and presented. Also, accidents affecting the RW and in particular SF management facilities to be established on the site should also be evaluated and their impact on the environment considered. As a general comment, nowhere in the EIS is considered the SF storage as an independent facility. With due consideration of the fact that at the moment, the type of such facility was not selected yet, such facility has to be recognized as an additional nuclear installation to be built on the site, and it has to be taken into consideration for the assessment of the environmental impact, irrespective of its type or commissioning date.

Based on all of the above, it is concluded that the impact of RW and SF generation and planned management operations to be performed at Paks II NPP are insufficiently analysed and/or presented. Most probably, RW and SF that might be produced following a severe accident affecting the new units, or the accidents that may affect the RW or SF management facilities to be built on the site will not significantly affect the Austrian territory, but in the absence of concrete results of the calculations performed in order to estimate such impacts, it is not possible to conclude this with a high level of confidence.

5 EVALUATION OF ANSWERS PROVIDED TO AUSTRIAN EXPERT OPINION ON SCOPING DOCUMENTATION

Under the preliminary consultation part of the environmental licensing process for Paks II, an expert opinion related to the Preliminary Scoping Document was submitted by Austria to the Hungarian Espoo contact. As such, under the evaluation performed by the Consultant in this stage, the EIS was also checked from the point of view of the answers to Austrian questions which, according to the International Chapter of EIS, were either included in the main text of EIS, either answered in the International Chapter (those considered as being outside the scope of environmental impact assessment). Consequently, the findings of the EIS evaluation in order to identify and verify the adequacy of the answers which should have been provided by the author of EIS to the questions formulated in UBA Report REP-0148 are listed below, in the order provided in the English Summary of the above-mentioned report.

Hungarian procedure

- (…) The EIS should describe the individual steps of the permitting procedure including the time schedule, showing when the decision on the type should be taken and whether this will be still during the EIA procedure. Also the information which authority is in charge of the individual steps of the permitting procedures should be provided.

Findings: a general licensing procedure is included in section 1.2 of EIS as well as in section 3.4.1 of the International Chapter, but this does not include the decision regarding what type of reactor will be selected, or the time schedules.

- The EIS should present explicitly, which target values MVM is basing the tender process on, how binding those will be and which are the priorities for selecting the reactor type.

Findings: Apparently, the decision was taken by the Hungarian Government, and there are no explanation on how this selection has been done included in EIS. Section 3.4.2 of the International Chapter clearly states that "no tendering procedure will be conducted anymore and the comments on the selection of the type are not relevant any more in the light of Act No II of 2014."

Completeness of documents

- The description of measures undertaken to reduce the impacts of the project needs to be supplemented with additional information. It should cover at least the requirements and recommendations the following parts of this expert study describe, but also describe radiation protections measures to be conducted during accidents.

Findings: for each impact found as having a relevance, adequate measures to mitigate the effects are included in EIA.

- References, annexes and the list of abbreviations should be made available also in German.

Findings: only the International Chapter and the Simplified public summary are presented in German (including the references to each of them).

Aspects of nuclear safety

Reactor types, incidents and accidents

- Meaningful technical description of the complete nuclear installation, among other things also detailed data on seismic safety.

Findings: a description of the nuclear installation is given in Chapter 6 of EIS, as well as some data about the seismic activity (see section 6.11.1). More information are given in an article submitted by the Contractor during the evaluation of EIS, which demonstrate that a comprehensive site seismic hazard evaluation program has been developed in relation with Paks II development, which consists in a 3D seismic survey, drilling of several deep boreholes, extensive geological mapping, and geophysical investigations at the site and its vicinity, as well as on near regional, and regional scale. While the implementation of the project is still in progress, the data provided in the article show that adequate measures for monitoring earthquakes on Paks site were taken by the operating plant already 2 decades ago, when a sensitive microseismic monitoring network was installed and it is in operation since 1995.

- Stage of development achieved:
  - reference plants under construction or in operation with a comprehensive description of the current status;
  - existing certification;
  - permits and check-ups conducted by permitting authorities of other states and status of those check-ups.

Findings: not considered; however, an answer to this question is provided in the Annex to this report (Chapter 6).

- Basic data on the operation of the plant:
  - operating period
  - fuel cycle
  - expected availability
  - burn-up
  - expected share of MOX

Findings: all data are presented in Chapter 6 of EIS.

- Detailed description of safety systems, among others also data about the requirements for the important safety relevant systems and components.

Findings: all data are presented in Chapter 6 of EIS.

- List of Design Basis Accidents

Findings: there is no such list included in EIS, but the requirements for design-basis conditions as well as for design-extension conditions are included in section 6.13 of EIS. Also, the definition and description of plant states is given in section 3.4.3.

- Detailed description measures to control severe accidents and the mitigation of accident consequences

Findings: a detailed description of the necessary measures to control severe accidents is not given in EIS, since severe accidents were considered only in the International Chapter, for the purposes of deriving the transboundary effect; due to the fact that the results presented in this chapter do not lead to doses to population that would necessitate the implementation of protection measures, there is no need to present such measures. However, the last Simplified public summary chapter gives a general description of the necessary response plans to radiological emergencies.

- Results of PSA (Level 1, 2 und 3):
  - probabilities/Frequency of core damages (CDF) and severe accidents with (early) large releases (LRF and LERF) including probability distribution (fractiles);
  - data on the share of internal triggers, internal and external events as well as the shares from operation and standstill times and severe accidents from the spent fuel pool;
  - data on the most important accident scenarios including accidents from the spent fuel pool and defining the necessary manual actions to be undertaken with the time available to complete them;
  - source terms for the most important release categories;
  - comprehensive presentation of spreading calculations as well as determining radiation rates of incidents and accidents.

Findings: answer provided in section 3.5.3 of International Chapter: "The management of the issues raised in these questions at such a length and details is not the function of the Environmental Impact Study, they will be discussed under the establishment licensing procedure." Indeed, all these issues should be presented in the Safety Assessment Report which should be prepared in order to obtain the nuclear safety licenses; however, the results of such probabilistic safety analyses could have been presented in EIS, provided that they are available. The requirements for the PSA results of the Russian units to be built at Paks are included in section 6.13.5.

- In addition the EIS needs to determine to which extent the individual reactor types fulfil European and international standards, in particular WENRA and IAEA requirements. Also the recommendations from the EU stress tests for NPP should be taken into account.

Findings: answer provided in section 3.5.3 of International Chapter: "Design of the Russian units was made in accordance with the official Russian legislation, taking into account at the same time the recommendations of the EUR, WENRA, and IAEA, as well as the requirements of the nuclear authority. Additionally, the units to be delivered at Paks must meet the Hungarian expectations and legal requirements alike, which in turn include the most up to date WENRA recommendations and the lessons learnt from Fukushima." Some considerations regarding the stress test are included in section 3.4.1 of EIS, where it is stated that the stress test performed at Paks NPP resulted in positive findings, and that the report emphasized good practices; no critical or significant deficiencies were found and some of the recommendations concerned developments in progress. However, there is no information provided in the status of the implementation of these recommendations, which are probably related with the construction of Paks II.

- The EIS needs to consider accidents affecting several reactors at the Paks site (up to six), also accidents affecting several reactors and several spent fuel ponds (up to six).

Findings: not considered. The joint operation of Paks II and Paks NPP was considered only for normal operation conditions.

- The EIS should also explain in which form potential environmental impacts in particular severe accident impacts are considered when selecting the reactor type.

Findings: not relevant anymore, since the reactor type to be built has been already selected.

Radioactive wastes

EIS should provide information on the following issues:

- Information about the classification system for radioactive waste.

Findings: included in section 19.2.1 of EIS.

- Data on the quantity of yearly/over the complete operational time generated highly active wastes: number of fuel elements and in case of the MIR 1200 reactor also the quantity of other highly active wastes.

Findings: included in section 19.8.1 of EIS.

- Detailed amount scheme of the yearly/over the complete operational time (incl. decommissioning) generated low – and medium active wastes incl. breakdown according to their activity levels and different activity categories for the individual reactor types.

Findings: the quantities of LILW expected to be produced during the operation of Paks II are given in section 19.8.1.1 of EIS.

- Information on the facilities available for treating waste of different kind which will be constructed in addition and in which parts of the plants radioactive waste is/will be handled.

Findings: included in Chapter 19 of EIS.

- Information on the planned interim storage of radioactive fuel elements: should/can the existing interim storage be expanded to store the waste from the new reactors?

Findings: included in section 19.4 of EIS.

- Information about the planned storage time for spent fuel in the interim storage.

Findings: included in section 19.4 of EIS.

- Information about the current stage of the DGR search: current stage of examination of the Bodai Aleurolit Formation (part of the uranium mine in the Mecsek Mountains), information about the necessary capacity in the DGR to store all the HLW of NPP Paks, time schedule for the construction/start of operation of the repository.

Findings: included in section 19.6 of EIS.

- Current status of planning the back-end of nuclear energy use in Hungary (open versus closed fuel cycle)

Findings: information provided in section 19.4.3 of EIS.

- Data concerning plans, where the low and medium radioactive wastes of the new reactors at NPP Paks will be stored (interim storage).

Findings: information provided in Chapter 19 of EIS.

- LILW repository in Bátaapáti: The low and medium radioactive wastes are to be stored at the existing repository in Bátaapáti. Therefore the EIS needs to contain information concerning the capacity of the repository at Bátaapáti and the need/possibility of enlargement.

Findings: not included.

- Data on the amount of radioactive inventory on the site as a whole, subdivided into the applied categorization of radioactive wastes.

Findings: not provided; same recommendation is given in Section 5 of this report too.

- Environmental impacts of the nuclear fuel cycle as a whole.

Findings: partially provided in section 20.6.5.1 where the doses calculated due to the transport of fresh/spent fuel and transfer on site to the Interim Storage Facility are given. However, for the purposes of EIS of Paks II project, an environmental impact assessment of the whole nuclear fuel cycle is not justified (nor possible, as long as a decision on how to close the fuel cycle has not yet been taken in Hungary).

- To comply with the polluter pays principle, sufficient reserves need to be accumulated for the construction of a final repository. We would welcome if information concerning this topic will be provided.

Findings: included in section 19.2.1.3 of EIS.

Energy Aspects

The Hungarian power plants

- The EIS should contain a detailed description showing the expected development of the Hungarian power plant generating capacities (decommissioning and new built) until 2030; showing how NPP Paks II would fit into the energy system (concerning the installed capacity and the annual production).

Findings: included in section 2.1.1 of EIS.

- Moreover we would welcome if the Environmental Impact Statement would include a comprehensible and sound analysis of the economic aspects of the project at hand to underpin the statement of the NPP being of “known economic efficiency”.

Findings: not provided. The EIS states in section 1.3.2.3 that economic or financial matters related to the installation of the planned units are not addressed.

Electricity demand prognosis for Hungary

- Electricity demand prognosis should be updated instead of using data now used in the EIA Scoping Report.

Findings: recommendation considered. In section 2.1.1 of EIS it is mentioned that the forecasts on consumer demand and the presentation of medium and long-term capacity development of the Hungarian electric power system have been addressed based on newer studies (published by the Hungarian electric power system operator in 2013), based on the electricity consumption and system load data of the past few years and on the economic growth predictions of various economic research institutes.

- Current prognosis data should be used to take into account the current developments in Hungary and in the EU, concerning both economic development and changed legal framework.

Findings: considered in section 2.1.1 of EIS).

Alternatives

It is recommended that EIS cover the following points:

- Technically and economically feasible alternatives in contrast to the concrete nuclear power plant project using a balanced energy mix need to be elaborated and presented in an appropriate manner. The alternatives need to consider an adequate renewable energy use next to the use of fossil energies. In particular the actual potentials of renewable energies in Hungary, like wind power, biomass, biogas and solar need to be presented in a sound manner. Moreover the replacement of existing plants with modern co-generation and the deployment of decentralized biomass heating plants need to be taken into account.

Findings: answer provided in section 3.5.1 of International Chapter:

"The ideas formulated by the Hungarian Government on energy policy are contained in the National Energy Strategy, making detailed recommendations to create harmony between energy and climate policy up to 2030 with a view to economic development and sustainable environment to determine the acceptable level of energy demand and the development projects in the field of the energy industry, setting up a road plan up to 2050. Detailed Impact Studies must be available prior to each of the decision milestones to provide as much up to date data and information as possible for the preparation of decision making."

However, more relevant is an answer provided to a similar question, in the same section of the International Chapter:

"The missing capacity predicted by the forecasts (nearly 6,500 MW in 2027) can be covered by renewable energy resources and small power plants partially only, since the exploitation of these potentials in the environments with favourable conditions has happened already. The shortage of capacity at this scale is best reduced by large unit output newly constructed power plants and such a beneficial option is provided by the erection of the new power plant, since the generation of electricity in a nuclear power complies with the decarbonisation efforts formulated in the EU energy policy and allows to create economically efficient, long term and safe provision of electric power supply, while the fuel can be procured from a number of sources in a stable manner and at predictable prices."

- A review of the eco balances and life cycle analyses is necessary to really cover the whole life cycle, including the decommissioning and storing the wastes from nuclear power plants.

Findings: while such information was not included in EIS, the explanations provided in sections 2.2 and 2.3 are considered sufficient.

Costs of nuclear power

It is recommended to include in the EIS the following:

- Production costs of NPP Paks II over the whole project cycle – from drawing up the project to construction and operation to decommissioning and storing all the radioactive wastes in interim storages and a repository – need to be analysed and presented in the EIS.

- Comparison of the production costs of Paks II with alternatives.
- Due to the high investment costs for new nuclear power plants the ability to guarantee a high nuclear safety level is of high importance. The EIS should explain how the project applicant can guarantee a continuous implementation of a high nuclear safety level with increasing investment needs.
- In the framework of this Environmental Impact Assessment from the Austrian point of view the severe accidents which cannot be excluded are of particular interest. According to current knowledge none of the reactor suppliers can categorically exclude severe accidents. Therefore the economic assessment should include also follow-up costs of severe accidents and be put into comparison with the existing nuclear liability provisions in Hungary. The EIS should show in particular whether severe natural disasters, which can cause severe accidents in the planned NPP, exclude liability claims in line with the provision of the Vienna Convention also according to the Hungarian Nuclear Liability Law.

Findings: not provided. The EIS clearly states in section 1.3.2.3 that economic or financial matters related to the installation of the planned units are not addressed.

6 EVALUATION OF PRESENTATION OF THE ALTERNATIVES, INCLUDING ZERO ALTERNATIVE, CONSIDERED FOR PAKS II

There is no presentation of the alternatives included in EIS. Chapter 1 and 2, as well as the PCD, provide information on the studies performed in Hungary in the last years in order to evaluate the country needs and the feasibility of different options to ensure the electricity demand.

For the selection of the NPP technology for the new Paks NPP units the company MVM Zrt together with the MVM Paksi Atomerőmű Zrt started a project called Lévai project on the preparation of a tender on supplying the NPP equipment and constructing two new NPP units. In the frame of this project the development of the Bid Invitation Specification (BIS) was carried out. The BIS among others contained a detailed specification of technical and safety requirements based on the actual specifications contained by the European Utility Requirements (EUR) and the effective Nuclear Safety Regulations issued by the Hungarian Atomic Energy Authority.

Originally, the suppliers of five reactor types were selected as candidates for being invited for the tendering process. These reactors types were the following (according to the Preliminary Consultation Documentation):

- AP1000 – Advanced Pressurized Water Reactor 1000 (Toshiba-Westinghouse),
- AES-2006 (Atomstrojexport, the name of this type is MIR 1200 in the international market),
- EPR – Evolutionary Pressurized water Reactor (Areva),
- ATMEA1 (Areva-Mitsubishi),
- APR1400 – Advanced Pressurized Reactor (KEPCO–Korea Electric Power Corporation).

The tasks of the Lévai Project were transferred to a new project company called MVM Paks II. Zrt formed in June 2012, and the work on developing the BIS continued.

In January 2014 the Hungarian Government and the company Rosatom signed an agreement on the cooperation between the parties in the field of development of nuclear technology with the possibility of establishing new NPP units on the territory of Hungary. In parallel to the preparation of this agreement, the Government of the Russian Federation made a financial offer to the Hungarian that would allow easy financing of the establishment of the new NPP in Hungary, and later in 2014 the agreement of the financing was also signed. According to the governmental communication, no other financing scheme can be found to be more beneficial for the country than this one. In addition, it was also stated that the Russian nuclear technology is fully known by the Hungarian and they have the necessary experience with the Russian NPP technology, and the technical support organizations are fully prepared to accept the new Russian technology. Therefore, the government made a rather political type decision on selecting the Russian AES-1200 (MIR 1200) reactor type, and the announcement of the tender was cancelled. A long negotiation process was then initiated to reach agreement on the design requirements based on the specifications laid down in the BIS. According to some reliable information, this created a difficult negotiating environment, as the development of the BIS was so performed so as to produce the strictest requirements from the EUR, IAEA Safety Standards, the Hungarian NSR and WENRA Reference Levels, in order to make the Hungarian selection from different reactor types easier (i. e. to decide which reactor type is closer to satisfy all these requirements). Nevertheless, these strict requirements were „inherited" by the expert team conducting the negotiations on the design requirements of the Russian reactors. It is believed in Hungary that with this approach the Russian designed NPP will be even safer than the reference plant (Leningrad NPP II) and will be in full compliance with the EUR requirements.

However, there is no indication in the EIS of the reasons for this selection, as requested by the EIA Directive.

7 DETAILED EVALUATION OF EIS

The results of the detailed evaluation of EIS are included in the Annex to this report. The conclusions and recommendations issued based on these conclusions are grouped under the thematic previous sections and summarised in the first section of the report.

As a general conclusion it can be stated that that, except the radioactive airborne emissions in accident conditions, none of the other impact factors analysed in EIS may affect Austrian territory. But, in case of accidents occurring at Paks site, the Austrian state territory could be affected as a result of radioactive releases into the atmosphere. Therefore, a detailed identification and evaluation of all possible accidents which may occur at Paks site is of great importance for the EIA procedure. Due to the proximity to the Austrian state territory and to the level of the radioactive inventory, the existing as well as the planned nuclear power plants poses a potential threat. Even if the probability for Beyond Design Basis Accidents is very low, they have to be assessed in the framework of the EIA procedure very carefully. For the assessment of a potential impact on Austria, the evaluation of possibly severe accidents including the maximum source term and the most unfavourable weather conditions, which could lead to radioactive fall outs on Austrian territory are of highest interest.

