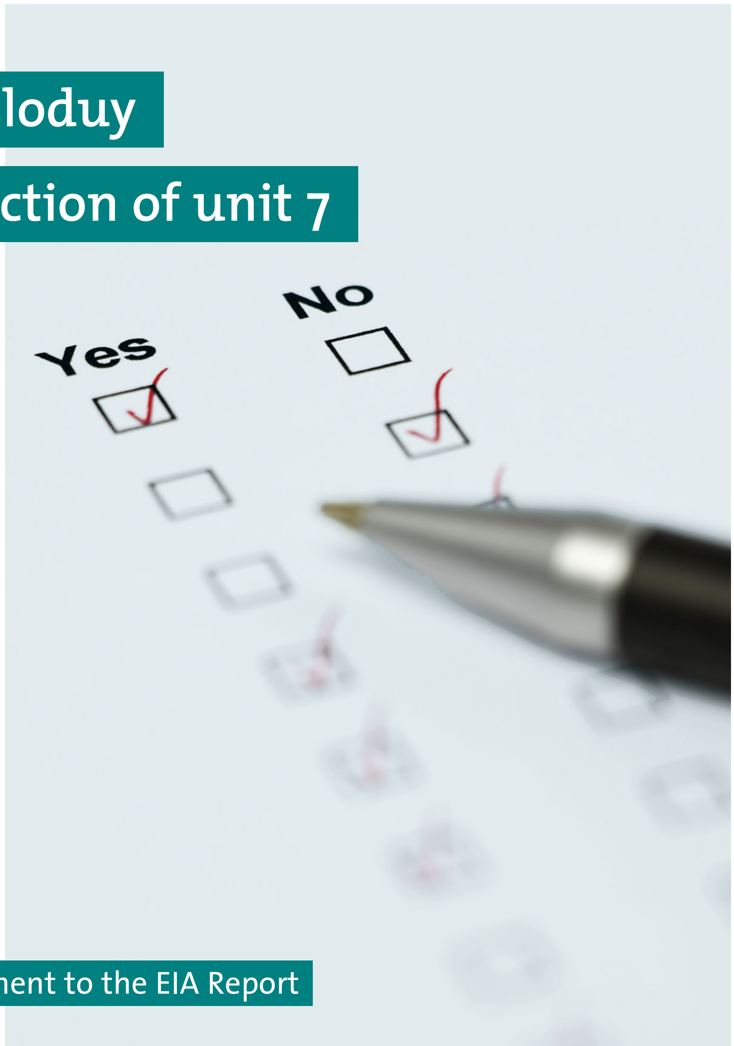
ENVIRONMENT AGENCY AUSTRIA umweltbundesamt

NPP Kozloduy

Construction of unit 7



Expert Statement to the EIA Report

lebensministerium.at

NIEDERÖSTERREICH

ÖSTERREICHISCHES ÖKOLOGIE INSTITUT

KOZLODUY NPP – CONSTRUCTION OF UNIT 7

Expert Statement
to the Environmental Impact Assessment Report

Andrea Wallner, Helmut Hirsch
Adhipati Y. Indradiningrat, Oda Becker, Mathias Brettner

By Order of the
Federal Ministry of Agriculture, Forestry,
Environment and Water Management,
Project Management Department V/6
"Nuclear Coordination"
GZ: BMLFUW-UW.1.1.2/0006-V/6/2013

and the
Province of Lower Austria

lebensministerium.at

NIEDERÖSTERREICH

ÖSTERREICHISCHES ÖKOLOGIE INSTITUT

REPORT
REP-0449

Wien, 2013

Project lead

Franz Meister, Umweltbundesamt

Authors in alphabetical order

Dipl.-Phys. Oda Becker (chapter 7)

Dipl.-Math. Mathias Brettner (chapter 5 and 6)

Dr. Helmut Hirsch, cervus nuclear consulting (technical review)

Adhipati Y. Indradiningrat, cervus nuclear consulting (chapter 3 and 4)

Mag. Andrea Wallner (Project management, chapter 1, 2 and 8)

Translation

Mag. Patricia Lorenz (German)

Übersetzungsbüro Quick Translation (Bulgarian)

Layout and typesetting

Elisabeth Riss, Umweltbundesamt

Title photograph

© iStockphoto.com/imagestock

For further information about the publications of the Umweltbundesamt please go to: http://www.umweltbundesamt.at/

Imprint

Owner and Editor: Umweltbundesamt GmbH
Spittelauer Lände 5, 1090 Vienna/Austria

Printed on CO_2-neutral 100% recycled paper

ISBN 978-3-99004-254-0

CONTENT

LIST OF TABLES

LIST OF FIGURES

SUMMARY

Kozloduy NPP is the only nuclear power plant operating in Bulgaria – it is located at a distance of approximately 700 km from Austria. Currently, two reactors are in operation: Kozloduy-5 and Kozloduy-6 are both Pressurized Water Reactors of the VVER V-320 type with a gross electrical capacity of 1,000 MW_e. The Investment Proposal (IP) of the “Kozloduy NPP – New Build EAD” envisages the construction of a new nuclear unit of the latest generation (III or III+) with installed electrical power of about 1,200 MW at the Kozloduy NPP site (Kozloduy-7 or new nuclear unit “NNU”).

Environmental Impact Assessment

In June 2013, the Republic of Bulgaria notified Austria of the planned construction of a new nuclear energy unit at the nuclear power plant Kozloduy. Competent Bulgarian Ministry for the Environmental Impact Assessment (EIA) is the Ministry of Environment and Water.

With reference to Art. 7 EIA Directive 2011/92/EU and Art. 3 Espoo Convention, the Austrian Federal Ministry of Agriculture and Forestry, Environment and Water Management informed the Bulgarian side that Austria would take part in the transboundary Environmental Impact Assessment as the possibility of significant transboundary impacts of the projects on Austria cannot be ruled out (letter of 26 June 2013).

In October 2013, the Bulgarian Ministry of Environment and Water sent the EIA-Report of the investment proposal “Construction of a new latest generation nuclear unit at Kozloduy NPP site”. The full report including annexes is available in English (EIA-REPORT 2013). Moreover, a non-technical summary and chapter 11 of the EIA-Report (Transboundary Impacts) are available in German.

The applicant of the investment proposal is the company “Kozloduy NPP – New Build EAD”. The applicant has assigned the Consortium “Dicon – Acciona Ing.” with the development of the EIA-Report.

The Umweltbundesamt (Environment Agency Austria) was commissioned by the Austrian Federal Ministry of Agriculture and Forestry, Environment and Water Management and the Province of Lower Austria to coordinate this expert statement and assist in organizational matters. The Austrian Institute of Ecology (Österreichisches Ökologie-Institut) in cooperation with Helmut Hirsch, Adhipati-Yudhistira Indradiningrat, Oda Becker and Mathias Brettner was assigned by the Umweltbundesamt to prepare the expert statement at hand.

The **goal of the expert statement at hand** is to assess whether the EIA-Report allows for making reliable conclusions about the potential trans-boundary impacts on the Austrian territory. Therefore, particularly safety features, severe accident management and the accident analysis with a focus on airborne transboundary emissions and the potential impact on Austria are discussed. Questions were formulated which need to be discussed during the consultations process within the EIA-procedure.

Description of the project

The EIA-Report provides information on the safety requirements that will be applied to the NNU. It explains that requirements of the Bulgarian legislation in the field of nuclear energy, requirements of the IAEA and the European Utility Requirements (EUR) will be taken into consideration, However, it is not clear whether WENRA documents (in particular, the safety objectives for new reactors and the additional work of WENRA-RHWG on new reactors) will also be taken into account for the NNU. From the Austrian experts' point of view the WENRA documents should be taken into consideration due to their significance. If this is already the case, this fact should be clarified.

In the field of nuclear safety, changes in safety requirements and safety objectives have been made in the light of the Fukushima accident. The information provided in the EIA-Report does not enable the conclusion whether and to which extent the lessons learned from the Fukushima accident will be taken into account in the requirements and safety analyses of the reactor types considered for the NNU, and to which extent they might already be covered by the design of the candidate reactor types. From the Austrian experts' point of view, more information should be provided about the question to which extent the lessons learned from the Fukushima accident will be taken into consideration.

Four different locations at Kozloduy NPP are presented in the EIA-Report as possible sites for the planned NNU. Information such as terrain characteristics of each site and existing infrastructure on each site is provided. However, from the Austrian experts' point of view information on analysis and assessments concerning to which extent the differences between the possible sites could also affect the safety of the NNU during its operation and decommissioning, and the performance of safety measures in accident conditions should also be provided.

Questions

- *Are WENRA documents for new reactors and the WENRA safety reference levels also to be taken into consideration with regard to the safety requirements for the NNU?*
- *To which extent are the lessons learned from the Fukushima accident to be taken into account in the safety requirements and safety analyses for the NNU?*
- *To which extent are the lessons learned from Fukushima already covered by the design of the candidate reactor types?*
- *Is it possible to provide more information on analysis and assessments which have been or are planned to be performed to compare the four alternative sites presented in the EIA-Report, especially those related to the safety of the NNU?*

Reactor type

The description of the reactor types taken into consideration provided in the EIA-Report only provides basic and general information of the reactors, mainly on the functions and the main components. The reliability and effectiveness of the safety systems in accident conditions are not elaborated, and there are no references to analyses or evaluations in this regard. From the Austrian experts' point of view, more information on the safety systems of the reactor types considered for the NNU should be provided. With regard to evaluations of their reliability and effectiveness, safety systems or measures such as passive core cooling systems, passive containment cooling system, in-vessel retention measures for AP-1000 as well as core catcher for AES-92 and AES-2006 would be of special interest. It is also of interest for the Austrian expert team to receive more detailed information on the comparison of differences between the reactor models V-392 M and V-491 of the AES-2006.

Values of core damage frequencies (CDF) and large early release frequency (LERF) for each reactor type are presented in the EIA-Report. However, it was not specified which scope is covered by these values, the uncertainties of the values are not discussed, and there is also no elaboration on the accident analyses which have been performed for the reactor types under consideration. Furthermore, from the information provided in the EIA-Report, it cannot be ascertained whether the concept of practical elimination is applied in the safety requirements for NNU in the context of severe accidents.

In general, information on the methods and results of safety analyses of the reactor types under consideration and also concerning the safety requirements (including the consideration of post-Fukushima lessons learned and, as far as applicable, the use of the concept of practical elimination) for the NNU are still lacking. From the Austrian experts' point of view, more detailed information on these aspects should be provided.

Questions

- *Would it be possible to provide more detailed information on the safety systems of the reactor types under consideration, especially concerning passive core cooling system, passive containment cooling system, in-vessel retention measures for AP-1000 as well as the core catchers of the AES-92 and the AES-2006?*
- *Would it be possible to provide information on the scope of the probabilistic analyses (in particular, plant states and event categories included) and the treatment of uncertainties in these analyses?*
- *Would it be possible to provide more details regarding the differences between the two types of AES-2006 under consideration?*
- *Is the concept of practical elimination applied in the safety requirements for the NNU?*
- *Assuming that the concept of practical elimination is applied in the safety requirements for the NNU, which exact criteria are used to define that a condition or accident sequence is practically eliminated?*
- *Would it be possible to provide information on assessments or analysis concerning the reliability and effectiveness of the safety systems of the reactor types under consideration?*

Site evaluation

Seismic Hazard Assessment

The seismic hazard study for the NPP Kozloduy site (the study is cited within the EIA-Report, but the reference is missing) was performed in the years 1991-1992. The EIA-Report describes the seismicity in Bulgaria and border regions and outlines the most important seismic areas. Within a 30 km zone around the site, no historical earthquake is known. According to geological and geophysical assessments, there is no evidence of major capable faults within the 30 km zone of the site. In general, the seismic hazard at the site can be seen as low. It is dominated by earthquakes that are located at distances of more than 80 km away from the site with much stronger earthquakes.