8 COMPILATION OF QUESTIONS

8.1 Introduction

No question

8.2 Environmental Impact Assessment Report

a) *Would it be possible to clarify how it was the selection of the Russian technology and in particular if the environmental impact aspects were considered, as requested by the DIRECTIVE 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment?*

b) *Would it be possible to clarify why it was cancelled the bidding procedure?*

c) *Would it be possible to clarify how the nuclear safety requirements are going to be implemented during the design, construction and operation of Paks II?*

d) *Would it be possible to provide information about the cumulative impact of all nuclear installations existing at the site and planned to be built on the site, not only for normal operation, but also for accident conditions, including the impact of one installation on the others, and the cumulative impact of accidents affecting more than one unit in the same time?*

e) *Would it be possible to provide information about the estimated impact of Paks II on all environment elements in case of beyond design base conditions (severe accident)?*

f) *Would it be possible to provide information about the preventive and mitigation measures?*

g) *Would it be possible to clarify why it was selected the 30 km radius for the general survey area and what is the purpose of the "deliveries area" indicated in Table 1.3.2-2 (section 1.3.2.3) of EIS?*

h) *Would it be possible to clarify why the radiological impact on the workers was not estimated?*

i) *Would it be possible to clarify why the impacts on soil, landscape, cultural values and traffic was not estimated?*

j) *Would it be possible to clarify who will be the future operator of Paks II?*

k) *In addition to these, it is suggested to correct the 90 Sv value of the dose constraint indicated in section 4.4.2.3 (page 97) of EIS.*

8.3 Consideration of Austrian comments to EIA Scoping Document

a) *Would it be possible to provide information about the reference plant and its certification?*

b) *Would it be possible to provide a detailed description of the measures for control of severe accidents and the mitigation of accident consequences?*

c) *Would it be possible to provide, if available, the results of PSA?*
d) *Would it be possible to provide information about the status of implementation of stress test recommendations for Paks II?*

8.4 Nuclear safety aspects

a) *Would it be possible to clarify why the emergency heat removal spray pools (which are a specific safety feature of the selected technology) do not appear in the design described in Chapter 6 of EIS?*
b) *Would it be possible to provide more information and, if available, documented proofs of the validation of TREX (Euler-model) code used for modelling the dispersion of accidental airborne releases?*
c) *Would it be possible to clarify the information presented in Tables 2 and 3 (columns "1 day", "10 day", "30 days" for DEC1 and respectively "0–1 days", "1–7 days", "7–30 days" for DEC2) in section 2.3.5 of the International Chapter?*
d) *Would it be possible to provide the total doses and the doses calculated on all exposure pathways due to airborne releases in case of beyond design basis accidents (DEC1 and DEC2)?*
e) *Would it be possible to clarify if the revision of the Hungarian NSR will imply the modification of the requirement to analyse only design base accidents for the purposes of environmental impact assessment in accident conditions?*

8.5 Radioactive waste and spent fuel

a) *Would it be possible to clarify if a national strategy and/or program for the management of RW and SF do exist in Hungary, according to the Council Directive 2011/70/EURATOM establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste?*
b) *Would it be possible to clarify who is the owner of the prime responsibility for the safe management of RW and SF according to the Hungarian legislation?*
c) *Would it be possible to provide information about the estimated impact of already existing RW and SF stored on Paks NPP site during the construction of Paks II?*
d) *Would it be possible to provide the total estimated quantities of RW and SF at the site (when all units will be in operation) and the existing quantities on Paks NPP site?*
e) *Would it be possible to clarify how it will be ensured the removal of residual heat from the High Level Waste (other than Spent Fuel) planned to be stored inside the Auxiliary Building?*
f) *Would it be possible to provide the doses to the workers and members of the public due to RW and SF management operations planned to be performed at Paks II calculated with the quantities and characteristics of the RW and SF which will be generated by Paks II?*

g) *Would it be possible to provide the types and quantities of RW and SF following severe accidents (and not only design-basis accidents)?*

h) *Would it be possible to provide the estimated impact of accidents affecting the RW and in particular SF management facilities to be established on Paks II?*

i) *Would it be possible to clarify the information given in section 8.1.2.1.5 of EIS in relation with the temporary storage of spent fuel on site for several decades "perhaps even beyond the plant's operation time" which contradicts the information given in Chapter 19?*

j) In addition to these, it is suggested to replace all the references to the IAEA Safety Series No.115 in Chapter 19 with references to Directive 96/29/Euratom and to correct the information relative to international and EU legislation given in section 19.1 of EIS.

9 ANNEX

Detailed evaluation of Paks II Environmental Impact Study

1. Basic information regarding the planned project

This chapter present the activities performed in the past in preparation of Paks II project (Teller project, Levai project, establishment of MVM Paks II Zrt as the project company, development of the National Energy Strategy, establishment of the Government Commission for Nuclear Energy and designation of Paks II as a high priority high-priority project for the national economy), the general licensing system for a new NPP in Hungary, the current situation of environmental licensing and the selection of the technology for the new NPP.

A general description of the entire licensing system is presented in section 1.2. Section 1.3 describes the environmental licensing process, as well as the results of the consultations held during the scoping stage; more details on this are provided in the International Chapter.

Section 1.1.5 presents the selection of the units to be built; this was done apparently through a political decision, and there is no mentioning of any reasoning of this selection. As such, in January 2014 the Hungarian Government signed an agreement with the Russian Federation Government for renewal of the nuclear cooperation agreement ceased several decades ago; under this agreement, 2 VVER-type reactors of 1,200 MW each will be built on Paks NPP site, with the Russian Competent Authority acting as the main contractor, for which the Hungarian Government will be given an intergovernmental loan from Russia.

This chapter also summarizes the surveys performed in order to provide a baseline for the EIS. Such surveys were focused on characterisation of the site, weather conditions, description of the geological formation, ground and underground aquatic environment, environmental radioactivity, noise and vibration, air quality, wildlife health status and population health status. All surveys were performed in 2012–2013, except for meteorological data which were collected (or considered) till 2010. The areas where these surveys were performed have been defined as follows: a direct impact area (with 3 km radius around the site), an indirect impact area (with 10 km radius around the site) and a general survey area (with 30 km radius around the site). While the impact area is defined according to the legal provisions in place, for the selection of a 30 km area for general survey it is not provided any explanation or justification. Also, a “deliveries area” with 25 km radius is indicated in Table 1.3.2-2, but the purpose of this area is not given. A clarification of these aspects would be needed.

The last section of this chapter present the results of the official consultations held with the environmental authority designated to issue the environmental license for Paks II (DdKTF).

2. Forecasts and strategies related to the planned project

This chapter provides an overview of the forecasts related to the use of electricity in Hungary, and the main statements of the National Energy Strategy 2030, the National Climate Change Strategies and the National Environmental Programme.

The forecasts of the energy consumption in Hungary presented in this chapter of EIS are based on two separate studies published in 2013 by MAVIR (the Hungarian Independent Transmission Operator Company). According to these studies, an annual increase of 1.5% in average in the net electricity consumption is expected after 2014, with a slight decline after 2020. Based on the forecast, the installed capacity of large power plants will decrease to ~ 3,500 MW by 2030 compared to 2013, mainly due to the shut-down of old Hungarian power plants. A capacity shortage of this size should be reduced, according to EIS, by newly built power plants with a high unit capacity. The construction of a new NPP is seen as a favourable solution, as the generation of electric power is economically efficient, allows safe power supply over the long term, and the required fuel can be purchased from known sources at a calculable price. Moreover, according to the National Energy Strategy 2030 approved by the Hungarian Parliament in 2011, promoting safe nuclear energy is foreseen as one of the means to achieve the strategic objectives aiming “to make Hungary self-sufficient with regard to energy“. The National Energy Strategy analyses several possible scenarios, from which the preferred one is the “nuclear – coal – green scenario” consisting in: long-term maintenance of nuclear power in the energy mix, sustainability of coal-based power generation and linear extension of the National Renewable Energy Action Program after 2020.

Based on Hungarian Act LX, National Climate Change Strategies are required for implementation of UN Convention on Climate Change and its Kyoto Protocol. As such, a National Climate Change Strategy was prepared for the period 2008–2025, being followed by a Second National Climate Change Strategy (NCCS-2) for the period 2014–2025, with an outlook to 2050. NCCS-2 includes the Hungarian Low-Carbon Roadmap setting the targets, priorities and courses of action for reducing the emission of greenhouse gases until 2050. For the purposes of establishing the NCCS, the future emission scenarios were analysed with the help of a carbon calculator developed by the Department of Energy and Climate Change of UK under a bilateral British-Hungarian cooperation program. Two scenarios have been examined with the help of the carbon calculator, representing the extreme values of emission trends: minimum GHG emission scenario and maximum GHG emission scenario. The study showed that if the minimum emission scenario is achieved, GHG emissions will drop radically already in the short run, primarily due to the increase of renewables and import; the expansion of Paks NPP is seen a decisive step in the medium term, resulting in significant reduction of emissions between 2020 and 2030. EIS also states that zero emission could be reached in 2030 due to the temporary parallel operation of the old and new units of Paks NPP, as well as to the further increasing imports, but it draws attention on the theoretical character of these calculations. However, NCCS-2 concludes that the structure of electricity production set forth in the National Energy Strategy will result in an emission reduction of about 70% by 2050 and that the long-term use of nuclear energy in Hungary is a basic pillar of decarbonisation.

3. A general guide to nuclear engineering

This chapter presents in general terms the nuclear electricity production in the world, with the number of operating NPP’s by reactor type and the number of ongoing projects, an introduction of PWR units, with an overview of the power production process, the necessary fuel and the main systems and facilities on the site, the international organizations playing different roles in nuclear safety and radiation protection (IAEA, ICRP, EURATOM, NEA-OECD, WANO, EUR, WENRA), as well as the nuclear safety principles and Hungarian regulatory requirements (which seems to be in line with EUR requirements). This chapter includes also a section presenting the Russian regulations which have to be applied for designing Russian reactors, but there is no statement on their compliance with the EUR requirements, or the Hungarian regulations, except of a mention of the EUR publication giving the specifications for LWR Russian units. The chapter also introduces the INES scale of events, with examples and a short presentation of the Hungarian notification system in case of an accident at Paks NPP; however, section 3.5 indicates that "Events of any level on the scale have to be reported to the National Nuclear Energy Office (OAH) and the Vienna headquarters of the International Atomic Energy Agency (IAEA) and also to other organs designated by local and international treaties". Since Hungary is an EU MS, it is also mandatory to notify EC; in addition, the IAEA Notification Convention clearly stipulates that neighbouring countries or countries with which bilateral agreements have been signed for notification of nuclear accidents might be notified directly (and not only via IAEA). Therefore, it is suggested to include in this Chapter also the notification of EC and the neighbouring countries which Hungary signed bilateral agreements on notification of nuclear accidents.

4. Description of the planned installation site

This chapter describes the location of the planned new units of Paks NPP, as well as the plant operating at present and its radiological influence on the environment and how is this monitored.

Paks NPP is located in Tolna County, 118 km south of Budapest. The plant lies 5 km south of Paks, 1 km west of Danube and 1.5 km east of Main Road No. 6.

The area envisaged for the new units is situated on the north from the existing units, having a total surface of 105.8 ha. The operating area will accommodate the new units, the auxiliary equipment and support systems, as well as other buildings. According to EIS, the area is accessible by road, rail and water, but the current infrastructure needs to be further developed or upgraded in order to allow daily commuting or the supply of large amounts of equipment in the installation period. Currently, there is no direct water supply or waste water disposal available and these issues need to be addressed during the preparatory phase of the project. Also electricity has to be supplied for the construction of the new units, and some possible solutions are already identified in EIS.

Paks NPP has four VVER-440/V-123 type reactor units operating at present, which were commissioned between 1982 and 1987. The initial nominal capacity of each unit was 440 MWe, but it was increased to 500 MWe, resulting in a total nominal capacity of Paks NPP of 2,000 MWe. The total heat output of the plant is 5,940 MWth. In 2013 Paks NPP generated 15,369.6 GWh electricity, accounting for 50.7% of Hungary's gross domestic electricity output. The reactors are fuelled with uranium dioxide, being moderated and cooled with light water, taken from the Danube and discharged back into the Danube. The spent fuel is temporarily stored on site, inside the Spent Fuel Interim Storage, after cooling 3–5 years in the reactor's spent fuel pond. The electricity generated by Paks NPP is transformed by the main transformers to 400 kV; the main transformers are connected to the national grid via a 400 kV overhead electrical power line to a 400/120 kV substation.

Paks NPP continuously monitors and reports its emissions into the environment. Waste water and used water emissions are monitored in accordance with a plan approved by DdKTVF; temperature, volume and quality of water intake and discharge are measured in various sampling points. According to this P[lan, the temperature of the water removed from and returned to the Danube is continuously measured; if the temperature of the discharged water exceeds 25°C, the water temperature is also measured 500 m downstream of the discharge point. In order to monitor potential sources of environmental pollution, Paks NPP also operates a groundwater monitoring system, as required by its environmental license.

In addition to these, Paks NPP also monitors the environmental radioactivity around the plant. In order to estimate the radiological impact of the operation of the plant, the measured values are compared with the baseline data obtained before the commissioning of the plant.

According to Decree 15/2001 (VI. 6.) of the Minister for the Environment, radioactive emissions to the air and water have to be monitored, together with the levels of environmental radioactivity related with these emissions. Two types of monitoring are performed by Paks NPP, continuous monitoring and environmental sampling. Online remote monitoring networks measure the airborne and liquid radioactive emissions on a continuous basis. An Emission Monitoring Laboratory uses isotope selective, high-precision laboratory investigation methods to improve the accuracy of the remotely measured values of the samples taken from the emitted media. The Environment Monitoring Laboratory measures the isotope selective radioactive concentration, the gamma radiation dose and the dose rate of the various environmental samples taken from of the environment within 30 km of the plant. Both laboratories are accredited by the National Accreditation Board.

Authorized limits for the radioactive emissions of Paks NPP were established in 2004 based on a 90 µSv/year dose constraint. The emissions of the plant in 2013 were at the level of 0.26% of the emission limit, which means that only 0.26% of the permitted values were actually emitted into the environment. The values reported in EIS for the previous years are in the same order of magnitude, far below the permitted levels.

Airborne radioactive substances are emitted from Paks NPP in a controlled manner, through the ventilation stack of Units 1-2, the air funnel of the sanitary building and the ventilation stack of Units 3-4. The ventilation stacks are monitored online, the inert gases are measured by a gamma spectroscopic method, Kr-85, aerosols, iodine, tritium, C-14 and Sr-89 and Sr-90 are measured by sampling (daily and weekly samples). Liquid radioactive substances are emitted from Paks NPP through one point in a controlled way: the water collected in tanks is drained to the warm water channel, after the radiological control of the content, via the permitted emission routes, through the outlet conduct that collects purified communal waste water above-balance waters before the energy dissipation device, and then they are discharged into the Danube. Activation and fission products, tritium and alpha-emitters are measured in liquid emissions for compliance with permitted levels.

In addition, environmental radioactivity is monitored by measuring the radioactivity of air, fall-out, soil, groundwater and natural vegetation (grass), surface waters (Danube, fish ponds, catch drain), water, sludge and fish, milk, as well as the ambient gamma dose and dose rate. Water, sludge, soil, grass, milk and fish samples are analysed by specific laboratory measurements. Two concentric rings of automatic stations are installed around Paks NPP, in order to continuously monitor gamma dose and dose rate, total beat activity and radio-iodine in the air, as well as to collect samples of aerosols, fall-out and wash-out for subsequent laboratory analyses. In addition to these, tritium content of groundwater is monitored by Paks NPP, using a network of groundwater monitoring wells. The tritium concentration measurements is supplemented by total beta and gamma spectrometry measurements whenever tritium concentration exceeded 500 Bq/dm^3; part of the wells on Paks site are equipped with continuous samplers in order to detect other radioactive substances that might be present (gamma-emitters, C-14, Sr-89, Sr-90, Pu-TRU) in addition to tritium.

The results of the radioactive emissions and environmental monitoring are reported and published every year by Paks NPP. They are also used to demonstrate compliance with the dose constraint. As such, according to EIS, the dose to the population due to operation of Paks NPP in 2013 totalized 48,2 nSv, which represent 0.0537% of the 90 µSv annual dose constraint. However, it is suggested to correct the number given in page 97 (section 4.4.2.3) for the dose constraint (due most probably to a typing error, 90 Sv are indicated instead of 90 µSv).

The measurements performed by Paks NPP are verified by the competent authorities, using the Joint Environmental Radiation Monitoring System. In addition to ambient dose rate, atmospheric aerosols fall-out and dry-out, surface waters, drinking water, sediment, soil and grass, leafy vegetables, meat and milk are measured by the authorities, in parallel with the NPP. The monitoring results are published yearly, under the title Report of the Joint Environmental Radiation Monitoring System.

In addition to these, a National Environmental Radiological Monitoring System is operated in Hungary, by various authorities and organizations with different responsibilities related with environmental monitoring at national level. The results of the measurements performed by this system are also published yearly. The 2012 Report of the National Environmental Radiological Monitoring System states that “the exposure of the population to radiation from man-made sources – other than those used for medical purposes – can be estimated between 3 to 6 µSv in recent years in Hungary” and that “the activities subject to licensing [such as Paks NPP] have negligible impacts on the environment and on the population”.

To conclude, all the statements related to environmental radioactivity monitoring, including radioactive emissions monitoring performed by Paks NPP and the Hungarian authorities are fully in line with the relevant international standards and recommendations (as per IAEA GSR Part 3, RS-G-1.8, WS-G-2.3) and in full compliance with the EC requirements (as per Directive 2013/59/EURATOM, art.35/EURATOM, art.36/EURATOM, Recommendation 2000/473/Euratom, Recommendation 2004/2/Euratom). Although not specifically mentioned in EIS, Hungary is reporting the environmental monitoring data as well as the radioactive discharges from Paks NPP to EC, as requested by articles 35 and 36 of EURATOM treaty. Such data are compiled by EC in two separate databases (EURDEP and RADD) which can be consulted online on the EC website, and they are also compiled in periodic reports published on EC website. The discharge data reported by EU MS are also used by EC to estimate the collective and individual doses to the public due to the operation of nuclear installation in EU MS. According to EC Radiation Protection Publication No. 176, the individual doses to the representative person due to airborne releases from Paks NPP in 2004 were 1.6 µSv at 0.5 km from the plant and 0.16 µSv at 5 km from the plant; in 2008, the doses were 1.1 µSv at 0.5 km from the plant and 0.13 µSv at 5 km from the plant; the liquid discharges had a much lower contribution to the doses. Thus, the dose reported in EIS for the operation of Paks NPP in 2013 is credible and it shows a clear decreasing tendency, which is in line with the tendency observed by EC in its Publication 176 and which also demonstrates that Hungarian regulators and Paks NPP are applying more and more stringent safety requirements.

One aspect that also worth mentioning is that under art.35/EURATOM, EC has the right to perform verifications in EU MS regarding the correct implementation of this article. Such verification was performed by EC in 2004 at Paks NPP, concluding that “the facilities necessary to carry out continuous monitoring of levels of radioactivity in the air, water and soil around the Paks site are adequate.”

In conclusion, our opinion is that at least the first factor listed in section 4.5 as being in the favour of building 2 new units at Paks can be credited.

5. Possible methods of condenser cooling in the new nuclear power plant units

Water cooled reactors require different quantities of water, depending on their size, capacity and type, mainly for dissipation of the heat generated in the plant. Water cooling systems are generally of two types: open loop cooling systems (once-through) or closed-loop cooling systems. Once through systems withdraw water from the sea, rivers or lakes to remove the heat from the power plant; once the cooling water is heated up, it is returned to its natural source. Closed loop cooling systems (such as cooling towers) recirculate the cooling water, but evaporation and other losses need to be supplemented by make-up water, which leads to the need for water consumption from its natural source.

In general, if a NPP is located close to a sea, a big river or a large lake, the cooling may be achieved with a once-through cooling system, which withdraw large amounts of water to circulate it through the condensers in a single pass and then to discharge it back into the feeding water body, a few degrees warmer and without significant losses from the withdrawn amount. If there is no such large water body close to the NPP, the cooling may be carried out by passing water through the condenser and then using a cooling tower, where an updraught of air through water droplets will cool the water. The cooling is achieved in particular through evaporation, with simple heat transfer to the air being of less significance. Wet cooling towers evaporate up to 5% of the flow to cool down the recirculating water that is returned to the condenser, but these 3 to 5% are effectively consumed and must be continually replaced.

Both these cooling options were analysed in separate studies, in order to select the optimum cooling method that can be built and economically operated at Paks II, with the best possible technology and efficiency under the given circumstances and environmental conditions, in compliance with the EU and Hungarian environmental regulations. According to the EIS, the results of these previous studies show that the feasible cooling methods for Paks II are fresh water cooling system, using the Danube water in a similar way as it is presently done for Paks NPP, and wet cooling towers, which can operate independently of the Danube in air cooling mode. The analysis of these possible cooling options is presented in Chapter 5, from the point of view of technology, cost efficiency and environmental protection. Although no exact data on the analyses performed are presented, it seems that all alternative solutions were analysed, and that the preferred one is an open-loop similar with the existing one, withdrawing water from Danube and discharging it back into the Danube. All possible impacts on the environment have been considered (heat load of discharged water in case of open-loop, or waste heat emission, noise and landscape in case of open-loop) and different measures to limit them are presented. In any case, since Paks II will be located on the Danube downstream from Austria, such impacts could not affect the Austrian territory.

6. Characteristics and basic specifications of the Paks II Nuclear Power Plant planned to be built on the Paks site

This chapter presents the characteristic features of the Russian VVER units planned to be built on Paks site, the primary circuit, the secondary circuit, the planned cooling systems, the auxiliary systems and facilities, the control engineering technology, telecommunication, the power systems, the architectural solutions, the installation site plan, the physical protection system and the characteristics of the nuclear fuel to be used, as well as a summary of some characteristics of the construction, operation and decommissioning stages of Paks II.

VVER-1200 is an improved version of the VVER-1000 unit with a longer designed operating life (60 years), with a higher built-in capacity and with higher thermal efficiency. The chapter provides some information on the Russian Federation plans for constructing such units in Russia, Europe (Finland, Czech Republic, etc.) and other parts of the world (Turkey, Jordan, etc.). The background of the VVER-1220 design development is summarized, with its two versions MIR 1200 – St Petersburg design and AES-2006 – Moscow design. Which of the two versions was/will be chosen for Paks II is not specified; however, in some other parts of EIS (e.g. Chapter 20) AES-2006 is mentioned. Considering that only the predecessor of one of the versions, the AES-92 (1,000 MWe PWR, the VVER design developed by AtomEnergoProjekt Moscow) was certified by EUR, it cannot be confirmed at this point that the design to be built at Paks II will be, by the time it is being built, also certified by EUR.

However, both the Hungarian bid invitation specifications (technical specifications for procurement of the plant) and the Czech Republic specifications (where the version chosen is already known to be the MIR 1200) have been developed making extensive use of the EUR requirements. Compliance with these specifications will ensure that the new plant will meet in fact the EUR, even without (for the time being) a formal certification.

The chapter provides a description of the main plant characteristics with emphasis of the cooling water systems, with the purpose of providing the background for the data used further in determining the plant impact: i.e. water abstraction and waste water discharge quantities and parameters, necessary modifications of existing water intake and discharge structures to accommodate Paks II, taking also into account the needs of Paks NPP units until the end of their extended lifetimes.

7. Connection to the Hungarian power grid

The new units of Paks NPP will have to be connected to the Hungarian power system. A preliminary feasibility study on the required electrical network developments (prepared under the Lévai Project) showed that the connection of the new units to the power grid requires a new 400/120 kV substation, a third 400/120 kV transformer to be installed in the region and also a dual-system transmission line. This chapter describes how the new units of Paks NPP will be connected to the grid, the installation site of the new 400/120 kV substation, the routing and the parameters of the 400 kV unit line and 120 kV transmission line, as well as the impact of the transmission lines (electrical and magnetic fields, corona discharge, ionizing effects, noise). None of these effects may affect Austrian territory, since even the local impact will be insignificant in comparison with the total impact of the plant.

8. Potential impact factors and impact matrices of Paks II

This chapter summarizes the potential impact factors related with the implementation of Paks II project. These impact factors are grouped depending on the locations that may be affected, the time when they may appear and their characteristic types.

As such, the locations identified by EIS as potentially affected during the construction and operation of the new units are: Paks NPP and its associated facilities, the unit line and transmission lines and the transport routes. In our opinion, these locations are affected during normal operations only, but in case of accident conditions, a larger area (off site) might be affected.

Chronologically, the impact factors may appear during 3 different stages, as follows: preparation, construction and implementation of the new units (which is foreseen to last ~ 10 years), operation of the plant (foreseen until 2090 when the last unit will be shut down) and decommissioning (for which no period is assumed).

The typical impact factors considered in EIS are: the use of environmental elements, the emission of conventional (non-radioactive) and radioactive pollutants, the generation and management of conventional (non-radioactive) and radioactive waste and the management of spent fuel.

All these potential factors are further detailed in the Chapter 8, for both normal and abnormal operations during all phases of the project and for all locations identified as possibly to be affected. One mention to be done is that in section 8.1.2.1.5 it is mentioned that for spent fuel it is envisaged temporary storage on site for several decades "perhaps even beyond the plant's operation time", until it will be relocated to a disposal site. This is in contradiction with the information given in Chapter 19 of EIS and it is suggested to correct this information, since such a long-time storage would entail consideration of all the specific (enhanced) safety features to be addressed and it might also affect the planned immediate dismantling option for decommissioning of Paks II.

Another important observation is that only design-basis conditions are considered for the evaluation of accident conditions, and it seems that this is due to the nuclear safety requirements currently in place in Hungary. According to the IAEA recommendations, the impact due to beyond design basis accidents and severe accidents at the nuclear power plant should also be evaluated for the purposes of assessment of environmental impact of new NPP. This aspect should be clarified since it might have an impact of safety of the plant. In section 3.4.3 of EIS it is mentioned the revision of the Nuclear Safety Regulations that will imply the modification of the definitions of plant states; it would be useful to know if this revision will also address the requirement to analyse the impact of beyond design basis accidents too.

9. Social and economic effects

The urban, rural and spatial developments in the study area (30 km around the plant) are analysed in this chapter, based on the national, county and local settlement plans and development concepts. The description of artificial (man-made) environment is based on data of the Hungarian Regional and Urban Development Non-profit Ltd. Co. and the development plans for the study area. The chapter covers the settlement structure, the economic and population profile of the region, the transportation routes, the land use, as well as the socio-economic impact of the new project.

The study area includes 75 settlements located on the territory of 3 counties (Fejér, Tolna and Bács-Kiskun). Based on the settlement plans of these counties, the regional zones for the settlements located in the study area were summarized in EIS and they include: arable land zone with excellent production capacity, forest area zone with excellent production capacity, landscape protection area zone with national and regional significance, extremely sensitive underground water quality protection zones, surface waters water quality protection and water catchment zones, mineral reserve management zones, world heritage-expectant area zone, historic settlement zones, zones regularly exposed to inland inundation, high-water river basin zones, zones exposed to geological danger, water erosion, wind erosion, etc.

The 75 settlements in the study area include 1 county capital, 10 cities, 7 large villages and 57 villages. Larger settlements are concentrated in the region next to Danube, while small and minor villages are found in areas farther from Danube in the Great Plain region.

The study area does not include world heritage sites, but several sites have been proposed to be awarded this title (the Hungarian section of the Roman Limes and the network of rural heritage buildings in Hungary). The protected historical monuments in the study area are also listed in this chapter, based on the Historical Monuments Register of Hungary.

According to the Government Decree No. 314/2012. (XI.8.), the municipality of Paks prepared a Zoning Ordinance and a Zoning Plan of the City of Paks, based on which the premises of Paks NPP and the areas designated for the construction of the new units and adjacent facilities are located within an economic-industrial building zone. According to the Municipality Ordinance (in effect since January 30, 2014), the Paks II building zone comprises the premises of Paks NPP and of the Interim Spent Fuel Storage Facility, where the following activities may be performed: electricity generation during the permitted operation, the interim storage of fuel spent during the permitted operation in Paks NPP, exclusively, and activities preceding and related to the preparation of the construction of the planned new units of the power plant.

According to the Settlement Structure Plan and Description adopted in 2011 by the Municipality of the City of Paks, the expansion of the NPP is not expected to increase the population significantly, therefore it would not create a need for the designation of new and larger residential areas; the expansion of the plant can be realized within the current premises of Paks NPP. The major directions of urban development are related with continuation of construction of urban infrastructure systems (road and public utility networks) and increase the quality of life.

According to the Hungarian Act LVII of 1995, water use is a concept integrated into the water management, together with preservation of utilization options and water damage prevention. As such, water beds settlement and regulation, protection against floods and inland inundation and water damage prevention are the key tasks to be performed in the study area. The most significant surface waters in the study area are: Danube, Kapos, Sió, Nádor-canal (Sárvíz), Szelidi lake, Fadd backwater, Szakmári lake, Matild lake, the artificial lakes next to Simontornya, cooling ponds of Paks NPP, fishing ponds at Akasztó. Several settlements in the study area belong to the quality protection water catchment area zone of surface waters, and there are also settlements belonging to the high-water river basin zone.

Two types of underground water are present in the study area: reservoir water in the Pannonian sandstone beds and soil water located in the Pleistocene-Holocene sequence. Underground waters need protection with the study area primarily in the settlements along the Danube river. The settlements of Tolna County (inside the study area) are located along the Danube, Sió, Kapos and Völgységi streams; these water reservoirs are sensitive due to missing appropriate geological protection (porosity and shallow porosity), thus they require enhanced protection. In Bács-Kiskun County the water quality protection areas of extremely sensitive underground waters are exposed to a high-level risk because they are located on the Danube gravel terrace area, sensitive to surface pollution and with high soil water position.

Based on the settlement plans, 63% of the study area is exposed to regular inland inundation, i.e. 48 out of 75 settlements. Inland inundation water is drained from these settlements through the inland inundation drainage canals Szekszárd-Báta, Bölcske-Bogyiszló, Szekszárd-Simontornya and Kalocsa.

The national, county and area settlement plans were used in EIS to prepare the profile of the transportation routes, road, railway, waterway network and air space use in the study area. As such, the area is crossed by M6 and M9 motorways, as well as a number of national main roads, planned roads and connections, Budapest – Rijeka and Budapest – Belgrade international railways and other national main and secondary lines, international waters (Danube, km 1,641–1,433) and waters of national significance (Sio channel). There are public ports within the region, as well as ferry lines, and 2 airfields/airports that can be developed to commercial airports.

A surface cover map and the land use profile of the study area was prepared using the ortophotos generated from coloured (RGB) and coloured infra (CIR) aerial photographs taken in 2013 as part of the initial studies; these were further computerized and the surface cover elements obtained were statistically processed. As a results, it was concluded that agricultural areas are significant in the region, cultivation of large-scale farming non-irrigated arable having the highest share in the region (56%), with small-scale non-irrigated arable lands being also present, as well as deciduous forests, intensive pastures and strongly degraded lawn areas.

The demographic characteristics of Paks and the settlements located in the study area are presented for the period 1990–2012 and 2020–2120 (predictions). The calculations were done using the data obtained following the 2011 population census and the demographic statistics of the Central Statistical Office for 2012 and 2013. Regarding the demographic characteristics of Paks region, the following information are presented: the profile of demographic conditions in Paks region between 1990–2012 (fertility, mortality, migration, and their effects on the number and composition of population), population of Paks region between 1990–2012 (number and composition of population), demographic characteristics of Paks region versus national figures (demographic indicators, within those specifically fertility and mortality indicators versus national average figures), demographic characteristics of Paks region for the future (hypotheses). Based on the data obtained from various population censuses, the Research Institute of the Central Statistical Office Demographic prepared county-level forward-looking calculations, which were performed using the cohort-component method, recommended by UN; with these calculations it is possible to predict changes in the population, including breakdown figures for genders and age groups, in order to provide the basic population data for long term planning. As such, the following data are presented: residential population of Paks region between 2020–2120 (number of residential population broken down to age groups), demographic indicators of Paks region between 2020–2120 (fertility and mortality rate, total fertility rate, life expectancy at birth and migration balance), other demographic indicators characteristic to Paks region (ageing index and dependence rate). As a conclusion of these forward-looking calculations, it is mentioned as a basic tendency that the population will for sure significantly decline on long term accompanied by population ageing.

The planned project is seen as having significant impacts on the national economy of Hungary, and obviously on the regional and Paks economy. At the national level it is expected that Paks NPP extension will result in improving the economic performance, since domestic enterprises are expected to start the necessary preparations to be involved into the project implementation, and all these will have a positive effect on education, development of human resources and technical assets of such companies.

From an energy policy point of view, it is considered that the „mix" which can ensure the electricity production for the country will remain well-balanced also after the decommissioning of units 1-4 of Paks NPP, and the country's dependence on direct electric energy import will be reduced compared with the "no-development" scenario; the price of the electricity generated by Paks development is expected to remain competitive on long term, thus allowing the domestic enterprises to increase their production.

Another positive effect identified in EIS is related to domestic suppliers who are expected to participate in the works related with the implementation of Paks extension project (in a proportion of 39–40%). The implementation of the project could last several years (maybe 10) and in this time several thousand jobs may be offered (to suppliers, service providers, or different activities like research, planning, manufacturing, transportation, building, assembly, commissioning etc.). Companies operating around Paks NPP (in building industry, manufacturing, assembly and transportation) could also be involved in implementing the project, either directly or indirectly (in auxiliary works e.g. infrastructure construction) thus enhancing the regional entrepreneurial potential and providing chances for employing local manpower.

No transboundary impact is expected.

10.Climate Profile of Paks and its Environs within a 30 km Radius

The climatic analysis of Paks region (Paks NPP site and the 30 km study area around it) was conducted by the Hungarian National Meteorological Service (OMSz) by analysing the certified data sets measured between 1981 and 2010 by the meteorological stations located in the region. The 30-year period used is considered long enough for providing a good profile of the climate's stability and variability in the study area. For the precipitation data, also the measurements performed by the conventional precipitation metering stations located in the area were used.

After 1997, a number of extreme weather situations occurred on the Hungarian territory, including the Paks region and because of this, detailed data processing was conducted for the period 1997–2010 to report these situations, having particular regard to deviations from average and extreme values.

The following meteorological parameters were investigated: temperature (monthly, annual and summer mean temperatures, temperature extremes, daily and monthly maximum and minimum values, number of hot and sweltering days, maximum and minimum temperature return values up to 20,000 years frequency), precipitation (monthly, annual, winter and summer half yearly total precipitation amounts, extreme monthly total precipitation amounts, daily amounts maximum per month, snow conditions, extreme daily total precipitation amounts and snow depth return values up to 20,000 years frequency, thunderstorm activity), duration of sunshine (average annual progression of sunshine duration), average annual progression and monthly extreme values of air pressure converted to sea level, evaporation and evapotranspiration (monthly average values of actual and potential evaporation), soil temperature (average annual progression at depths of 2, 5, 10, 20, 50, 100 cm), wind conditions profile for the 1997–2010 period at a height of 10 m (wind direction frequency in respect of 16 directions, in annual, as well as summer and winter half year breakdown, monthly and annual wind speed values, monthly and annual development of windless conditions frequency, average daily and annual progression of wind speed, maximum wind gust velocity and frequency per 16 wind directions, number of days with moderate gale force winds, relative frequency of average wind speeds, atmospheric stability conditions, maximum wind gust extreme's return values up to 20,000 years return, investigation of tornado occurrence probability, determining tornado characteristics).