For the site of the NPP Kozloduy a deterministic and a probabilistic assessment were performed on the basis of common principles. The briefly described deterministic procedure reflects international practices. For the probabilistic analysis a standard program (EQRISK) was used. Model uncertainties were considered using a logic-tree - which is the typical practice in probabilistic seismic hazard assessment.

The general applied methodology of seismic hazard assessment conforms to international practices. However, only the PGA value is used to characterize the seismic hazard, without also referring to the response spectra. Response spectra are important as they contain the information about the frequency dependent impact due to seismic events.

The seismic hazard study was performed 20 years ago. So the question arises whether the results still fulfill the actual state-of-the-art in seismic hazard assessment for nuclear facilities.

Concerning the assessment of the seismic hazard the following questions arise.

Questions

- *Which seismic hazard study (reference) was used as a basis of the environmental impact assessment?*
- *Which field studies were undertaken and which methods were applied in detail to identify main geological structures and to evaluate Neogene-Quarternary activities?*
- *Please publish the values of the horizontal response spectrum for annual exceedance probability of 10^{-4} and which spectral shape has been applied. Were normalized standard spectra, scaled to 0.2 g used?*
- *Was one spectral shape used for all seismic sources or different ones for close and far distances?*
- *Would it be possible to provide us with the values of the vertical seismic motion considered for the site?*
- *Was an evaluation conducted to make sure that the seismic hazard assessment from 1991-1992 still fulfills the actual state-of-the-art in seismic hazard assessment for nuclear facilities (e.g. regarding model parameters, response spectra, consideration of uncertainties and assessment of local site effects)?*
- *Which evaluations have been performed in the course of the periodic updates of the seismic PSA and in the PSR, on the basis of the information available and verified, concerning the need of a re-assessment of the seismic hazard on the site?*
- *Are there current plans for re-assessment of seismic hazards at the Kozloduy site – either within the scopes of the periodic safety review for the existing units, or specifically for the new unit?*

- *Was it made sure, that new data about seismicity and tectonics (obtained in the last 20 years) could have not have a considerable influence on the seismic hazard results?*
- *The seismic hazard is given in peak ground accelerations for an annual exceedance probability of 10^{-2} and 10^{-4}. The resulting accelerations are 0.1 g and 0.2 g. To which fractile values of the hazard curve do these accelerations correspond (e.g. mean, 50% fractile)?*
- *How are local site effects taken into account (considering amplification due to soil resonance) and what are the shear wave velocity profiles at the sites?*
- *The EIA-Report states that "Three-component accelerograms (continuation 61 s), measuring the geological conditions on the site" are given in addition. How are these accelerograms used and are these accelerograms real earthquake registrations or synthetic time-histories? How are they obtained?*

External Human Induced Events

Aircraft crash

The EIA-REPORT (2013, CHAP. 6.2.1 AND CHAP. 2.3) does not provide clear information on the extent to which the NNU will be designed to withstand a supposed crash of large passenger or military aircraft.

Concerning the possibility of aircraft crashes and the respective basic design of the NNU, the following questions arise.

Questions

- *Are there relevant risk contributions due to airways or airport approaches passing within 4 km of the site or air space usage within 30 km of the plant for military training flights?*
- *Is it justifiable, to conclude that aircraft crashes of type 3 ("crash at the site owing to air traffic in the main traffic corridors of regular Civil Aviation and traffic in the military flight zones") can be excluded when considering*
  - *Art. 30. (1) of the Bulgarian Regulation BNRA (2008) according to which it is not allowed to neglect sources of human induced hazards with a frequency of occurrence greater than or equal to 10^{-6} events per year,*
  - *the tentative value of 10^{-7}/a for a Screening Probability Level stated in IAEA (2002) and*
  - *the derived annual frequency for aircraft crashes of 5.66×10^{-7} (on an area of 0.5 km²) and of 1.13×10^{-6} (on an area of 1 km²) based on traffic data within 30 km of the site?*
- *To which extent will the NNU be designed to withstand a supposed crash of large passenger or military aircraft?*
- *Which loads shall be covered by the design (e.g. mechanical impacts in form of load-time curves, thermal impact as a consequence of burning fuel)? Which systems necessary for providing the basic safety functions shall be protected by adequate design strength of the respective buildings and which by redundancy in combination with physical separation of the respective buildings?*

Leaks of hazardous fluids and gases

The conclusions in EIA-REPORT (2013, CHAP. 6.2.3 AND 6.2.4) concerning potential impacts due to facilities at the Kozloduy NPP and due to gas pipelines are not fully comprehensible as relevant information is contained in separate documents which are not available.

Concerning explosions in storage facility No. 106, no results for the case that administrative fire protection rules are not (fully) followed are presented in the EIA-Report. No information is available whether a probabilistic risk assessment was conducted for explosions in this facility.

The EIA-REPORT (2013, CHAP. 6.2) does not contain considerations about the formation of pressure shock waves due to explosions outside the perimeter of the NPP and their possible impact on buildings of the NNU. The Report also leaves open whether relevant impacts due to explosives transported next to the site have to be taken into account. This is not in compliance with the requirements contained in IAEA (2002).

The EIA-Report does not mention whether the NNU should have a basic design against pressure shock waves due to external explosions.

Concerning the possible impacts due to hazardous fluids and gases the following questions arise.

Questions

- *Would it be possible to provide information on the conducted analyses and their basic approach with respect to facilities at the Kozloduy NPP site and the planned gas pipelines?*
- *Would it be possible to provide information whether only single events were considered (e.g. a single failure of a storage facility) or also combinations of events like an interconnected cascade of destructions and subsequent explosions (e.g. a release of explosive gases because of foregoing fires or local explosions) with respect to the events listed in the EIA-REPORT (2013, CHAP. 6.2.3)?*
- *Would it be possible to provide information on the probabilistic assessment for the violation of administrative fire protection rules in storage facility No. 106?*
- *Were analyses conducted to find out whether relevant impacts from to explosives transported next to the site are possible (e.g. ships on the Danube or trucks) and need to be taken into account?*
- *Have analyses on the formation of pressure shock waves and their possible impact on buildings of the NNU due to explosions outside the perimeter of the NPP been conducted (e.g. due to pipelines or transportation of explosives)?*
- *Will the basic design of the NNU be required to withstand pressure shock waves? If this is the case: Would it be possible to specify the design values?*

Fire

The conclusion in EIA-REPORT (2013, CHAP. 6.2.8) concerning potential impact due to external fires is not fully comprehensible as relevant information is contained in a separate document which is not available. Therefore, the following question arises:

Question

- *Would it be possible to provide more information on the analyses conducted and their basic approach with respect to facilities at the Kozloduy NPP site and the planned gas pipelines?*

Other External Events

Off-site flooding

Based on the information provided in BG-NR (2011) the conclusion in EIA-REPORT (2013, CHAP. 6.2.6) that the Kozloduy NPP site is flood-proof is considered to be well founded.

In addition BG-NR (2011) and in the peer review country report ENSREG (2012) state that in some buildings of the existing NPP, where the lowest elevation of rainwater or domestic sewer is below 32.93 m, water penetration from outside may be possible. Therefore, the following question arises.

Question

- *Does the planning require to exclude an ingress of water into safety relevant buildings of the NNU via rainwater or domestic sewers by taking adequate design provisions?*

Extreme winds and tornadoes

The EIA-REPORT (2013, CHAP. 6.2.7) does not present any information on the design basis values against wind load. Therefore, it is not clear whether also loads due to tornadoes shall be covered, e.g. due to a design against other impacts (e.g. air pressure waves).

Other extreme meteorological impacts beside wind and tornadoes or not discussed in the EIA-Report.

Concerning the possible impacts due to tornadoes and other meteorological conditions, the following questions arise.

Questions

- *Will loads due to tornadoes be covered, e.g. due to a design against other impacts (e.g. air pressure waves)?*
- *Which design values will be assumed for the NNU concerning the full spectrum of meteorological impacts (i.e. the impacts treated within the ENSREG stress test)? What are the respective probabilities of exceedance?*

Accident analysis

The treatment of accidents (design basis accidents and severe accidents) in EIA-REPORT (2013) is very general. A significant amount of relevant information is not provided e.g. the list of design basis accidents considered, the effectiveness of special features of the NNU concerning prevention and mitigation of severe accidents, and scenarios for severe accidents.

The EIA-Report claims that a lot of technical information and data have been studied and analyzed. However, none of the points explicitly mentioned in the introduction to chapter 6 of the EIA-Report are subsequently further addressed.

Also, no information is provided on how the lessons learned from Fukushima have been taken into account.

Concerning the source term for design basis accidents the statement with reference to the EUR that the underlying accident has a probability of occurrence approximating the value of 10^{-6}/year cannot be unambiguously deduced from the EUR. Therefore, it should be further explained.

The information provided in the EIA-Report is not sufficient for an assessment of potential radiological consequences due to severe accidents. Additional information concerning the technical background of the severe accident source term is necessary. Therefore, it is not possible to confirmed that the source term for severe accidents presented in EIA-REPORT (2013, CHAP. 6.1.3.3) represents an upper limit. Concerning the source term for design basis accidents, the following question arises:

- *What is the precise connection between the statement in the EIA-Report that the underlying accident has a probability of occurrence approximating the value of 10^{-6}/year and the EUR?*

Concerning the derivation of the source term for severe accidents and the question whether it represents an upper limit, the following questions arise - as far as the answers are reactor-type specific, they should be provided for each reactor type under consideration:

Questions

- *Which initiating events have been considered in the determination of possible core damage states? Have core damage states originating from events with containment-bypass been considered? Which design extension conditions (e.g. external events beyond the design basis) have been considered?*
- *What are the frequencies of the respective core damage states and the statistical confidence level of these frequencies?*
- *How have the releases rates provided in NRC (1995) been applied for the derivation of the source term? How has the possibility that the source terms derived in NRC (1995) may not be applicable for fuel irradiated to high burn-up levels (in excess of about 40 GWD/MTU) been taken into account?*
- *Which requirements have been applied to the potential suppliers of the nuclear facility with respect to the definition of the severe accident source term? In which way have these requirements been used for the determination of the fraction of nuclides released from the containment to the environment?*
- *How effective and robust are safety systems as well as measures for prevention and mitigation of severe accidents in case of different design extension conditions (e.g. external events beyond the design basis)?*
- *Which design basis and beyond design basis accident scenarios have been considered?*
- *What are the frequencies of scenarios with large early releases?*
- *Which values have been assumed concerning the efficiency of the retention of radioactive nuclides inside the plant? What is the technical justification for these values?*
- *Has the assumed release of Cs-137 (30 TBq) been taken directly from the "Regulation on Ensuring the Safety of Nuclear Power Plants" BNRA (2008)?*

- *Which accident scenarios and which plant respectively containment states have been judged to be practically eliminated?*
- *Which arguments guarantee the necessary high confidence for the scenarios or for the plant states respectively containment states which are judged to be practically eliminated?*
- *In which manner have the lessons learned from Fukushima been taken into account?*

Trans-boundary Impacts

Chapter 11.4 of the EIA-REPORT (2013) deals with the trans-boundary impacts on the Republic of Austria caused by a major accident. According to the EIA-Report, the analyses of a severe accident with a Cs-137 source term of 30 TBq confirm the absence of radiological risks to the Republic of Austria.