Based on the temperature analysis it is concluded that average temperature is showing an increasing trend at annual level; the analysis of the daily occurrence of summer, hot and sweltering days also shows even more frequent extremities within single years. Similarly to temperature, a positive trend is reported for precipitation at annual level. It is also noted that the scatter of annual totals was also higher in the last ten years, this suggesting the occurrence of extreme precipitation. Extreme precipitation values that can be expected every 2, 4, 5…, 100,000 years were calculated using the Gumbel statistical method on the basis of daily total precipitation measured at Paks between 1981 and 2010.

The direction in which pollutants will spread is primarily influenced by the prevailing wind direction, the distance that emitted substances will reach depending on the wind speed. Since 1997, wind has been measured at the Paks station using an automated VAISALA WAA type anemometer positioned at a height of 9.8 m above the ground. The period 1997–2010 was found long enough for the purposes of climate studies, therefore only these data were taken into account. As such, the prevailing wind directions are from NW (11.6%) and N-NW (11%), with the S direction appearing as the secondary maximum (8.1%).The relative frequency of wind directions was also examined for higher speed winds (exceeding 3 m/s); in such cases, winds mainly blow from NW and N-NW. Regarding the wind speed, it is noted a decreasing tendency in the annual average wind speed (1.6–1.7 m/s). Winds between 1.1 and 2 m/s blow most frequently. Wind speeds between 5.1 and 6 m/s occur at a lower percentage and those above 6 m/s quite seldom. Regarding the extreme winds, the reported direction of maximum wind gusts is NW in most cases, followed by S, then the N-NW directions. Wind gusts between 2 and 4 m/s occur most of the time, but those between 1 and 2 m/s and 4 and 6 m/s are also common; wind speeds exceeding 12 m/s only occur in a lower proportion, and those exceeding 17 m/s only seldom. The 2, 4, 5…, 100,000 yearly return periods of maximum wind gusts were also determined using the Gumbel's statistical method.

In order to analyse the extent to which the period under consideration deviates from the average conditions, and if any significant difference can be detected in the surroundings of Paks NPP, the data measured between 1 April 2012 and 30 November 2013 by 4 weather stations (OMSZ's Paks station plus 3 additional temporary weather stations) were analysed. Data measured at Paks station between April 2012 and March 2013 were first correlated with the 1981–2010 average values, then the 4 weather stations' one year (April 2012 to March 2013), as well as 8 month (April 2013 to November 2013) data series were compared. The data received from Paks stations showed similar values with the ones measured at national level in the same period. The data received from all 4 stations showed quite similar values, due to their proximity.

For the wind data at different altitudes the 10-minute breakdown data recorded since 2006 by the instrument tower of Paks NPP were used. The measurements were taken at 20, 50 and 120 m. Based on the data recorded by this tower, it is concluded that the N-NW wind direction prevails (14%) at 20 m, and N occurred most times beside that; the S and S-SW directions were also relatively common. The N-NW direction was also most common (13.3%) at 50 m height, the increase of the NW direction with growing height being clear. Wind speed typically increases together with altitude in the troposphere, which is also shown by the analysed data. While the frequency of the 2–4 m/s range is only slightly hardly greater at 20 m than that of the range below it, its dominance is clear at 50 m and at 120 m. During the period under consideration, maximum average speed was 12 m/s at 20 m, almost 18 m/s at 50 m, and values above 20 m/s also occurred at 120 m. The magnitude of maximum wind gusts also shows an increase with height. No wind gusts exceeding 25 m/s occurred at 20 m, but gusts greater than 30 m/s were recorded at 120 m.

In order to study the climate change, OMSZ adopted 2 regional climate models: ALADIN-Climate (a regional climate model developed by Météo France) and REMO (a regional climate model developed by the Max Planck Institute in Hamburg). For the purposes of estimating the climate change affecting Paks site, these 2 models were used to scale down the results of their global parts to a bounded range with a finer resolution. The effect of human activity regarding the future was taken into account based on the global carbon dioxide concentration values of an average scenario when the global models were run. Results were evaluated for the 30 km study area, for three 30-year future periods (2011–2040, 2041–2070, 2071–2100). As such, gradual warming is expected for the surroundings of Paks during the 21st century according to both models, at annual, seasonal and monthly level alike. In the case of precipitation, no linear or unequivocal changes will occur over the 21st century, either concerning the three future periods, the seasons or the two models. The change of relative humidity is according to the models: a decrease is expected for every season, therefore also at annual level, in respect of all three future periods in the vicinity of Paks. The models do not forecast any major or unequivocal changes regarding wind speed.

11. Modelling the Danube bed morphology and heat load on the Danube

This chapter presents the general hydrological features of the Danube, the methodologies applied for the evaluation of the impact of Paks NPP on the Danube, as well as the impact of construction, operation and decommissioning of the power plant on the Danube.

The first section of the chapter lists the relevant EU legislation, as well as the Hungarian laws and decrees as applicable.

Danube is the second largest river in Europe with a length of 2857 km. The Upper Danube includes the Bavarian and Austrian basins, the Middle Danube flows within the Carpathians Mountains and the Lower Danube crosses Romania. The river enters Hungary at Rajka in the 1850 river km profile and leaves the country south of Mohács at 1433 river km. The Paks NPP profile is at 1527 river km from the mouth. In the surrounding of Paks site the Danube is slightly of low course section character. The average water flow of the Danube varies from Dunaújváros to Mohács between 2,300–2,330 m³/s.

For the purposes of EIS, the Danube was studied in order to determine how the Paks site will be affected in case of extreme conditions, to investigate the morphodynamic changes developing as a result of the various hydrological events and to assess the typical parameters of the heat plume in the Danube due to discharges of warmed up cooling water into the Danube.

The cooling water requirements of the currently Paks NPP units at full capacity ranges up to 25 m³/s per unit (100 m³/s in total). The maximum operating cooling water needs of the proposed 2 x 1,200 MW new units is 66 m³/s per unit (132 m³/s in total). The maximum cooling water extraction level and returned hot water volume with both NPPs in operation is 232 m³/s.

The area of the Danube channel bottom studied consists in the 128 km long river section from Dunaföldvár (Danube 1560.6 river km) down to the national border (Danube 1,433 river km). For estimating the impact of Gabčíkovo (Čunovo) barrage system as a water level control facility, the range of investigation was extended from Dunaföldvár upstream to Vámosszabadi (Danube 1,805.6 river km). For this, the one dimensional (1D) model (HEC-RAS) was applied. The water environment at the site was investigated using different two dimensional (2D) and three dimensional (3D) models. The morphodynamic assessment of the impacts was performed using the Delft3D-Flow model. The assessment of the heat load impacts was performed using the OpenFOAM 3D software and River2D and Delft3D in two dimensions.

The impact of the cooling water extraction in extreme low water level situations (579 m³/s as resulted from the statistical processing of the low water levels recorded in 1965–2011 was examined taking into consideration the current information on the channel bottom morphology in comparison with the current status (i.e. the highest level of water extraction by Paks NPP – 100 m³/s). The calculations were performed assuming 232 m³/s cooling water extraction, with 100 m³/s hot water discharge via the existing hot water canal, plus 132 m³/s hot water discharge through the recuperation structure designed 200 m upstream into the Danube. As a failure incident, landslide was assumed upstream of the cold water canal to the Danube at extreme low water level conditions.

The impact of the cooling water extraction in case of flooding situation was examined in extreme high water level situations (14,799 m³/s) taking into account the current information available on channel bottom morphology in comparison with the current status (i.e. the highest level of water extraction by Paks NPP, 100 m³/s). The calculation were performed assuming 232 m³/s cooling water extraction, and 100 m³/s hot water discharge via the hot water canal, plus 132 m³/s hot water discharge through the recuperation structure (designed 200 m upstream into the Danube). The impact of the bursting of a dam (or artificial cutting through the embankment) on the Danube section upstream of the cold water canal outflow was also modelled. Landslide was assumed as a failure incident downstream of the hot water canal outflow on the left bank.

Based on the analysis performed, it is concluded that the construction of Paks II will have no relevant impact on the low and high water levels, the flow conditions on the Danube, or the river morphology changes in the Danube bed. Only the foundation of the recuperation structure planned to be installed 200 m upstream of the current existing hot water outflow will have a minimum impact influencing the flow conditions on the immediate Danube right bank, but this will not influence the navigation prior to the commissioning of the recuperation works. Similarly, the extension of the cold water canal mouth profile is expected to have a minor effect on the flow rate space of the flow.

For the operation of Paks II, it is planned to ensure the water supply to the 4 existing units and 2 new units by the extension of the channel bottom in the existing cold water canal (deepening by approx. 1.7 m and widening of the cross profile). The water extraction plant will be implemented in the cold water canal, so it will have no direct impact on the Danube flow space and Danube river bed, but only a minor indirect impact (due to the operation of the transfer pumps of the water extraction plant and of the cold water canal section leading to it). Hot water from the existing 4 units is discharged into the Danube by the existing hot water canal, through an existing energy dissipation device. For the 2 new units, a new hot water channel bottom will be built in order to discharge the hot water from the two new units, and at the Danube mouth of it a recuperation plant will be set up. The proposed construction of the hot water canal mouth will have a direct impact on the Danube flow conditions and local morphology will be changed due the recuperation power plant. The new hot water discharge outflow point will cause impoundment upstream, directly downstream of the cold water canal mouth, because it will break the nearly parallel shoreline current established in the riparian zone of the Danube. Large scale eddies with nearly vertical axis will appear between the inflow of the cold water canal and of the new hot water inflow. The highest discharge from the water extraction plant is expected between 2030 and 2032, when all 6 units will operate simultaneously. The impacts will consist in local modifications of the flows, which will be more evident in low and medium water periods on the Danube.

The impact of the heat load on the Danube due to the simultaneous operation of Paks NPP and Paks II discharging hot water at 2 distinct locations was investigated using a 3D hydrodynamic and heat transport model. The results shows that downstream of the new discharge point a whirl zone is formed which will carry away a part of the water flowing into the river from the original discharge point, and because of this the temperature drop is not monotonous up to the second inlet profile. An extra heat will appear on the upstream zone of the second discharge point. Based on the results it can be concluded that in the case of a joint heat load from both power plant, the 30 °C limit will not be observed in all days of the year due to the large amount of heat discharged and the increased background temperature (taken a Danube discharge rate below 1500 m³/s with an expected maximum 1 day/year duration). For such cases, corrective measures are proposed, such as monitoring, deloading, unit maintenance, unit shut down; also post cooling is recommended (installation of a post cooling system).

For the operation of Paks II alone (after the shutdown of Paks NPP), the heat load will be less than in case of joint operation, but according to the calculations the required 30°C limit can only be met downstream of the transverse dam – in the case of a Danube discharge rate below 1,500 m³/s with an expected maximum 1 day/year duration – due to the maximum gradual increase of the background temperature over time occurring as a result of the climate change. Similar measures are proposed also for this case (monitoring, deloading, unit maintenance, unit shut down, post cooling).

In order to define the impact area of the hot water discharge and the eventual transboundary impacts across the southern national border, the characteristics of the heat plume formed in the 3 km Danube bed environment as a result of the hot water discharge into the Danube were calculated from the +500 m profile up to the national border (Danube 1,525.75 – 1,433 river km). The hot water will travel approx. 93 km from the place of introduction into the Danube (Danube 1526.25 river km), up to the southern national borderline profile (Danube 1,433 river km) in the Danube bed, during approx. 24 hours at Danube medium water discharge rate (2,300 m³/s). According to the calculations presented in EIAS, the increased temperature at the southern border national border profile of the Danube (1,433 river km) will not exceed 30°C. However, there are no clear statements about the transboundary impact.

Based on the calculations performed for extreme flood events (a flood discharge rate recurrent in every 20,000 years), under the most unfavourable conditions (the flood control dike on the Danube right bank bursts, any of the bank line profile of the cold water canal and hot water canal is damaged), the inundation will not threaten the ground level of the site, but provided the wave motion becomes more intensive for whatever reason, it may generate an emergency situation and may affect vulnerable objects on the surface or in the public utility ducts. Therefore, the vulnerable objects situated close to the surface are recommended to be provided by active protection (parapet wall, etc.).

The Danube river section was investigated for the cases of extreme flood situations recurrent in every 20,000 years. Partial closure of the main channel as a result of a landslide downstream of the hot water canal was considered as a failure event (during joint operation) with respect to Danube water extraction and return, the conclusion being that water levels exceeding the inundation levels at Paks site with the Danube right bank flood control embankment are not possible even. Landslide incidents causing major channel closure were also investigated, the simulations showing insignificant effect. Formation of ice gorges in high water conditions was also investigated, the conclusion being that the duration of an adversely large continuous ice cover will be no more than 2–3 days, following which the ice pack or ice gorge will collapse; no ice flood on the site is foreseen.

The impact of the water retention incidents at extreme low water stages of the Danube violating the rules of operation of the Čunovo barrage system was investigated as a failure incident. According to the license, no water must be retained at Danube discharge rates lower than 1,000 m^3/s. The Water Management Service will detect the launch of undesirable depression waves in the Medve Danube profile, thus their arrival to Paks can be forecasted 1.5–2 days in advance, which should be enough for cease of water retention. In case this will not be possible and the depression waves will endanger the cooling water extraction, the power plant has to shut down the units. Another event investigated was ice gorge formation upstream of the cold water canal; this may cause serious problems in the cooling water supply of the power plant, in particular at extreme low water. However, since 10 or 15 very cold days are needed between the breaking-up and floating of ice and the formation of continuous ice cover and they must have been preceded by several months without precipitation, prevention of this event is possible (an ice breaker fleet provides assistance against the ice along the Hungarian Danube-section). In the case of temporary loss of cooling water supply due to low water levels, bank filtrated wells to be installed on the Danube and the water body of the Danube itself may be used; the water production capacity of the bank filtrated wells does not reduce substantially in the extreme situation where the extraordinary low water stages on the Danube prevail for a period of 3–4 days, since groundwater replenishment is reinforced in these cases from the background. The impact of extreme level Danube river wall collapses, slides of steep banks on the cooling water extraction was also studied and found negligible and transient.

For the decommissioning stage of Paks II, the EIAS states that the expected impacts will be lower than the impacts of construction and operation of the plant.

In conclusion, the operation of Paks II and in particular the joint operation of Paks NPP and Paks II will have a local impact on the Danube, but appropriate mitigation measures are proposed in the study. The heat plume will travel downstream from Paks, to the southern border, thus no effect can appear on the Austrian part of the Danube.

12. Assessment of water quality in the Danube and other surface waters according to the Water Framework Directive

This chapter presents the analysis and evaluation of the characteristic physical and chemical parameters of the Danube, the characteristic features of the fauna and flora in the Danube (phytoplankton, phytobenton, macrophyte, macrozoobenton, fish communities), the status of the Danube sections upstream and downstream of Paks site, the changes in the Danube properties based on the parameters determined for the normal operation conditions resulting from the findings of the modelling, as well as a proposal for the environmental monitoring system.

The first section of the chapter lists the relevant EU directives and Hungarian laws and decrees governing the water quality management.

For the purposes of the assessment of compliance with EU Water Framework Directives (WFD), a number of tests were performed in 2012–2013 in the profiles of the Danube, as well as in several water bodies having direct or indirect communication with the Danube. The sample profiles were divided into the following sections: upstream, near downstream, distant downstream sections. In order to evaluate biological elements a mid-distance (downstream) section was also specified on the distant section. Each of the profiles investigated belongs to the water body called "Danube between Szob and Baja". The water body concerned is the section of the Danube between 1560,6 to 1481,5 river km. This water body is ranked as “very large calciferous Lowland River”. From the water bodies connected to the Danube, tests for compliance with WFD were done in 2012 in the Kondor Lake, the Fishing Ponds fed by the hot water discharged from Paks NPP and the Dead Danube of Fadd, periodically fed on hot water. Additional tests were performed in 2013 in the Northern Dead Danube of Tolna and the downstream section of the Sió-channel. The Tolna-Dead-Danube also receives hot water intake periodically from the hot water canal of the power plant. Sió channel has no direct connections with Paks NPP, but during floods Danube water inundates Sió channel as well. Under the tests, the physical and chemical parameters as well as the biological parameters were measured for compliance with the limit values given in WFD.

The sampling was performed in accordance with the applicable Hungarian, EU and ISO standards and WFD requirements. The results were evaluated based on the Common Implementation Strategy for the WFD (ECOSTAT guidance document no. 13), and the Hungarian guidance. According to these, the ecological status of the Danube in the studied area was found moderate. Also, the EIS states that the discharges from Paks NPP into the Danube do not cause grade level changes in the studied water body. The ecological status of the Paks Fishing Ponds (Kondor Lake and Angler Pond) was found poor, but the discharge from Paks NPP has no detectable impact on any of the assessed water bodies. The ecological status of the Dead Danube of Fadd was found moderate, but the discharge from Paks NPP has no detectable impact on the assessed water body and no such impact can be expected from the construction or operation of Paks II. The ecological status of Northern Dead Danube of Tolna was found poor, but the discharge from Paks NPP has no detectable impact on the assessed water body and no such impact can be expected from the construction or operation of Paks II. The ecological status of Sió canal was found poor, but the discharge from Paks NPP has no detectable impact on it and no such impact can be expected from the construction or operation of Paks II. However, nutrient exposure of the Sió canal was identified as being possible during the operation of Paks II and Paks NPP, which may reinforce the impact of the hot water discharge indirectly in the area below the mouth, resulting in an ecological status other than the natural one downstream.

During the construction of Paks II, groundwater discharge from the dewatering of the work pit (which may contain tritium) and the discharge of treated municipal wastewater will have no detectable impact on the Danube wildlife under normal operating conditions. Operating occurrences at the municipal waste water treatment plant might have a direct impact, but this will be limited to an area up to a distance of 500 m. No contamination sources leached out from the groundwater and originating from the construction operations are expected, no indirect impact in this context will occur. In the construction period of Paks II no transboundary environmental impacts affecting the Danube or damaging the ecological structure of the Danube wildlife can be expected.