Only results of detailed safety assessments for the considered reactor type of the proposed NNU would allow to exclude a larger source term than 30 TBq – in case it can be proven beyond doubt that such a larger source term cannot occur ("practical elimination"). Such results, however, are not yet available. Therefore, a source term for e.g. an early containment failure or containment bypass scenario should be analyzed as part of the EIA.

Calculations of a severe accident at the Kozloduy NPP site with source terms used in the FLEXRISK (2013) project or in a study by the Norwegian Radiation Protection Authority (NRPA 2012) show possible consequences for Austria, while the release of 30 TBq Cs-137 would not be expected to cause such consequences.

For a potential Cs-137 release of 54,460 TBq (as used in the flexRISK project), a considerable contamination of the Austrian territory would result under specific weather conditions. Most parts of Austria show depositions over 10 kBq/m². The central part of the country would be contaminated with 100 to 200 kBq/m². The results show that, even if the source term is smaller by a factor of 20 – as used in the calculation of the Norwegian Radiation Protection Authority (2,800 TBq) – the calculated Cs-137 depositions of large areas shows volues above 1 kBq/m², thus reaching the threshold that triggers agricultural intervention measures in Austria.

The Austrian experts recommend to calculate the consequences of a severe accident with a large release, in addition to the limited release scenario presented in the EIA-REPORT (2013), since the effects can be widespread and long-lasting and even countries not directly bordering Bulgaria, like Austria, can be affected. Furthermore, they recommend to provide detailed information concerning the used program for the dispersion calculation (ESTE EU Kozloduy).

All in all, the information contained in the EIA-REPORT (2013) does not permit a meaningful assessment of the effects that conceivable accidents at the Kozloduy NPP site could have on Austrian territory. The analysis of a worst case scenario would close this gap and allow for a discussion of the possible impact on Austria. This should be taken into consideration in the further course of the EIA process.

Questions

- *The EIA-Report (2013) mentions that the ESTE EU Kozloduy database contains source terms related to spent fuel pools and accidents at different levels of damage to the containment (leaks in the containment). From the Austrian experts´ point of view these source terms are of utmost interest. Would it be possible to provide those source terms?*
- *Would it be possible to provide source terms for accident scenarios apart from ESTE EU Kozloduy, which would include accidents in the spent fuel pools for the reactor type under consideration for the NNU with calculated large release frequencies (LRF) below 1*10E-7?*
- *Can information about the used program ESTE EU Kozloduy be provided? Why is the program ESTE EU Kozloduy and the used input parameters (including weather scenarios) considered to be appropriate for the calculation of the long-term effects for Austria?*
- *Can more information about the results of the dispersion calculation be provided? Why, for example, are only results for the distance of 200 km presented, whereas the distance for transport of the radioactive substances after 48 hours with wind velocities of 2 m/s or 5 m/s is about 346 km or 864 km, respectively?*
- *Is it envisaged to apply all four Criteria for Limited Impact of EUR as intended in EUR? Why are the specific Criteria for Limited Impact of EUR not quoted for the three cases considered in Table 6.1-7 of the EIA-Report (2013), but only the criteria for economic impact?*
- *Why are the calculated doses in case of the severe accident at the NPP Temelin 3&4 the same as those presented in the EIA-Report (2013) for the NNU?*

Radioactive Waste Management

The State Enterprise for Radioactive Waste (SE-RAW) is responsible for Radioactive Waste Management in Bulgaria. The concrete plans on Radioactive Waste management are described in the Bulgarian "Strategy for Managing the spent nuclear fuel and radioactive Waste until 2030", therefore the content of the EIA-Report on RAW is not evaluated in detail.

According to Directive 2011/92/EU Annex IV a, description of the project, including an estimate, by type and quantity, of expected residues and emissions resulting from the operation of the proposed project is a compulsive requirement of an EIA-Report.

The EIA-Report gives information on estimated SNF quantities. As the quantity of the SNF is highly dependent on the not yet selected reactor type the SNF quantities vary considerably.

Concerning LILW quantities, the same applies – conditioned LILW from 180 m^3 to 250 m^3 per year will be produced. No information is given on the question which reactor types produce which quantity of LILW or on how this corresponds to the EUR which require generation of not more than 50 m^3 of LILW per 1,000 MW per year.

The EIA-Report gives mainly information on the existing facilities – a lot less detailed information is given on the NNU – the actual topic of the EIA. E.g. the question of SNF interim and final storage for the NNU is left open to decide later; though an open fuel cycle is envisaged, a closed fuel cycle has not been ruled out yet.

From the Austrian expert's point of view, more information on the expected quantities of RAW should be given – open questions concerning spent fuel should be either answered or a time schedule when these questions can be answered should be given.

Questions

- *When will the decision whether an open or closed fuel cycle will be implemented in future be taken?*
- *Interim storage of SNF in case of an open fuel cycle: Will the existing dry spent nuclear fuel storage facility (DSNFSF) be enlarged to accommodate the SNF from the NNU or will separate facilities be used? Will/can also the existing wet interim storage (spent nuclear fuel pond of the SNFSF) be used for the NNU?*
- *Long Term storage of HLW: What is the current status concerning the planned construction of a long-term repository with a period of administrative control not shorter than 100 years for HLW and medium active RAW category 2b mentioned in the EIA-Report (2013, Chap. 2.3.3)?*
- *Are the capacities of the current LILW interim waste storage facilities sufficient to accommodate the LILW from the NNU as well?*
- *What quantities of conditioned LILW will be produced by the different reactor types/which levels of activity?*

Main Conclusions

The expert team arrives at the following main conclusions

Reactor type

- Information on the methods and results of safety analyses of the re-actor types under consideration and also concerning the safety requirements (including the consideration of post-Fukushima lessons learned and, as far as applicable, the use of the concept of practical elimination) for the NNU are lacking.

Site evaluation

- The seismic hazard is low at the site. Apart from that, the seismic hazard study was performed already 20 years ago.
- The EIA-Report is not clear on determining to which extent the NNU will be designed to withstand a supposed crash of large passenger or military aircraft.
- Leaks of hazardous fluids and gases/fire: The conclusions in the EIA-Report concerning these topics are not fully considered to be well founded as relevant information is contained in separate documents which are not available to the expert team. There is no statement whether relevant impacts due to explosives transported next to the site have to be taken into account.

- Based on the information provided in BG-NR (2011) the conclusion in the EIA-Report that the Kozloduy NPP site is flood-proof is considered to be well-founded.
- In the EIA-Report, no information on the design basis values against wind load is presented. Therefore, it is not clear whether also loads due to tornadoes need to be covered. Other extreme meteorological impacts beside wind and tornadoes or not discussed in the EIA-Report.

Accident analysis/trans-boundary impact

- The information provided in the EIA-Report is not sufficient to assess the potential radiological consequences caused by severe accidents. Additional information is necessary, e.g. a list of design basis accidents considered, the effectiveness of special features of the NNU concerning prevention and mitigation of severe accidents, and scenarios for severe accidents, information concerning the technical background of the severe accident source term.
- According to the EIA-Report, the analyses of a severe accident with a Cs-137 source term of 30 TBq confirm the absence of radiological risk to the Republic of Austria. However, the Austrian experts recommend to calculate the consequences of a severe accident with a large release, in addition to the limited release scenario presented in the EIA-Report.

ZUSAMMENFASSUNG

Hintergrund

Das KKW Kosloduj ist das einzige in Betrieb befindliche Atomkraftwerk in Bulgarien – es ist ca. 700 km von Österreich entfernt. Zurzeit sind zwei Reaktoren in Betrieb: Kosloduj 5 und Kosloduj 6, zwei Druckwasserreaktoren vom Typ WWER V-320 mit einer elektrischen Bruttoleistung von 1.000 MW_e. Das Investment Proposal (IP) für einen neuen Reaktor in Kosloduj „Kozloduy NPP – New Build EAD“ sieht die Errichtung eines neuen Blocks der jüngsten Generation (III oder III+) mit einer installierten Leistung von etwa 1.200 MW vor (Kozloduy 7 oder new nuclear unit „NNU“) vor.

Umweltverträglichkeitsprüfung

Im Juni 2013 notifizierte die Republik Bulgarien Österreich über die geplante Errichtung eines neuen Leistungsreaktors am Standort des KKW Kosloduj. In Bulgarien ist für Umweltverträglichkeitsprüfungen das Ministerium für Umwelt und Wasser zuständig.

Bezugnehmend auf Art. 7 der UVP-Richtlinie 2011/92/EU und Art. 3 der Espoo-Konvention, informierte das Österreichische Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft Bulgarien, an der grenzüberschreitenden UVP teilnehmen zu wollen, da mögliche signifikante grenzüberschreitende Auswirkungen des Projekts auf Österreich nicht ausgeschlossen werden können (Schreiben vom 26. Juni 2013).

Im Oktober 2013 übermittelte das Bulgarische Ministerium für Umwelt und Wasser den UVP-Bericht zum Investitionsvorhaben für die Errichtung eines neuen KKW “Construction of a new latest generation nuclear unit at Kozloduy NPP site”. Der vollständige Bericht einschließlich der Anhänge steht auf Englisch zur Verfügung (EIA-REPORT 2013). Eine nichttechnische Zusammenfassung und das Kapitel 11 des UVP-Berichts (Grenzüberschreitende Auswirkungen) gibt es auch auf Deutsch.

Der Projektwerber des Investitionsvorhabens ist das Unternehmen “Kozloduy NPP – New Build EAD”. Der Projektwerber beauftragte das Konsortium “Dicon – Acciona Ing.” mit der Erarbeitung des UVP-Berichts.

Das Umweltbundesamt wurde vom Österreichischen Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft und dem Bundesland Niederösterreich beauftragt, diese Fachstellungnahme zu koordinieren und bei organisatorischen Angelegenheiten unterstützend mitzuwirken. Das Österreichische Ökologie-Institut wurde vom Umweltbundesamt beauftragt, in Zusammenarbeit mit Helmut Hirsch, Adhipati-Yudhistira Indradiningrat, Oda Becker und Mathias Brettner die vorliegende Fachstellungnahme auszuarbeiten.

Ziel der vorliegenden Fachstellungnahme ist es einzuschätzen, ob der UVP-Bericht es ermöglicht, zuverlässige Aussagen über potentielle grenzüberschreitende Auswirkungen auf österreichisches Territorium zu treffen. Daher werden insbesondere Sicherheitsfragen, Management schwerer Unfälle und Unfallanalysen mit Schwerpunkt auf luftgetragenen Emissionen und den potentiellen Auswirkungen auf Österreich behandelt. Es werden Fragen formuliert, die bei den Konsultationen zum UVP-Verfahren zu behandeln sind.

Beschreibung des Projekts

Im UVP-Bericht werden die Sicherheitsanforderungen dargestellt, die das NNU zu erfüllen hat. Der Bericht führt aus, dass im Bereich der Kernenergienutzung nationale Gesetze, die Vorschriften der IAEO sowie der European Utility Requirements (EUR) herangezogen werden. Dennoch ist nicht klar dargestellt, ob die WENRA Dokumente (insbesondere die Safety Objectives for New Reactors und die ergänzenden Arbeiten der WENRA-RHWG zu neuen Reaktoren) auch für das NNU zur Anwendung kommen werden. Aus Sicht der österreichischen Experten sind die WENRA Dokumente aufgrund ihrer Bedeutung zu berücksichtigen, und wenn das bereits der Fall sein sollte, sollte dies klargestellt werden.