During the independent operation of Paks II, the largest environmental impact on the ecological status of the Danube is represented by the warmed up cooling water, but the findings of the ecological analysis indicate that the impact will not be a lethal or sub lethal acute effect, but rather a long term, chronic impact. Considering these, the impact caused by the heat load is classified as a long term effect, with medium strength and high significance. Operation of the recuperation hydropower plant is suggested for the purposes of the discharge temperature as well as the construction of an auxiliary cooling capacity if necessary. The increase of the temperature could be detected at a distance of approx. 1,000 m, where the heat plume will reach the main current line of the Danube. In addition to this, cooling water and other wastewater discharged into the main riverbed of the Danube will change the flow conditions in the Danube at the outlet and as a results, the findings of the ecological studies suggest that in the surrounding of the discharge point the species composition of the phytobenthos and macrozoobenthos, as well as of the fish community will be modified and their abundance will increase at least partially. This impact is considered a long term one, with medium strength, but low significance. A ban on fishing and angling is suggested in a 250 m radius around the discharge point for the purposes of protecting the fish community. The impact area will not reach the national borders, thus no transboundary impact can be identified.

The same impacts were identified in the study as having significance during the period of joint operation of Paks II and Paks NPP, but the impact areas will be larger. The discharge of the warmed up cooling water will represent the most significant impact on the ecological status of the Danube. The temperature increase will be detectable up to approx. 11 km downstream; the heat plume will reach the main current line of the Danube but it will not cross it significantly. Operation of the recuperation hydropower plant is suggested for the purposes of the discharge temperature; also, in low water seasons, shut down of the operating units may be necessary and the construction of an auxiliary cooling capacity may also be needed. In addition to this, cooling water and other wastewater discharged into the main riverbed of the Danube will change the flow conditions in the Danube at the outlet and as a result, the species composition of the phytobenthos and macrozoobenthos, as well as of the fish community will be modified and their abundance will increase. This impact is considered a long term one, with medium strength, but low significance. A ban on fishing and angling is suggested in a 250 m radius around the discharge point for the purposes of protecting the fish community. The impact area will not reach the national borders, thus no transboundary impact can be identified.

From all potential failure events threatening the wildlife of the Danube not resulting in radioactive contamination (which were analysed in Chapter 13 of EIS), the release of untreated municipal waste water via the hot water canal was identified as having a significance, though low. Such discharge can exert only a locally detectable impact on the ecological system of the Danube, due to the high ratio of dilution and quick mixing. The untreated wastewater flow let into the river in the case of a failure event is expected to be degraded completely within a 500 m section as a result of the mixing and biological processes. As countermeasures, it is suggested to set up a buffer capacity in the wastewater treatment plant and to develop a response plan in case of a failure event.

For the decommissioning of Paks II, the EIS states that existing waste water treatment plant will be able to handle the increased wastewater volumes generated during the dismantling of the plant, and that the discharge of the treated wastewater into the Danube through the hot water canal will have no impact on the water chemistry or ecological status of the living watercourse of the Danube. The discharge of hot cooling water will gradually decrease in this stage until it will stop, so this process will not have any impact on the water chemistry or ecological status of the Danube. In case any major amount of dewatering in the work pit will be necessary during the dismantling, the extracted water may contain tritium which is disposed of in the cold water canal and subsequently into the Danube, but this will have no impact on the water chemistry or ecological status of the Danube, as already presented in the previous chapters. No transboundary physico-chemical and ecological impacts are expected on the Danube during the dismantling of Paks II.

The last section of the chapter includes a proposal for the extension of the monitoring program currently operated by Paks NPP, as requested by the water rights operation license. Since the environmental impact of the proposed Paks II and the operating Paks NPP on the Danube and on the underground water below the Danube cannot be differentiated, it is considered appropriate in EIS to continue the monitoring during the joint operation period, but with an increased detection density of the current facilities and additional instruments.

13. The geological formation and subsurface waters on the site and in its immediate environs

This chapter presents the area subject to the analysis, the baseline conditions of the geological formation and the subsurface waters on the site and its surroundings, the impact of the construction, operation and decommissioning of Paks II on the geological formation and the subsurface waters in the studied area, as well as a proposal for monitoring subsurface waters.

According to the Hungarian legislation (which is transposing the Water Framework Directive 2000/60/EC), the environment of Paks NPP belongs to the 1-11 Sió river basin planning subunit, being located on its eastern edge and it has to be treated as a sensitive area from the groundwater quality point of view, due to the fact that the top of the porous main aquifer formation can be found within 100 m below surface. In the same time, the protection zones of operating and future drinking water facilities (such as Csámpa water resource that provides communal water supply to the power plant) are to be considered as highly sensitive areas in respect of groundwater condition.

Two types of underground water occur in the region: groundwater confined in the Pannonian sand layers and contiguous groundwater in the Pleistocene-Holocene beds. On Paks site, a filled-up layer of variable thickness and composition is located up to the groundwater, under which new Holocene casting clay, casting sand and casting sludge can be found. Through these layers, precipitation may reach the groundwater while leaking vertically. The low floodplain is covered by a network of former meanders filled up. Currently, it is protected from flooding by flood-control dams built at a 96–97 mBf level (meters above the Baltic sea level), but changes in the Danube water level influence the evolution of the groundwater level. About 6–8 m above the upper and middle Pleistocene alluvium of the Danube, the latter's lower Holocene terrace rises up, consisting in riverine small and medium-grained sand interspersed with small gravel layers. The latter's surface is covered by upper Holocene quicksand. The Danube has little or no effect on the groundwater conditions on the terrace. The Danube valley is flanked from the northwest by a loess plateau rising to a height of 160–180 mBf. Precipitation falling on the surface of the loess plateau, seeping in the soil and gathering above the clay zones is led to the erosion base in the more porous layers. The aquitard bedrock of the groundwater storage layer is composed of upper Pannonian sedimentary material. Due to the pressure conditions of the water stored in the aquifer, groundwater cannot flow down to the confined groundwater under natural condition.

The characterization of the geological medium and underground waters in the area of Paks NPP was performed on the area covering the assigned extension site and its local surroundings. The horizontal extent of the study area was determined by the underground water level and water quality detection network (consisting of more than 220 wells currently operating on the NPP site and in its vicinity, as well as the wells of the Csámpa Waterworks); the vertical dimension of the study area was determined by the position of the confined groundwater aquifer, extending down to a depth of 210 m from the surface.

The baseline conditions of the geological medium were determined in 2012 by local measurements. 40 exploratory wells were drilled in the study area at a depth of 10 m. Point samples from the soil were collected from different depth ranges up to 10 m, for chemical laboratory testing of organic and inorganic compounds. In summary, it was concluded that the geological medium in the study area is not contaminated.

The hydrogeological conditions of the study area were determined by assessing the information available, as well as by comparing them with the measurements performed in 2012. The groundwater characteristics of the currently operating NPP and its surroundings are known from measurements performed in the period preceding the construction of the plant as well as during the construction of the plant. The quality of confined groundwater was then known from the analysis of the wells at the Csámpa Waterworks. The contamination status of the groundwater was analysed based on the data sets covering the period 2005 – 2010. Apart from this, in order to evaluate the baseline conditions of groundwater on the site, quarterly monitoring tests were performed (in 2012) on selected wells which are currently in operation on the site. The analyses of water samples were performed by an accredited testing laboratory who measured the inorganic compounds as well as the volatile and non-volatile organic compounds. None of the compounds' concentration exceeded the B limit contamination level (action level above which a clean up has to be performed), so the quality of groundwater in the study area is identical to that observed elsewhere.

In order to estimate the impact of Paks II on the groundwater, a complex groundwater flow model was used, accompanied by the analysis of the most mobile radionuclide's spread (namely tritium). Since the power plant is located on the Danube bank, the main contributor to the groundwater flow prevailing in the vicinity is the Danube itself and the closely related cold water canal. In addition to these, Kondor Lake and the western loess plateau have an influence on the groundwater on the site. The input parameters for the hydrological site model (water levels of Danube, cold water canal and Kondor Lake, precipitation data measured in the vicinity of the site, tritium concentration measured by on-site monitoring wells) were provided by the data measured in the period 2012–2013. The Visual MODFLOW program applying the finite difference method was used to define the flow of underground water. By using data for the above mentioned period, the distribution of the groundwater table and the velocity space and particle trajectories emerging in the saturated zone during typical low medium and high water levels in the Danube was studied. The time-varying velocity space forces the particles in the given layer to travel on special paths; relevant paths from potential sources (sewer system bordering the main building on the west, the auxiliary buildings and NPP units) were run; it was found that 72 – 150 days are required to travel 100 m under the given circumstances.

During the preparatory stage of the project, no large-scale works are expected, only logging and minor earthworks related to the relocation of utilities, so the impact of preparatory works is considered neutral. During the construction period, the soils from the working pits to be used for the foundation of the new facilities are considered as waste. By construction of working pits, slopes and temporary roads, dust will be generated especially in the dry, hot summer season. Dust generation of soils can be seen as a negative impact on the air quality, especially in the narrow vicinity of earthworks, but this phenomenon is periodic, only related to open working pits, so it can be reduced by watering or spraying the transport routes. The stability of working pits for foundations is mostly endangered by intense precipitation. Sandy soils are very sensitive to erosion, so a proper state of working pits should be ensured by proper drainage of precipitation. In the construction area, an increased layer load is expected due to the weight of facilities. Increased compaction of soils is a consequence of the growing layer load. The largest extent of compression is manifested by sandy sediments. The impact of foundations on the subsoil can be regarded as neutral, but uneven soil subsidence accompanying compaction may have an adverse effect on the structure of buildings.

During construction of the new power plant, dewatering of the working pit that will be created for foundation will impact the groundwater level and a high amount of groundwater will be removed by dewatering which will end up in the Danube. During dewatering of the working pit of the second unit, a minor decrease of the water level will be observed. The impact area does not extend to the northern tip of the current units, so no effect whatsoever can be expected in the area of the existing units. However, when making the foundation of the first new unit, the impact of dewatering of the second unit must be taken into account. The depression cone caused by dewatering of working pits will attract the water from its environment, and the most mobile pollutant (tritium) will also move along. Normally, the tritium plume flows towards the cold water canal in an N-NE direction, but as a result of dewatering, it will take an N direction. Two conclusions are drawn from the hydrological model of the site: dewatering has only a very limited impact (an area with approx. 10 m in diameter) and any contaminant entering the groundwater can only end up in the downstream neighbouring countries via Danube. During normal operation, no contaminant release to the groundwater is allowed. Even in case of operational occurrences, the amount of contaminants entering the groundwater will be only a fraction of the planned liquid releases, so even the transboundary impact will be negligible.

A modified hydrological model of the site was used in order to estimate the impact of Paks II (with the addition of the locations of new blocks, hot and cold water channel extensions and other buildings which may modify the current flow conditions). The model show a permanent condition, which means that the Danube water level will be constant throughout the period of operation. The effect of Paks II on the flow direction and velocity of the groundwater can be observed in the volume under buildings with deep foundations; the flow will be diverted along the sides of buildings, but even in this case, the prevailing direction will also point toward the cold water canal. The flow rate will increase in volume under the relevant buildings. In case of low and medium water levels (of the Danube), the relevant directions will not deviate from the aforementioned direction, only the velocities will change in such a way that the greatest velocities towards the cold water canal will appear at low water levels.

Based on the assumed position of calculated flow paths and technological systems, a proposal regarding the installation locations of the groundwater monitoring well network was included in this chapter. Monitoring wells must be placed in such a way so as to ensure the detection on any uncontrolled leakage into the groundwater or into the unsaturated zone.

During normal operation of the new units, tritium is expected to be the only isotope with a measurable impact. The new units will increase the tritium activity concentration of the Danube by 0.96 Bq/dm3 in the case of low water. Taking into consideration that the drinking water limit is 100 Bq/dm3, it is concluded that the impact on the Danube or the bank-filtered water resources utilizing water from the Danube will be negligible.

The individual scenarios presented in the study indicate the entry of radioactive contaminants into the groundwater as unlikely, so the contamination of groundwater is only possible indirectly. The only possible pathway is from atmospheric fallout and/or leaching to the soil surface, then spreading in the unsaturated zone until reaching the saturated zone. This process is considered as not having an effect on the groundwater due to the large sorption capacity of the soil and the isotope specific access time which may be hundreds of years (even for tritium, the infiltration time may range up to 10 years). On the other hand, after reaching the saturated zone, the Danube will be the final destination of groundwater (due to typical flow characteristics). However, since the shortest access times (from tritium) between the site and the Danube (12–20 years), it is considered that there will be sufficient time for treatment and clean-up of any potential event before the contaminants will reach the Danube.

In the planned area of the new units, the storage of chemicals, oil content of transformers and diesel oil storage are identified as the most likely potential contamination sources. Since the plant area is located approx. 1,000 m away from the Danube riverbank, the migrating oil lens would reach the Danube in approx. 3,000 years. Since oil contaminants are less soluble in water, direct groundwater transport will not be a dominant factor. The biodegradation half-life typical of oil derivatives is in the range of 1–2 years (while sufficient oxygen content is ensured) so sufficient time is available for demarcation and clean-up of the assumed oil lens before they could reach the Danube.

14. Geological formation and subsurface waters in the Danube valley downstream of Paks

This chapter presents the area subject to the analysis, the baseline conditions in this area, the method used for estimating the indirect impacts on subsurface waters in the Danube valley and the indirect impact of the operation of Paks II.

Considering the hydrogeological features of the Danube Valley, Paks II can only indirectly impact the subsurface water outside the site, via the Danube. The relations between Danube and the groundwater system are multiple and varied, depending on the water cycle of the Danube. Groundwater in the Danube Valley is stored in a Danubian alluvial, pebbly, sandy sequence from Pleistocene and Holocene ages. The general direction of groundwater flow follows the descent of the terrain; the flow runs from NW to SE on the right bank and from E to W on the left bank. The highest groundwater levels can be found on the loess plateau W of Paks.

Based on the evaluation of the values measured by the underground water monitoring systems operated by Paks NPP (under its Environmental Monitoring Program) and by Water Management Directorates – which are considered as the baseline data for evaluation of Paks II operation in the future –, it is concluded that the hydrodynamic impact area of the Danube during the highest floods extends to approx. 1,000 m from the bank line on the right side of the river and to approx. 1,200 m from the bank line on the left side of the river. In most of the year, groundwater seeps from the tributaries towards the Danube, and the Danube drains groundwater-bearing formations. In natural circumstances, water seeps from the Danube into the sequence containing groundwater in the course of floods only. The water moves towards tributaries only as long as the water level of the Danube maintains this reversed flow system.

Another important conclusion of the study is that the hydrodynamic impact area of the Danube does not coincide with the area where Paks II may have an impact on groundwater. The results from modelling the site and the surface water of the Danube show that no such contaminant will be transported in the Danube during the normal or abnormal operation of the plant that would have to be included in the study. The only indirect impact of Paks II on groundwater in the Danube Valley will be driven by the thermal effect on Danube. The seasonally changing temperature of Danube influences the temperature of groundwater along the riverbank. The mode and extent of the heat transport between waters flowing in the riverbed and under the surface may vary depending on the current hydrological conditions and temperature. The thermal load generated by Paks II will modify these natural conditions. Using numerical hydrodynamic and heat transport modelling, the future changes occurring in underground water in terms of time and space were examined.

Two scenarios were selected in this respect: the joint operation of Paks NPP and Paks II (in 2032) and the operation of Paks II only (after the shutdown of Paks NPP in 2085). Conservative estimations were used, by selecting for calculations extreme hydraulic cases (permanent low water condition in summer, and flood wave passing after low water in summer). The results obtained suggest that the indirect impacts of Paks II will not result in a constant temperature increase in the groundwater system. A temperature rise of few °C may occur only in summer in the hydraulic situation of constant low water. According to the hydrodynamic modelling, in case of the joint operation of Paks NPP and Paks II

(2032), during the peak loads a temperature rise of 2.8 °C of the groundwater in the vicinity of warm water inflows in the layers close to surface may appear. At the same time, a temperature rise of few tenth of °C may occur at the border of the studied area, along the line of Sió channel. In case of single operation of Paks II (2086), these values will decrease to a level almost identical with the present (baseline) conditions, with the mention that the temperature rise will not appear along the line of Sió channel.

Thus, the conclusion of the study is that, based on the current knowledge, an increase of few °C of the temperature of groundwater will not cause a significant change of the water quality, so it will not cause any damage to the natural systems or to the layers produced by water works and it will not have any detrimental effect on the production of water works.

15. Noise and vibration

This chapter presents the noise generated by the construction and operation of Paks II, based on the baseline conditions at the site, as well as the noise reduction options and the proposed monitoring system.

The first section of the chapter lists the relevant Hungarian laws, decrees and standards governing the protection against noise and vibration, as well as the noise load limits.

For the purposes of estimating the current noise and vibration levels at the site, noise and vibration load measuring data available for the site and its environment were collected and analysed, noise measurements in the area were performed on facades, along the work network to be protected, on public roads, as well as at two points in the residential areas next to the planned plant area, and also vibration measurements were performed.

Regarding noise protection, the studied area was located within Paks residential area, along Main Road No. 6 in inner suburban zones, and on areas north, east, west and east of Paks on the adjacent settlements that should be protected from noise. As a results of the measurements performed it was determined that the noise caused by traffic on the frequented roads along residential areas is quite significant, and the traffic distribution and density can determine the ambient noise status of areas exposed to traffic. The baseline noise load of residential areas located next to heavy traffic roads is several times in excess of the noise load limits in effect in these areas. The measurements performed in the environment of residential buildings along the Danube embankment area showed values below the permitted noise load limits, since no traffic is allowed in the area. The noise measurements and traffic counts performed on Paks NPP inner area showed almost identical noise load hits the areas located next to the Main Road No. 6, so the noise limit is exceeded in residential zones due to the traffic.

Regarding vibration protection, the studied area was delineated by the Danube River and cold water channel from the east, Main Road No. 6 from the west, the service road in Paks NPP from the south and agricultural area from the north. The results of the measurements performed showed two typical frequency ranges in case of large-size trucks as well as in case of trains.

The noise load expected during the construction of Paks II was calculated using Soundplan 7.2 program. The results of the calculations show that the noise load limits can be ensured during every construction phase at the areas and also the buildings to be protected. The traffic load increment arising from Paks II construction will cause traffic noise increment, and thus the baseline load values will increase. The construction impact area covers the Paks NPP site and non-residential adjacent areas, as well as the residential buildings along the Danube River and on the western side of Dunaszentbenedek village. No cross-border noise impact is expected to arise during construction of Paks II.