Im Bereich der nuklearen Sicherheit kam es im Lichte des Unfalls von Fukushima zu Änderungen der Sicherheitsanforderungen und Sicherheitsziele. Den Informationen im UVP-Bericht ist allerdings nicht zu entnehmen, ob und in welchem Ausmaß die Lektionen des Fukushima-Unfalls bei den Anforderungen und Sicherheitsanalysen für die in Betracht gezogenen Reaktoren für NNU berücksichtigt werden, und wie weit diese bereits durch das Design der Kandidatenreaktoren abgedeckt werden. Die österreichischen Experten vertreten die Ansicht, dass mehr Informationen darüber zur Verfügung gestellt werden sollten, in welchem Ausmaß die Lektionen aus Fukushima berücksichtigt werden.

Vier verschiedene Stellen im Areal des KKW Kosloduj nennt der UVP-Bericht als möglichen Standort für das geplante NNU. Es werden Informationen betreffend Terrainmerkmale jedes Standorts und vorhandener Infrastruktur aufgezählt. Dennoch ist es die Ansicht der österreichischen Experten, dass auch Information über Analyse und Bewertung darüber nötig ist, wieweit sich die Unterschiede zwischen den möglichen Standorten auch auf die Sicherheit des NNU in Betrieb und während der Dekommissionierung auswirken könnten. Sowie bei der Durchführung von Sicherheitsmaßnahmen unter Unfallbedingungen

Fragen

- *Werden WENRA Dokumente für neue Reaktoren und die WENRA Safety Reference Levels auch bei den Sicherheitsanforderungen für NNU herangezogen werden?*
- *In welchem Ausmaß werden die in Fukushima gemachten Lektionen bei den Sicherheitsanforderungen und Sicherheitsanalysen für das NNU berücksichtigt werden?*
- *In welchem Umfang sind die in Fukushima gemachten Lektionen bereits in das Design der Kandidatenreaktortypen eingeflossen?*
- *Wäre es möglich mehr Informationen über die Analysen und Bewertungen anzuführen, die durchgeführt wurden oder vorgesehen sind, um die im UVP-Bericht angeführten vier verschiedenen Standorte zu vergleichen, vor allem Informationen betreffend die Sicherheit des NNU?*

Reaktortyp

Die Beschreibung der in Betracht gezogenen Reaktortypen im UVP-Bericht beschränkt sich auf allgemeine Informationen über die Reaktoren, vor allem deren Funktionen und die wichtigsten Komponenten. Die Zuverlässigkeit und Effektivität der Sicherheitssysteme unter Unfallbedingungen wird nicht betrachtet, es fehlen auch Verweise auf Analysen oder Bewertungen zu dieser Frage. Die österreichischen Experten vertreten die Meinung, dass mehr Informationen über die Sicherheitssysteme der für das NNU in Betracht gezogenen Reaktortypen zur Verfügung zu stellen wären. Bewertungen der Zuverlässigkeit und Wirksamkeit, der Sicherheitssysteme und Maßnahmen wie des passiven Kernkühlungssystems, des passiven Containment-Kühlsystems, In-vessel retention für AP-1000 wie auch den Core Catcher beim AES-92 und AES-2006 wären von besonderem Interesse. Ebenso von Interesse wäre für die österreichischen Experten detailliertere Information über die Unterschiede zwischen den Reaktormodellen V-392 M und V-491 des AES-2006.

Der UVP-Bericht geht auf die Werte der Kernschmelzhäufigkeit (CDF) ein, wie auch auf die Häufigkeit großer Freisetzungen (LERF) für jeden der im UVP-Bericht vorgestellten Reaktortypen. Allerdings wird die von diesen Werten abgedeckte Bandbreite nicht definiert, Unsicherheiten dieser Werte werden nicht behandelt und es fehlen auch Betrachtungen der Unfallanalysen, die für die in Betracht gezogenen Reaktoren durchgeführt worden sind. Darüber hinaus ist es nicht möglich mit der Information im UVP-Bericht die gesicherte Schlussfolgerung zu ziehen, dass das Konzept des praktischen Ausschlusses bei den Sicherheitsanforderungen für das NNU im Kontext schwerer Unfälle angewendet wurde.

Im Allgemeinen fehlt Information über die Methoden und Resultate der Sicherheitsanalysen der in Betracht gezogenen Reaktortypen, wie auch zu den Sicherheitsanforderungen (einschließlich der Berücksichtigung der Post-Fukushima Lektionen und soweit anwendbar, die Anwendung des Konzepts des praktischen Ausschlusses) für NNU. Die österreichischen Experten sehen es als notwendig, mehr Informationen über diese Aspekte zur Verfügung zu stellen.

Fragen

- *Wäre es möglich detailliertere Information über die Sicherheitssysteme der in Betracht gezogenen Reaktortypen zur Verfügung zu stellen, insbesondere zum passiven Kernkühlungssystem, dem passiven Containment - Kühlsystem, In-Vessel-Retention (Schmelze -Rückhaltung durch Kernaußenkühlung) für den AP-1000 als auch die Core Catcher für den AES-92 und den AES-2006?*
- *Mehr Information zum Umfang der Wahrscheinlichkeitsanalysen (insbesondere Bedingungen der Reaktoren, die eintreten können als auch Ereigniskategorien, die berücksichtigt wurden) wäre wünschenswert.*
- *Könnte mehr Information über die Unterschiede der beiden in Betracht gezogenen AES-2006 zur Verfügung gestellt werden?*
- *Wird das Konzept des praktischen Ausschlusses bei den Sicherheitsanforderungen für den NNU angewendet?*
- *Sollte das Konzept des praktischen Ausschlusses bei den Sicherheitsanforderungen für den NNU angewendet werden, wäre es wissenswert, welche Kriterien angewendet werden, um zu sicherzugehen, dass eine Bedingung oder ein Unfallablauf praktisch ausgeschlossen werden kann?*

- *Wäre es möglich Informationen über die Auswertung oder Analyse über die Zuverlässigkeit und Wirksamkeit der Sicherheitssysteme der Reaktoren zu erhalten, die in Betracht gezogen werden?*