For the operational period, it is estimated that the noise emission in the residential area will remain within the noise load limits. The road traffic will increase during Paks II operation, but the traffic increment will not cause detectable changes in the noise load. The impact area of Paks II operation covers the site, the adjacent non-residential areas, Danube River, certain real properties in Dunaszentbenedek village and partly NW corner of Uszód. No cross-border noise impact is expected.

For the estimation of the noise load during deviation from normal operation, a power outage or black-out was assumed. In such cases diesel generators will be used for ensuring safe power supply for the relevant consumers. The results of the study show that the noise emissions from Paks II during such type of event will remain below the noise load limit permitted for residential area. The impact area in such cases covers the site, the neighbouring unpopulated areas, Danube River and certain lands in Dunaszentbenedek village.

For the decommissioning stage of Paks II, it is stated that the noise load limits applicable in the areas and buildings to be protected can be maintained. No increment in noise load levels arising from road traffic could be defined at this stage.

For the joint operation of Paks II and Paks NPP, the calculated values were added to the values of outdoor noise measured on the site. The noise load arising from simultaneous operation of the two plants at the facades to be protected was calculated with the Soundplan 7.2 program. The impact area in this case will cover the site, the un-populated areas in the region, Danube River and certain lands in Dunaszentbenedek and Uszód village. Based on the modelling, it is stated that no cross-border noise impact arising from the simultaneous operation of Paks NPP and Paks II can be expected.

Taking into consideration that Paks II will be constructed far away from all neighbouring populated settlements, noise measurements are considered not necessary. In order to ensure low noise load, it is proposed in the study to use equipment and machines emitting the lowest possible noise, as well as the use of M6 Motorway as the alternative route for traffic and transportation instead of Main Road No. 6.

The measurements performed in order to estimate the baseline vibrations demonstrated that the existing levels do not exceed the relevant limits, but in the same time it was found that one minor bump, default, cavity or crack on the road surface could significantly increase the amplitude of the measured vibration. Thus, it is recommended in the study to monitor the quality of roads and repair them whenever necessary both during the construction and operation phases of Paks II. Also, a vibration monitoring program is proposed along Main Road No. 6 in two points, but only for buses, trucks and large trucks that may affect the residential areas.

16. Ambient air

This chapter presents the area subject to the analysis, the baseline conditions of ambient air quality on the site and its surroundings, the impacts of construction, operation and decommissioning of Paks II on the air quality in the studied area, as well as a proposal for monitoring air quality.

According to the Hungarian legislation, which is described in the first section, the surroundings of Paks NPP belong to the air pollution zone category “10. Other area of country” which is a zone category of rather low amounts of air pollutants.

The second section of this chapter describes in great detail the establishment of the baseline for ambient air quality. For the study, measurements at 6 measuring points in the vicinity of the Paks site have been conducted in 2012–2013 to describe the baseline status of the area in the environment of the site. Based on these measurements the baseline air pollution status of the area has been defined.

NO_2, NO_x, SO_2, CO, PM_{10} (particulate matter in the order of ~10 micrometres or less), TSPM (Total Suspended Particulate Matter), settling dust, and O_3 concentration values have been measured between January 24, 2012 and March 28, 2013. Based on the measurement results the study comes to the conclusion that the ambient air quality during the measuring period was excellent in respect of SO_2 and CO, and fair regarding NO_2, PM_{10} and O_3.

In the next section, modelling of the propagation of non-radioactive air pollutants is described. The distribution of non-radioactive polluting materials arising from the construction and the operation of Paks II, the air quality prognosis and the impact area have been determined by using a Gaussian model. Climatic data typical for the area, and the average and most characteristic figures for preparing conservative estimates have been applied.

For the study, meteorological data of 2011 have been used for the simulation, because during that year there were several weather conditions unfavourable for aspects of air pollution propagation and dilution (so-called “cold cushion” remaining for a long time in 2011 November), thus the results represent some over-estimation. 2011 had an extremely dry summer with 1–3 weeks heat waves that are favourable for enriching the air pollutants. Data sources were the data from the meteorological measuring tower located at the site of Paks NPP and freely accessible data from the American Global Forecast System (GFS) for data which could not be provided by Paks NPP meteorological tower.

Section 4 is devoted to the impacts of emitted non-radioactive air pollutants onto the ambient air quality during the construction of Paks II. According to the calculations, the impact area during the construction phase will remain within 500 m distance from the source points regarding every polluting material and work phase in case of calculating with real meteorological data. Using conservative meteorological data, the impact area will remain within 1,000 m distance. The impact area of pollution arising from traffic for NO_x during the construction phase will be approx. a zone in 100 m radius. It is stated that under extremely unfavourable meteorological conditions the health limit values might be exceeded during the construction phase, and therefore the construction works might be or might need to be suspended (based on the meteorological forecasts).

The nearest residential buildings are in between 1,3 km and 2,9 km distance from Paks II construction area; the study notes that from this point of view there would be no need for establishing monitoring stations for air quality. However, under consideration of the minimum 10 years duration of the construction process, it would be reasonable to monitor the air quality of residential areas close to the planned site. The study proposes 1 measuring point at the left bank of the Danube and another measuring point in Paks city. Also described in detail is the proposed measuring program that should be implemented.

The next section describes the impacts of non-radioactive air pollutants emitted during the operation of Paks II. The study identifies the four 7.5 MWe diesel generators as primary point sources with impact on the ambient air quality in this stage. According to the plans, these diesel generators should operate only in test or pilot operation mode under normal operating conditions of the power plant, thus the impact of the diesel emissions, due to emission time and quantity of emitted polluting materials should not exceed the legal limits.

Section 6 gives a short description of the impacts of Paks II decommissioning onto the air quality. It is noticed that impacts that may emerge in this stage can be hardly estimated due to the very long time horizon of this event and unavailability of exact data related to the decommissioning. When the plant equipment is decommissioned and demolished, it is assumed that the load would be most probably very similar as during the plant construction phase. This would include works performed on the plant area and road traffic related to the transportation of the demolished materials. The direct impact zone affected by air pollution during the decommissioning phase can be described as the area delineated for the construction works during the structure construction period. Indirect impacts will also emerge during the decommissioning period, and the impact zone of traffic can be predicted as similar to the indirect impact zone of the implementation phase.

The final sections are dedicated to the impacts of the simultaneous operation of Paks NPP and Paks II and the transboundary environmental impacts with regard to non-radioactive air pollutants. According to the study, the established baseline already includes non-radioactive emissions from the Paks NPP operation, adding the simulations for the operation phase of the Paks II the study comes to the conclusion that the simultaneous operation of the plants will not have any adverse impact with regard to non-radioactive emissions and thus to the ambient air quality.

Based on the detailed modelling results, it is concluded that neither impacts of non-radioactive emissions from Paks II standalone operation or from simultaneous operation with Paks NPP may lead to any cross-border pollution.

17. Non-radioactive wastes

This chapter presents the area subject to the analysis, the baseline conditions of non-radioactive waste on the site and its surroundings and the impacts of construction, operation and decommissioning of Paks II on the amount of non-radioactive waste in the studied area.

In the initial sections the Hungarian legislation with regard to non-radioactive waste and the general characteristics of waste collection, storage, transport and treatment are given. Statutory rules on waste, waste collection and individual types of waste are described in general as well as in detail.

Sections 3 to 5 describe the estimated non-radioactive waste amounts for construction, operation and decommissioning of Paks II.

The construction process of the new units involves the production of significant amounts of conventional (non-radioactive), typically construction, hazardous and non-hazardous industrial waste, as well as municipal waste.

The largest amount of waste is soil produced during the excavation of the working pit. The estimated quantity of this waste type is in the range of 1.4 million m^3/2.5 million t. Part of the excavated soil will be refilled, the part that cannot be re-used at the site must be disposed in a landfill, where it may be used for landscaping and covering purposes.

During the operation period of Paks II a yearly amount of 800 t non-hazardous waste and of 100 t hazardous waste is estimated in the study. These numbers have been derived from the EIA prepared by Fennovoima Ltd. for the planned 1,200 MWe Hanhikivi 1 NPP in Finland which will also be powered by the Russian AES-2006/VVER 1200 reactor. Numbers taken from the Hanhikivi 1 EIA have been adapted to reflect the planned total 2,400 MWe capacity of the Paks II units.

During the joint operation of Paks NPP and Paks II yearly amounts of waste are given with 2,240 t non-hazardous waste and 380 t hazardous waste. These amounts have been calculated by using actual numbers from the operation of Paks NPP (from 2004–2013) and again numbers from the above mentioned EIA for the Finnish Hanhikivi 1 NPP project. Actual Paks NPP values for 2013 are presented in detail, giving waste fractions and quantities for both non-hazardous waste as well as hazardous waste.

The decommissioning of Paks II according to the study will generate mostly demolition waste, presumably in large quantities, ~400,000–500,000 t of inactive concrete waste are to be expected from the demolition of the buildings.

The study notes that during all service life phases, selective waste collection at the Paks II site following the applicable regulations has to be implemented in order to prevent environmental pollution. Actions must be taken to ensure the recycling of waste as much as possible so that as little waste as possible would have to be dumped in landfills for disposal. Removal, recycling or disposal of various waste types has always to be done by organisations with relevant licenses and in compliance with statutory regulations of Hungary.

The environmental impacts of non-radioactive waste produced during the service life of Paks II are seen as remaining local, and no transboundary environmental impacts are expected.

18. Wildlife and ecosystem

This chapter presents the area subject to the analysis, the baseline conditions of the biosphere and the ecosystem on the site and its surroundings, the impacts of construction, operation and decommissioning of Paks II on the biosphere and the ecosystem in the studied area, as well as a proposal for bio-monitoring.

The initial sections summarize the applicable Hungarian legislation and describe the limits of the study area which was restricted to 3 km, 10 km and 30 km r around the future Paks II site. Within the 30 km area, 19 Natura 2000 areas and 3 Ramsar Convention sites are located. This includes 2 National Parks (Danube-Dráva National Park and Kiskunság National Park) as well as 6 Nature Protection Areas. Within the 10 km area, 6 Natura 2000 areas are located from which one – Tolnai-Duna – will be directly affected by the planned recuperation water power plant and energy dissipation structure of Paks II.

Section 3 of this chapter presents the establishment of the baseline conditions. Bio-monitoring studies were conducted in 2012–2013 to explore the flora and vegetation at the site as well as the flora of the environment of the Paks NPP within the 3 km area. The purpose of the examinations was to survey the current state of the biosphere on the site and in the environment of Paks site and, based on that, to prepare a description and assessment of the base condition of the biosphere. In addition, priority species on the Natura 2000 sites within the 10 km area have also been surveyed.

Vegetation: the landscape structure within the 3 km radius of the Paks NPP is rather heterogeneous. The diversity of the area is well-shown by the fact that from the botanical aspect, the area can be distinguished into 11 landscape types based on the vegetation type featuring the landscape which was the basis of the botanical assessment. These different areas are all characterized in short.

Flora: compared with former surveys (1999–2003), the study comes to the conclusion that no major change has happened in the flora of the area in the last more than 10 years. Species of the ruderal groups dominate the area, but the proportion of stress tolerant species is also significant. This is seen as an evidence of the fact that the area is under strong anthropogenic impact.

Fauna: for the study, zoological samples were taken in six terrestrial and three aquatic areas within the 3 km area including aquatic habitats (Danube, fishponds, Kondor Lake), arable land, soft wood gallery forest, steppe and grasslands at Paks site, a forest plantation, dry steppes and a natural forest. Base states have also been established for the 6 Natura 2000 areas within the 10 km area, including the Tolnai-Duna area.

Section 4 is dedicated to the evaluation of the impact of the construction phase on flora and fauna of the area. Additionally to the impacts the sections also proposes environmental protections measures which should be set into effect in order to minimize the impacts. As such, it is stated that due to works on the construction area, the current uncharacteristic dry, semi-dry grasslands will disappear. These habitats are covered by weeds, degraded and disturbed, hardly exceeding the lowest category level of natural status. Occupation of the area between the cold and warm water channels and the construction of the recuperation power plant and the energy dissipation structure on the bank of the Danube will entail the partial removal of the current willow, poplar flood plain forest – a narrow riparian zone of which is Natura 2000 site. This forest is not under protection but it has a good natural status, a community of fast dynamics with a favourable forecast for regeneration under unchanged water flow conditions. Annual intensive arable land cultures, uncharacteristic dry, semi-dry steppes, spontaneous stands of non-native tree species, acacia plantations, scots and black pine plantations, weedy degraded open sand steppes will be affected by the construction of the long distance transmission lines related with the new power plant. Regarding the local fauna, the construction of Paks II will have many direct impacts on animals, including on protected species. However, these impacts are considered are being insignificant and non-separable from natural fluctuation in case of aquatic fauna and butterflies. In connection with the changing structure of the plantation, a less valuable fauna of orthoptera may evolve, and this phenomenon may expand to areas not disturbed. This change might negatively affect amphibians and reptiles and may give rise to the reduction of their food basis. In the communities of soil surface anthropoda, invasive and synantrophic species (linked to humans) may also appear and spread. A decrease in the isolated population may lead to its local disappearance or even genetic transformation. The fragmentation of populations represents a potential hazard for amphibian and reptiles and, to a certain extent, though on a larger spatial scale, small birds, birds maintaining a territory, and species hatching in the area as well. All these direct and indirect impacts will affect the area of Paks NPP and Paks II as a whole, including the track of the new transmission line and its 1–200 m wide area, the transport routes, the Danube section under the outflow of warm water channels, as well as the fauna living there. The works to be performed during the construction will probably not have any trans-boundary environmental impact on the fauna.

Section 5 of this chapter deals with the evaluation of the impact of the operation phase on flora and fauna of the area. During the period of operation, grass plantations in park like environment and secondary degraded grasslands are expected to develop in the densely built-up area of the plant. Limitations will be prescribed for the cultivation mode in the safety zone of the transmission lines during the operation of the long distance transmission lines. The impact of Paks II causing water level fluctuations and temperature changes has no demonstrable impact on the flora of the embankment. However, this will have an impact on the aquatic macroscopic invertebrates in the Danube riparian region, as well as on the entire river section downstream from the NPP. The increase of the water discharge may change the hydrological and river bed morphological conditions of the area and thereby the use of the habitats by fish. The water temperature increase may affect the population dynamics and metabolic processes of the fish. However, these hydrological and river bed morphological changes are not considered detrimental for fish. The completion of construction works of Paks II will be followed by landscaping, which means that undisturbed, predominantly dry steppe habitats will gradually evolve there, similar to the currently existing ones, their former orthoptera and soil surface anthropoda assemblages from the adjacent remaining habitats patches will be able to get resettled again, thus valuable communities may settle again and survive during the operation period. Protected butterfly species are not expected to settle here in the future; the same is expected for the open steppe areas to evolve along the route of the long distance transmission lines to be constructed. The operation of Paks II is not expected to cause direct damaging impacts to amphibians and reptiles. Certain species are expected to resettle, which is important considering that all amphibian and reptile species are protected. As for the birds, species similar to those currently present can be expected to arrive. Due to the long-term relative lack of disturbance of the operation area, a number of protected and highly protected birds species found their habitats here (mostly as a feeding site). The increased number of long distance lines and poles holding those is considered as a continuous source of danger during operation. No trans-boundary impacts are expected in respect of flora or fauna.

Malfunctions or accidents are considered as not having an impact on the areas covered by vegetation valuable for nature conservation. However, it is recognised that fires will result in the damage or destruction of the vegetation on the affected area. Emergencies related to waters, water system in connection with the Danube may cause damage to plant and plant associations breeding in the riparian zone of the Danube. In case of emergencies involving release of hot water into the Danube, the animals which are tied to their places will decrease and mobile populations will wander away within the aquatic ecosystem. This may lead to the reduction of the number of individuals, or the complete disappearance of the protected species populations. As most of the environment is characterised by dry habitat, they are highly exposed to the risk of extensive fires. In such situations, the land animal populations living there may be injured or their communities may disappear. This is especially true for the pine plantations along the route of the transmission lines. With regard to transmission lines, electric discharge may pose fire danger. Most of the gaseous compounds released by fire are toxic, as well as the deposited remaining materials. Petroleum products spilled on soil surface may cause suffocation of animals living in the soil. All such impacts and their effect will greatly depend on the concentration of the pollutants discharged into the environment, or on the extent of the area affected, but all these may change in time.

The decommissioning of Paks II is expected to have a negative impact on the animals living around the site, as it is stated in section 6 of this chapter. The impact of the decommissioning will greatly depend on the dismantling technology. Largest impact will be exercised by the demolition of the power plant and the related facilities (transmission lines, etc.). Similar impacts with the ones expected during the construction stage will have to be taken into account. As an impact of the demolition works, vegetation and habitats regenerated during the operation period will be affected. Following demolition, the original or similar status of habitats will be restored by rehabilitation. The rate of re-cultivation will determine to what extent biosphere can take possession of the area again. The site of the power plant is however considered small enough to cause a significant change in the environment as a result of decommissioning of the plant. As such, no transboundary impacts on flora or fauna are foreseen.

19. Radioactive wastes and spent fuels

This chapter presents the applicable legislation related to the management of radioactive waste (RW) and spent fuel (SF), the planned management steps, the baseline conditions at the site, as well as the impact of Paks II construction, operation and decommissioning.

The first section of the chapter lists the international standards, EU directives and Hungarian laws, decrees and standards governing the RW and SF management. The second section of this chapter describes the regulatory system governing the management of RW and SF in Hungary, along with a list of the main international organizations playing a role in the field. An explanation of the international basic safety standards is also presented, but this is somehow incorrect, in the sense that the IAEA BSS from 1996 (Publication No.115) was indeed replaced by IAEA GSR Part 3, but not by the EU Directive 2013/59 (which replaces the Directive 96/69/Euratom). Moreover, the ICRP recommendations from 1990 (published in ICRP Publication 60) were revised in 2007; these updated recommendations were published in ICRP Publication 103 and they represent the basis for revision of both IAEA and EU. While the transposition of the new EU BSS (Directive 2013/59) is indeed required to be done by EU MS till February 2018, taking into consideration that the EIS was issued in 2014 and at that time the EU revised BSS was already published, the references to the old IAEA BSS could have been replaced with references to the new EU BSS. Moreover, the IAEA BSS is not mandatory, while the EU Directives are, so it is suggested to replace the references to the IAEA (old) BSS with references to the EU (old) BSS – Directive 96/69 which is still valid and mandatory for all EU MS.

Further, it is mentioned here that "The NE Act also claims that in respect of managing the radioactive waste and spent fuel generated in Hungary, the ultimate liability is assumed and borne by the Hungarian State."; this is true, but it should also be mentioned that the prime responsibility for the RW and SF belongs to the generator of that waste/spent fuel, as it is stated in EU legislation,) and international standards. In this sense, it should also be added that the waste generator is not only responsible for minimizing the waste he produces and for disposing it, but also to manage it in a safe and secure way.

Another observation is that the whole section describing the national strategy and national program on RW management (19.2.1.1) is written at the future tense. This might be due to an erroneous translation, but in the same time it might imply that Hungary has not yet a national strategy and/or program for management of RW/SF, as requested by the Waste Directive 2011/70. Therefore, a clarification is needed.

Following, the detailed rules on RW management are presented, in terms of classification of RW, exemption and clearance and nuclear safety requirements for RW and SF. While all these are presented in general terms, they are to a great extent in line with the international standards, with one exception: the constant confusion between "storage" and "disposal"; this might be a translation error, however, it should be corrected.

The third section of this chapter consists in a general presentation of RW classification, sources of waste during energy production, basic principles of RW management (during NPP operation, waste inventory, strategy and method of waste characterization) and the waste management technologies (the basic requirements for RW processing technologies in a NPP and some considerations about central RW processing facilities). One important aspect mentioned at this point is that a joint waste management for Paks NPP and Paks NII NPP is considered a "non-viable" solution and therefore, a separate waste management technology should be established for the new units. Following this, the RW management steps, including final disposal, are described, in terms of the available solutions and technologies, but again only general concepts. The SF management section is presenting the options taken into consideration for the new units of Paks NPP, and it includes a comparison of the wet storage technology with the dry storage technology. From all the options analysed in the study, the dry cask storage seems to be the preferred solution for Paks II. The options for closing the nuclear fuel cycle are also discussed, highlighting both the benefits and disadvantages of direct disposal vs. partial reprocessing; either way, disposal of HLW in deep geological repositories is recognized as being needed in EIS. Building a reprocessing facility in Hungary is seen as very unlikely, so if partial reprocessing will be chosen, this will have to be done abroad.

For the dismantling of Paks II, the EIS assumed immediate dismantling, taking into consideration the international trends and that the current legislation ensures the costs of dismantling being available till the end of service life, that the final disposal of RW generated during dismantling is possible to be ensured in due time and that the necessary knowledge is not expected to be lost. According to the national legislation, a preliminary (separate) investigation should be done regarding the dismantling activities and an impact assessment is to be performed, prior to shut-down of the NPP. In addition, a dismantling permit is required to be obtained from the Hungarian Atomic Energy Authority. For the authorization of the establishment of a new NPP, a Preliminary Dismantling Plan should be prepared; during the lifetime of the facility, this Plan should be updated every 5 years.

The baseline conditions of the site are presented in section 19.5. According to EIS, there is no RW or SF present on the site where Paks II will be built. This is true, but in our opinion, the RW and SF generated by Paks NPP – which is stored on site – should have been presented. There is a Central Nuclear Financial Fund established in Hungary for financial contribution to the management of RW and SF; the future authorization holder for the operation of Paks II should begin to pay its contribution to this Fund the year following the year when the new unit will be put in operation. There are two RW storage facilities in operation in Hungary, from which the National Radioactive Waste Repository in Bátaapáti may receive solid short-lived LILW. For final disposal of HLW, long-lived LIWL and SF, a deep geological repository is necessary to be established in Hungary. According to EIS, a number of studies were conducted in the area of the Western Mecsek hills, which is the most suitable site for disposal of HLW in Hungary. In 2004, a conceptual plan regarding the emplacement of HILW was completed, while in 2008 the conceptual plan of the long-term program of the study was completed. In 2014, the studies were expected to restart in Western Mecsek, where a deep geological laboratory is planned to be built till 2030.

During the construction of Paks II, only sealed radioactive sources will be used on the site, so no RW is expected to be generated in this phase of the project.

According to EIS, due to the new types of reactors envisaged for Paks II, a smaller amount of RW (mostly LILW) will be generated compared with the operating units. The systems of the new units are designed so as to be able to process the RW generated during the operation of the plant, such that the emission of liquid and gaseous waste and the production of solid waste will remain as low as reasonably achievable. With the exception of special treatment equipment (supercompactor, HLW container) and special operations for certain individual waste forms (dust-like ion-selective sorbents, solvents), collection, treatment and conditioning will be based on the experience accumulated on the operating plant and the relevant requirements (waste acceptance criteria, radiation safety standards etc.).

The solid RW expected to be generated during the operation of the new units will consist in: equipment removed from the reactor and parts of it (components of the handling equipment of the control rod, thermometers, transducers from ionizing chambers and their leads etc.), contaminated, disassembled tools beyond repair, pipe sections, valves, contaminated tools and parts, exhausted aerosol and iodine filters from the gas cleaning and ventilation systems, contaminated work clothing, shoes, disposable personal protective equipment, contaminated building elements, insulation and solidified liquid radioactive waste (cemented evaporation residue, cemented used ion exchange resin). The average amount of annually generated solid RW for one unit before treatment are also given – 114,5 m^3, but it is not possible to check if the quantities are indeed lower than the quantities produced by the operating units, since no such data are presented.

Liquid RW expected to be generated during the operation of the new units will consist in: waters from equipment, fittings, pipelines and decontamination of rooms, regeneration, loosening and transport waters from the filters of special water treatment systems, water coming from draining systems and potential leakage, washing and rinsing water from the liquid waste evaporation systems, liquid waste from sampling and laboratories, liquids from draining equipment, pipe sections, fittings and potential leakage, shower water from primary loop dressing rooms and waters from special laundry. Secondary waste will also be generated following the cleaning and handling of liquid RW, and this will consist in evaporation residues, spent ion exchange resins, mud and inorganic isotope-selective sorbents. The average amounts of the annually generated liquid RW for one unit under normal operating conditions are given – 35,6 m^3, but again it is not possible to check if the quantities are indeed lower than the quantities produced by the operating units, since no such data are presented.

Estimations of average amounts of solid or solidified LILW and HLW produced during the operation of Paks II that will have to be disposed of are presented, before and after treatment, as well as in terms of the necessary items (barrels, assemblies) to be disposed of. For estimating these numbers, the new waste treatment and conditioning technologies envisaged to be implemented together with the new units were taken into consideration.

The SF that will be generated during the operation of Paks II after 60 years of operation will account for 3,348 t. For this estimation, the data provided by the supplier were used, as well as the data known from the operating units.

Following, the RW and SF management operations planned to be performed at Paks II are described. All of them are following the international standards and good practices, except for HLW, which should be managed in a similar way like SF. Placing it in shielded containers in the auxiliary building where it will be stored until the dismantling of the units or until an adequate disposal facility will be built in Hungary seems to be not enough; removal of radiation heat should be ensured (as for the SF) and in general, storage of HLW is done in dedicated facilities, for which safety should be ensured exactly in the same way as for SF storage. This aspect needs to be clarified, since it might have an impact on the safety of the plant.

For the management of liquid RW, the report mentions that during the design of primary loop systems of the new units all aspects which are important for minimization of liquid waste were taken into consideration. For collecting, treatment, storage and conditioning of liquid RW, the new units of Paks NPP will be equipped with dedicated systems.

Regarding the SF, after being discarded from the reactor, it will be placed into the SF decay pool which is located close to the reactor, inside the containment, for cooling down until a temperature which will allow its dry temporary storage. SF can be stored in the pool maximum 10 years; after this period, it will be transferred to the temporary storage on site (envisaged between Unit 4 of Paks NPP and Unit 1 of Paks II). At this point, the EIS specifies that another option is available: the SF cartridges may be transported to the Russian Federation for temporary technological storage or for technological storage and reprocessing; the SF, or in case of reprocessing the nuclear waste, will be stored on the territory of Russian Federation for 20 years, then it will be sent back to Hungary for temporary storage.

According to the EIS, the impact of RW generation during normal operation of Paks II will be limited to the storage areas and facilities on the site, the transport routes to the repository or reprocessing plant in case of SF, and the repository sites. However, the impact of RW and SF management operations during the normal operation of Paks II seems to have not been performed. The only information found about any calculations that might have been performed relates to the chapter on environmental radioactivity. But in this chapter, calculations are presented for the baseline conditions of Paks NPP, using the activities and characteristic features of the RW and SF management operations currently performed at Paks NPP. For Paks II, the only statement in this chapter is that similar operations will be performed and as such, the results of the calculations performed for the existing units show that the dose constraint will not be exceeded. Based on these, it is concluded that, if the operating procedures that will have to be established by the operator of Paks II will be observed, the environmental impact originating from the management of RW and SF in normal operation of the plant will not reach or go beyond the national borders of Hungary. While this is generally true, such statement should have been substantiated with calculations of the actual doses to be incurred by the population as a result of the RW and SF management operations planned to be performed at Paks II in normal operation conditions.

Paks NPP and Paks II are completely independent facilities, so the solutions for RW management will be implemented separately. In normal operation conditions, the generation and emission of RW from one facility will have no effect on the other one. In the case of failure events, the emissions from the affected unit might have an impact on the other ones. During the joint operation, the new units will be in the first decade of their operation; the on-site storage of RW and SF produced during this period will be done in the auxiliary building and in the cooling pool, so no dispatch of RW from the site and no manipulation of SF outside the containment are expected in this time. Thus, the impact of RW and SF expected during the joint operation of the two NPP's will come almost exclusively from the operating units of Paks NPP.

RW that might be generated in failure events is planned to be collected in the auxiliary building for storage before further treatment. According to EIS, in case of PWR units, planned leakages of the primary coolant loop are collected in a closed system. The amount of radioactive waste produced can be significantly reduced by the continuous monitoring of the radionuclides getting potentially into the secondary loop through the heat exchanger tubes of the steam generator due to non-hermetical sealing, by the extraction of the radionuclides getting into the secondary loop with water cleaning systems, and furthermore by the recirculation of the contaminated water into the waste treatment system of the primary loop. Because of this, it is considered that in the course of design-basis accidents, the location and the time of RW production will be limited to the auxiliary building. Thus, the impact area of the direct environmental impacts will be limited to the safety zone of the site, and therefore an analysis of indirect and transboundary environmental impact was not performed. While it is recognized that design-basis accidents which might affect or involve the onsite RW and SF facilities cannot usually have a transboundary impact, it has to be mentioned that severe accidents (or design extended conditions) affecting the power plant or accidents affecting the SF storage were not considered for these analyses.

Regarding the decommissioning of Paks power plants, the EIS specifies that for Paks NPP the accepted solution is ”deferred dismantling with 20 years of protected preservation”, while for Paks II it is “immediate dismantling”, the objective being a ”clean-up” of the site for further use. From dismantling of Paks II, large quantities of RW (mostly LILW but also HLW) are expected to be generated. However, no estimations are given in the report. The disposal of this large amount of waste is recognized to require significant mining and transport activity, however the impact area of these activities will remain within the national borders; decommissioning will take place inside the country, at a significant distance from the borders and as such it is considered that transboundary impacts may only be possible in very extreme situations, but such analyses were not performed. However, this is not considered incorrect, since the procedure described earlier in this chapter (for licensing the decommissioning of a NPP) follows the international standards and practices; these type of analyses will be needed at the time of the shutdown of the units.

20. Ambient radioactivity and exposure of the population living in the vicinity of the site to radiation

This chapter presents the current ambient radioactivity with the study area, the health status of the population living within the study area and the exposure of this population to ionizing radiation. The impacts of the construction, operation and decommissioning of Paks II on the exposure of the population to ionizing radiation are modelled and evaluated.

The first section of the chapter lists the EU BSS (Directive 96/69) and the relevant Hungarian laws and decrees governing the radiation protection. According to these, dose limits and dose constraints are established, as requested by the EU (and international) basic safety standards. The total exposure of the population to ionizing radiation shall not exceed 1 mSv/year effective dose. For the new units of Paks II, a dose constraint of 90 µSv/year was established by the competent authority of Hungary. The operator of Paks II shall also report to the competent authority, after the commissioning of the plant, the measurement results and the dose calculation demonstrating the observance of the dose constraint. General intervention levels are also given in the Hungarian legislation, and they correspond to the levels used at international level for taking urgent protective measures and countermeasures in case of nuclear accidents or radiological emergencies.

The current environmental radioactivity in the study area was analysed based on the measurements performed by Paks NPP and different competent authorities 30 km around the site, as well as based on a study undergone in 2012. The values of environmental radioactivity and radioactive discharges measured by Paks NPP between 2001 and 2011 were analysed, together with the environmental radioactivity levels measured by the competent authorities around Paks NPP (for verification purposes) in the same period. These include: ambient gamma dose rate, in-situ gamma spectrometry measurement, activity concentration in ground level air (aerosols, radioiodine, tritium and radiocarbon), soil and grass (gamma-emitters, radiostrontium), Danube water and sediment (gamma-emitters, radiostrontium, tritium), fish pond fish, water and sediment (gamma-emitters, radiostrontium, tritium), groundwater (gamma-emitters, tritium), milk (gamma-emitters). The measured values were analysed in order to identify the environmental features governing the dispersion and dilution of radioactive materials emitted by the plant, in terms of the characteristics of the atmospheric, surface and subsurface water-bound migration of radioactive materials, as well as the radiological conditions of the environment surrounding the site. The data collected were then statistically processed, in order to obtain reliable information. Only the measured values that were above the detection limit with an error not exceeding 20 % were kept for analysis.

In addition to this, a study of radioisotope occurrence in the study area was performed in 2012, in order to determine the current radiological status of the environment in the study area. The following measurements were performed in 5 test locations: in-situ gamma spectrometry measurement, gamma dose rate measurement, soil activity concentration measurement, grass, sedge and tree bark activity concentration measurement. Once the samples were processed, gamma spectrometry measurements were performed in order to determine the natural and artificial gamma-emitters, the gross-beta activity and K-40 concentrations, and the activity concentration of Sr-90.

Based on these measurements it is concluded in EIS that during the period 2001–2011 mainly H-3, C-14, Sr-90 and Cs-137 were detected in the different environmental samples taken from the area surrounding Paks NPP (up to 30 km). Sr-90 and Cs-137 are assumed as being a consequence of Chernobyl accident and atmospheric nuclear tests, and not of the operation of the plant, as the concentrations measured around the plant show similar values with the ones measured elsewhere in Hungary by the National Environmental Radiation Monitoring System. The occurrence of tritium and radiocarbon are traced back to natural origin, too. Their occurrence on-site in groundwater is recognized as being due to the plant, but the extent of exposure is limited to the site boundaries. The typical radionuclides (Mn-54, Co-60, Co-58 and Ag-110 m) were detected in only few samples of air, fallout, sediment and soil samples. Radioiodine was detected in cases when there was an operational failure in the NPP, when the impact of the Fukushima accident reached Hungary or the emissions of the Institute of isotopes were measured. The supplementary measurements performed in 2012 confirmed the presence of Sr-90 and Cs-137 in different environmental samples. Based on all these, it is concluded that it is not possible to evaluate the environmental impact of normal operation of Paks NPP by radioactivity measurements in environmental samples, which demonstrate that the actual plant is operated safely, in accordance with the international and EU standards and good practices.

Following, the health status of the population around Paks NPP is analysed. To do so, the incidence of diseases potentially related to ionizing radiation was evaluated among the population living within 30 km around the site, in order to identify if additional risks can be linked to Paks NPP. In this respect, the following parameters were assessed: cause-specific mortality (for 10 years), mortality established based on hospital care because of cancer (for 3 years), incidence of developmental disorders (for 3 years), incidence based on non-cancer diseases with genetically component needing medical care (for 5 years) and mortality established based on hospital care because of cardiovascular diseases (for 1 year). The main objective of the study was not to measure the induced effect, but to demonstrate that the health of people living near the plant is not at risk. The study was carried out in two phases. The first phase consisted in an analysis of the available databases in order to identify the base line conditions for further studies. General practitioners were involved in the second phase of the study, in order to support a coherent assembly and processing of the information retrieved from the databases. The results of the study indicate that the risk of the tumour diseases experienced near Paks NPP is not increased by the vicinity of the plant. In conclusion, the study did not found an increased risk for morbidity caused by cancer among people living in the vicinity of Paks NPP.

The evaluation of radiation exposure of the population living around Paks NPP was done using the existing data sets (radioactive releases data from 2001–2011) and the characteristics of the site determining the dispersion of radioactive materials into the environment. For the assumed releases, scenarios were developed in order to describe emissions into the atmosphere, and the water bodies. Other exposures due to various sources and activities on the site were also taken into account, including the transfer of radioactive waste, the transport of fresh and spent fuel, the movement of radiation sources within the site, and industrial radiographic testing. Direct exposure to the radiation coming from Paks NPP was neglected, since the measured values of dose rates around the plant are within the background range. Using the developed scenarios, the radiation exposures of the critical group (hypothetical group including children living in Csámpa and Gerjén) were determined using internationally accepted methods and programs. The results obtained were then compared with the dose constraint established for the operation of Paks NPP (100 µSv/yr, of which 90 % can be used by the power plant and 10 % by the interim spent fuel storage facility).

In order to describe the atmospheric propagation of radionuclides during normal operation, the Gaussian plume model was used. The method assumes constant average atmospheric conditions for a prolonged period (e.g., 1 year) near the source, and calculates nuclide concentration in the air above ground level, plus ground surface depositions. For abnormal operation conditions, a similar model was used, giving the concentrations assuming constant emission and meteorological conditions for a given time. Using the concentrations given by the atmospheric dispersion model, the doses to critical group due to external exposure (gamma dose and beta dose to skin due to immersion into the cloud, gamma dose due to ground surface and resuspension) and internal exposure (inhalation dose due to resuspension and ingestion dose due to food consumption) were calculated. Doses to the critical group were calculated using the airborne release data and meteorological parameters from 2009; this year was selected because the reports of Paks NPP shows the second highest dose to the population and in order to obtain conservative estimates. However, why it was necessary to do such calculations it is not clear; as long as the monitoring performed by the NPP is verified by the monitoring performed by the authorities, and the doses to the populations are already calculated, an analysis of these doses would have been sufficient. Moreover, there are differences between the values calculated in EIS and the ones given in Table 20.4.2-1 (probably reported by the NPP), which are not explained. Similar calculations were performed for the emissions between 2001 and 2011 from the Interim Spent Fuel Storage facility, using the same initial conditions as applied for the atmospheric emissions of Paks NPP.

For the calculation of the doses due to liquid discharges from the power plant and the Interim Spent Fuel Storage facility, a model assuming partial mixing of the radioactive releases on the Danube banks was used. Hydrological parameters are used to calculate the distance-dependent partial mixing correction factors. For conservatism purposes, the activity concentration reducing effect of sedimentation was neglected in the calculations. The doses due to external exposure (to contaminated water volumes, contaminated riverbank and irrigated soils) and internal exposure (to drinking water, and the consumption of fish, irrigated plants and other food of animal origin contaminated due to watering or feed based on irrigated plants) were then calculated for each year (between 2001 and 2011) for both critical groups (Gerjen small children and adults).

Separate calculations were performed for tritium entering groundwater on Paks site. The potential exposure of the population drinking contaminated water was estimated using the values measured by the wells existing on site and a simple model assuming that the tritium having found a way into the soil first penetrate and traverse the confining layer and then propagate along with groundwater movement. Based on this it was then determined how the activity concentration of tritium in groundwater changes at a water takeout located 500 m away from the plant. The value obtained was 16.5 Bq/m^3, which is 4 orders of magnitude lower than the tritium limit in drinking water (100 Bq/dm^3).

For estimation of exposure due to other activities at the Paks site, a computer model was developed to simulate the different activities based on the available data. For determination of the source-term, the isotope ratios related to the activity to be investigated were used. The simulations were done with the MCNP5 software program, an internationally recognized 3D neutron and gamma transport code using the Monte Carlo simulation method. With this, the dose to a person standing 10 minutes alongside the road 5 m away from a vehicle transporting RW from Paks site to the repository is 0.135 nSv/year. The dose to a member of the public staying for half an hour 5 m away from a train transporting fresh fuel to Paks NPP is 0.66 µSv. A member of the critical group staying at the fence of Paks NPP (500 m away) during each transfer of spent fuel to ISFS will receive 13 nSv. Moving radiation sources or contaminated equipment on the site will lead to a very small dose, far below 1 nSv. Industrial radiographies performed on site will results in a dose of 5.62 µSv for a person standing at the fence during each test performed in one year.

In conclusion, the annual levels of radiation exposure of population are generally 3 orders of magnitude smaller than the dose constraint. The radiation exposure values calculated from radioactive discharges are in the range of tens to 100 nSv/year range, while the values due to other activities on the site or related with the operation of the plant may occasionally exceed this values, but only for short time, so under a conservative approach it is concluded that the annual radiation exposure of members of the population living in the vicinity of Paks NPP is in the order of µSv.

The radiological impact of Paks II during its construction may arise only from radiography testing. Industrial radiographies are performed with high activity sources (e.g. 2 TBq Ir-192, 5 TBq Se-75, 100 GBq Co-60), either on site or off site. During transportation and placement for testing, the source is in its own shielded holder casing; during the test, the radiation source is present in the environment without protection. Assuming that a test may take 5 minutes, the doses per test are calculated at different distances. Knowing the number of tests to be performed, it is possible to estimate the total doses to the population. The values given in EIS are very low (up to few µSv) and they do not represent a matter of concern even for the local population.

The radiological impact of Paks II normal operation was estimated using the airborne releases data provided by the Russian vendor and the same models described for estimation of radiation exposure of population due to operation of Paks NPP, slightly modified to take into account the differences in the design of the new types of reactors. As such, airborne discharges will take place from 2 points in case of Paks II, situated at different heights. The doses to small children (1–2 years) and adults were calculated at different distances (up to 30 km from the plant), considering the meteorological conditions of 2009 (the worst case). The results of calculations show similar values as for Paks NPP airborne releases, much smaller than the 90 µSv/year dose constraint.

In order to estimate the radiological impact of Paks II operating in design-basis conditions, the DBC4 emission data provided by the Russian vendor were considered and the atmospheric dispersion model used to estimate the radiation exposure due to operation of Paks NPP. Early (10 days emission-based) and late (30 days emission-based) doses to small children and adults were calculated at different distances up to 30 km, assuming summertime emissions, under common meteorological conditions (atmospheric stability class D, low precipitation level. The late doses due to ground surface deposition were integrated for 50 and 70 years, respectively, while for internal doses always committed dose factors were used. As an additional conservative assumption, permanent presence and exclusive consumption of locally produced food were assumed; no potential protective measures were considered. The results show effective doses lower than <90 µSv/year; the highest value (21 µSv) is for late dose to small children at 400 m. Thus, it is concluded that beyond the safety zone (500 m from the external technological building) only neutral effect can be expected. This leads also to the conclusion that under design basis accident conditions, no transboundary impact will be observed. However, severe accidents were not considered.

The combined radiological impact of Paks NPP, Paks II and ISFS operating in normal conditions was estimated by summing up the estimated impact of each facility. This impact area will be the perimeter of the combined safety zones of Paks II, Paks NPP and ISFS.

Using the liquid releases data provided by the Russian vendor and the same models described for estimation of radiation exposure of population due to operation of Paks NPP, the doses to the critical group due to liquid releases from Paks II were estimated (Gerjen small children and adults). The results obtained are similar to the values estimated for Paks NPP and much smaller than the dose constraint.

Taking into consideration that Paks II units will be placed within the current environmental monitoring area of Paks NPP, the environmental monitoring program implemented at present by Paks NPP should only be extended to cover the area surrounding the Paks II site. In addition, it is proposed in EIS to increase the number of automatic monitoring stations and groundwater monitoring wells, as well as the capacity of the Environmental Monitoring Laboratory. In order to ensure the monitoring of airborne and liquid releases from Paks II units, in the new stacks and at the points of liquid discharge continuously operating sampling and remote measuring systems similar to the current ones will be installed.

Regarding the radiological impact of Paks II decommissioning, the only information given in the EIS is that based on international experience, an increased impact compared with the operational period is not to be expected, since the only differences that may appear consist in different release points and RW amounts. While much larger amounts of RW will have to be handled during decommissioning – but these will be planned in advance –, the radioactive releases are most likely to be much lower than in the operational phase. Therefore, the maximum radiological impact is indeed in the same order of magnitude as during the operation.

21. Exposure of wildlife to radiation in the vicinity of the site

This chapter presents the current and expected exposure of wildlife to radiation in the immediate surroundings of Paks site, following the international requirements and guidelines for limitation of exposure of plants and animals.

In 2007, ICRP revised its 1990 recommendations for the system of radiological protection; one of the updates introduced in ICRP Publication 103 refers to the need to establish a framework for protection of the environment as a whole, and not only in relation with the transfer routes to human been. While ICRP continues to believe that the standards established for environmental control in order to protect the public ensure the protection of other species too, it is also aware of the fact that other environments need to be considered, such as areas where the ICRP recommendations for protection of humans have not been used or where humans are absent. In the same time, in some countries the national authorities ask a clear demonstration that the environment is being protected even under planned exposure situations. Therefore, ICRP considers that a clearer framework is required to be developed now in order to assess the relationships between exposure and dose, between dose and effect and the consequences of such effects for non-human species, on a common scientific basis. In the absence of specific technical guidance at the moment, ICRP proposes the use of Reference Animals and Plants and, in order to establish a basis for acceptability, additional doses calculated to these reference organisms could be compared with doses known to have specific biological effects and with dose rates normally experienced in the natural environment. No dose limits for environmental protection, or other numerical levels are proposed by ICRP at the moment.

These recommendations were adopted by both EC and IAEA in their revised BSS (Directive 2013/59/Euratom and respectively, IAEA GSR Part 3), but only as a general requirement for radiological protection of the environment as a whole. No specific requirements are formulated yet, and therefore many countries are implementing this general requirement using the available (technical) guidelines (namely, ICRP Publication 91 and IAEA-CN-109).

The approach recommended by ICRP was used in EIS in order to estimate the exposure to radiation of biota due to operation of Paks NPP and the radiological impact of Paks II. The assessment tool developed under the EC-funded project ERICA (Environmental Risks from Ionising Contaminants: Assessment and Management) was used, in combination with the radioactive releases data measured by Paks NPP and environmental radioactivity monitoring data provided by Paks NPP and the competent authorities performing verification monitoring in the area. In order to conclude if an effect might appear on the plants and animals studies, the calculated dose rates were compared with 10 µGy/h (the so-called “predicted no-effect dose rate” introduced in the Final Report of ERICA project).

Using the natural radionuclides concentrations measured in environmental samples taken from the study area, it is concluded that the background radiation exposure of terrestrial animals and plants living around Paks NPP is below 0.5 µGy/h, with the exception of creatures accumulating lichen and mosses who might slightly exceed this values, due to the fact that lichen and mosses may exceed even the reference level. The background radiation exposure of fishes, aquatic birds, amphibians and aquatic mammals is in the same order of magnitude as for the majority of terrestrial animals and plants. All the other aquatic creatures form a separate group, with approx. 20-fold the previous value.

In order to estimate the impact of Paks NPP operation on the biota, artificial radionuclides concentrations measured in environmental samples taken from the studied area by the plant, the competent authorities, plus some dedicated tests were used, in combination with release data. The conclusion of the study was that the contribution of Paks NPP to the exposure of terrestrial plants and animals is in the same order of magnitude like the contribution of Chernobyl and nuclear testing fallout, both being 4 order of magnitude lower than the reference level. Regarding aquatic plants and animals, the contribution of Paks NPP is sometimes 1–2 orders of magnitude higher than the contribution of Chernobyl and nuclear testing fallout, but still 4 orders of magnitude lower than the reference level.

The construction of Paks II will have no effect on biota, since no radioactive material will be released off site.

For the estimation of the radiological impact of Paks II normal operation on the biota living around the plant, the design-releases data provided by the vendor were used as an input to PC-CREAM 08 code (developed by HPA, UK) to obtain the fallout of the airborne material on the ground (radioactivity concentrations in the air and on the soil). These data were then used as input in ERICA Tool, in order to estimate the radiation exposure of the reference animals and plants. The resulting doses are 3 orders of magnitude lower than the reference level (at 3 km from the emission point). The design liquid releases data provided by the vendor were used in a similar way; the dilution of discharged material was modelled (using the IAEA recommended methods) and the concentrations obtained were then introduced in ERICA program. The estimated total dose rate for insect larvae that live in the sediment (so who are the most exposed to artificial isotopes accumulating in the sediment) is only 1 nGy/h.

Concerning the impact of joint operation of Paks NPP and Paks II, the anticipated dose rates affecting animals and plants will be in the order of tenth nGy/h (4 orders of magnitude below the reference level).

In order to estimate the radiological impact of Paks II in case of accident situation, the same DBC4 design-basis accident was analysed. The airborne release data provided by the vendor were modelled using PC-CREAM 08 computer code, and the results obtained were introduced in ERICA software. The calculated early dose rates are lower than the reference levels; the late dose rates do not reach 10% of the natural background radiation exposure in the environment of Paks NPP, with regard to any of the animals and plants.

In conclusion, the new units of Paks II will add insignificant incremental dose rate to actual natural radiation exposure of animals and plants living in the vicinity of the plant. No trans-boundary effect is thus expected.

Regarding the decommissioning of the plant, EIS considers that immediate dismantling (which is assumed for Paks II) will imply the biggest environmental risk because the activity stock is the highest at this time (since short-lived and medium to long-lived radionuclides will still represent the majority of the waste). The operational radioactive releases will stop. The waste water resulted from contamination will be collected and chemically treated and can be released under control, provided that the emission limits are observed. In terms of activity, this volume will be insignificant. Some radioactive material from structural elements can get in the groundwater (primarily by solution) when the slab foundation will be demolished. The migration of radionuclides from the main building to the Danube will take more than 12–20 years. But since the foundation of the units is in the saturated zone, no surplus load considerably different from the operational stage is expected. In general, the mobility of radioactive materials (except tritium and radiocarbon) getting this way in the groundwater is minor. During dismantling, any local contamination can be controlled and removed, so it is considered unreasonable to evaluate the impact of decommissioning on biota, since normal operation proved to have practically no effect on animals and plants.

22. Summary impact matrices and aggregate impact areas

This chapter summarizes the findings of the environmental impact assessment performed for the planned construction and operation of Paks II. These findings are presented in a tabular form, for each of the impact factors categories considered under the EIS (use of environmental elements, generation of conventional waste, emission of radioactive waste, generation of spent fuel) which were estimated both for normal operation and design-basis accident conditions during the construction, operation and decommissioning of Paks II. Information about the processes triggered by each impact factor, the affected environmental element, the dimensions of the impact areas and the nature of the impact (strength, duration and significance) are also included.

None of the impacts summarized in this chapter and analysed under the EIS will have a cross-border character.

International chapter

This chapter summarizes the assessment results concerning transboundary impacts of Paks II, as well as the answers to the questions and comments received to the Preliminary Consultation Document which are not covered by the scope of EIA.

As a first comment, it is not clear what is the status of this chapter; as long as it is not included in the Table of Content of the EIS, it seems that is not part of EIS. Thus, a clarification is needed in this respect.

The first section of this very short chapter gives a brief summary of the transboundary effects investigated in the main document (EIS) and presented in a tabular form in Chapter 22 of EIS.

Then, the conclusions summarized in this section are basically stating that "cross border impact are not anticipated even in the case of operating troubles". Due to the fact that "operating troubles" are not defined, it is assumed that this term refers to "operational occurrences", although in the technical chapters of EIS, all evaluations performed for accident situations were considering design-basis accidents. As defined in IAEA Safety Glossary (2007 edition), the (anticipated) operational occurrences are not considered as accident conditions, while the event used to estimate the radiological impact in accident conditions of Paks II is a design-basis-accident – DBC4 (a design-basis condition with very low probability of occurrence, as explained in EIS section 3.4.3.2). In addition to these, severe accidents (or beyond-design-basis-accident, or DEC2 according to Hungarian classification of plant states) should have been analysed too, not only for purposes of (nuclear) safety analyses, but also for purposes of EIA (see requirement 14 para. 4.50 of IAEA GSR Part 4 and paragraph 4.4.2.10 of IAEA NG-T-3.11). This event is considered and analysed only in this chapter.

In this respect, it is mentioned that TREX (Euler-model) code was used to simulate the airborne releases for the purposes of calculating the doses to population far from Paks II. The model is briefly described but no other information or reference is given regarding its validation except of the mention that all software programs are validated. Therefore, more details are needed to be presented about the validation process of this specific code which was used to calculate the doses to population in neighbouring countries.

Also, clarification is needed in order to understand Tables 2 and 3 presenting the radioactive releases in case of beyond design basis accidents, and in particular the values given in the 3 columns called "1 day", "10 day", "30 days" for DEC1 and respectively "0–1 days", "1–7 days", "7–30 days") for DEC2. In the same sense, the fourth, fifth and sixth paragraphs in section 2.3.5 need to be verified and clarified (e.g. there is no column 0–10 days in Table 2).

The results presented in section 2.3.5 are incomplete. The inhalation doses might be the main contributor to the total dose, but in the absence of the other doses, this can't be checked. It is therefore recommended to present the doses calculated for all exposure pathways (as specified in section 20.6.2.1.1), as well as the total doses.

Simplified public summary

This chapter present the summary of the analyses performed for the purposes of environmental impact assessment for Paks II development project and documented in EIS. In addition to this, an Emergency Management and Action Plan is presented in the last section. For this plan it is mentioned that it will be necessary to be developed at a later stage in the project, in such a manner so as to be in correlation with the current Nuclear Accident Prevention and Action Plan of Paks NPP. The plan has to include provisions for the necessary actions to prevent general emergency situations and accidents with environmental impacts and, upon their occurrence, actions to mitigate their environmental consequences. Such provisions are currently in place at Paks NPP and they are regularly audited by the nuclear regulatory authority of Hungary.

10 LIST OF ABBREVIATIONS

BDBA .... beyond design-basis accident

BIS .... Bid Invitation Specification

BSS .... Basic Safety Standards

DBA .... design-basis accident

DEC .... Design Extension Condition

DBC .... Design Basis Condition

EHRT .... Emergency Heat Removal Tank

EIS .... Environmental Impact Study of Paks II

EU .... European Union

EURATOM .... European Atomic Energy Community

EUR .... European Utility Requirements

EIA .... Environmental Impact Assessment

EURDEP .... European Radiological Data Exchange Platform

GHG .... Green House Gases

HLW .... High-Level Waste

IAEA .... International Atomic Energy Agency

ICRP .... International Commission on Radiological Protection

LILW .... Low and Intermediate Level Waste

MS .... Member States

NSR .... Nuclear Safety Regulations

NPP .... Nuclear Power Plant

NEA-OECD .... Nuclear Energy Agency of the Organization for Economic and Co-operation Development

NCCS .... National Climate Change Strategy

OMSZ .... Hungarian National Meteorological Service

RADD .... Radioactive Discharges Database

RW .... Radioactive Waste

SF .... Spent Fuel

SG .... Steam Generator

UN .... United Nations

WANO .... World Association of Nuclear Operator

WENRA .... Western European Nuclear Regulators Association

WFD .... Water Framework Directives

11 References

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PERSPEKTIVEN FÜR
UMWELT & GESELLSCHAFT umweltbundesamt

Umweltbundesamt GmbH
Spittelauer Lände 5
1090 Wien/Österreich

Tel.: +43-(0)1-313 04
Fax: +43-(0)1-313 04/5400

office@umweltbundesamt.at
www.umweltbundesamt.at

EMAS
Geprüftes
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