Bewertung des Standorts

Bewertung der seismischen Gefährdung

Die Studie über die seismische Gefährdung für den Standort des KKW Kosloduj (diese Studie wird im UVP-Bericht erwähnt, doch fehlt der Literaturverweis) wurde in den Jahren 1991/1992 ausgearbeitet. Der UVP-Bericht beschreibt die Seismizität in Bulgarien und den Grenzgebieten und skizziert die wichtigsten seismischen Gebiete. Innerhalb einer 30 km Zone um den Standort ist kein historisches Beben verzeichnet worden. Der geologischen und geophysikalischen Bewertung zufolge gibt es keine Beweise für größere aktive Bruchlinien innerhalb der 30 km Zone des Standorts. Allgemein betrachtet, ist das seismische Risiko am Standort gering und besteht vor allem aus Erdbeben, die sich über 80 km entfernt vom Standort befinden. Dabei handelt es sich um wesentlich stärkere Erdbeben.

Für den Standort des KKW Kosloduj wurden eine deterministische und eine probabilistische Analyse auf der Grundlage allgemeiner Prinzipien durchgeführt. Die kurz beschriebene deterministische Methode reflektiert internationale Praxis. Bei der probabilistischen Analyse wurde ein Standardprogramm (EQRISK) verwendet. Unsicherheiten des Modells wurden durch die Verwendung eines Logik-Baums betrachtet – einer typischen Vorgangsweise bei seismischen Risikowahrscheinlichkeitsbewertungen.

Generell entspricht die für die Bewertung des seismischen Risikos angewendete Methode der internationalen Praxis. Allerdings ist das seismische Risiko nur durch den Wert PGA bestimmt, die Antwortspektren werden nicht angeführt. Die Anwortspektren sind jedoch wichtig, da sie die Information über die häufigkeitsbedingten Folgen eines seismischen Ereignisses enthalten.

Die Studie zur seismischen Gefährdung wurde vor 20 Jahren ausgearbeitet. Daher stellt sich die Frage, ob die Resultate noch den Anforderungen vom Stand der Technik für die seismische Risikobetrachtung bei Nuklearanlagen erfüllen können.

Bei der Bewertung der seismischen Gefährdung stellen sich folgende Fragen:

Fragen:

- *Um welche Studie zur seismischen Gefährdung (Referenz) handelt es sich, die als Grundlage für die UVP dient?*
- *Welche Feldstudien wurden unternommen und welche Methoden wurden für die Identifikation der wichtigsten geologischen Strukturen und für die Bewertung der Neogen - Quartäraktivitäten angewendet?*
- *Wie sieht das horizontale Antwortspektrum für die Wiederkehrzeit von 10^{-4} aus und welche Spektralform wurde angewendet? Sind normalisierte Standard-Frequenzen, bezogen auf 0,2g, verwendet worden?*
- *Wurde eine Spektralform für alle seismischen Quellen verwendet oder wurden unterschiedliche je nach Entfernung – näher oder ferner – angewendet?*
- *Wurde die vertikale seismische Bewegung am Standort betrachtet?*

- *Wurde überprüft, ob die Bewertung der seismischen Gefährdung aus den Jahren 1991-1992 noch die aktuellen Anforderungen vom Stand der Technik für Bewertungen von seismischer Gefährdung bei Nuklearanlagen erfüllt (z.B. bei Modellparametern, Antwortspektren, Betrachtungen der Unsicherheiten und die Einschätzung von lokalen Auswirkungen am Standort)?*
- *Welche Bewertungen wurden im Rahmen der periodischen Aktualisierungen der seismischen PSA und in der PSR auf der Basis der verfügbaren Informationen durchgeführt und verifiziert um festzustellen, ob die Notwendigkeit einer Re-Evaluierung der seismischen Gefährdung des Standorts vorliegt?*
- *Liegen aktuell Pläne für die Re-Evaluierung der seismischen Gefährdung des Standorts Kosloduj vor – sei es im Rahmen der PSR (Periodische Sicherheitsprüfung) für die bestehenden Blöcke oder speziell für den neuen Reaktorblock?*
- *Wurde überprüft ob die neuen Daten zur Seismik und Tektonik, die in den vergangenen 20 Jahren gewonnen wurden, wesentliche Auswirkungen auf die Resultate über die seismische Gefährdung haben könnten?*
- *Die seismische Gefährdung wird als maximale Bodenbeschleunigung mit einer Wiederkehrwahrscheinlichkeit von 10^{-2} bis 10^{-4} angeführt. Die resultierenden Beschleunigungen betragen 0.1 g and 0.2 g. Welchen Fraktilwerten der Gefährdungskurve entsprechen diese Beschleunigungen (z. B. Durchschnitt, 50%-Fraktil)?*
- *Wie werden die lokalen Standorteffekte berücksichtigt (angesichts einer Verstärkung durch die Bodenresonanz) und welche Scherwellengeschwindigkeiten kommen am Standort vor?*
- *Der UVP-Bericht hält fest, dass zusätzlich "Drei-Komponenten-Akzelerogramme (Kontinuität 61 s) zur Messung der geologischen Bedingungen am Standort" angegeben wird. Wie werden diese Akzelerogramme verwendet und registrieren diese Akzelerogramme reale Erdbeben oder synthetischen zeitlichen Verlauf? Wie werden sie gewonnen?*

Externe von Menschen ausgelöst Ereignisse

Flugzeugabsturz

Der UVP-BERICHT (2013, CHAP. 6.2.1 AND CHAP. 2.3) informiert nicht genau über das Ausmaß der Widerstandsfähigkeit des NNU gegenüber angenommenen Abstürzen großer Passagier- oder Militärflugzeuge.

Zur Problematik möglicher Flugzeugabstürze und dem jeweiligen Basisdesign des NNU stellen sich folgende Fragen:

Fragen

- *Gibt es relevante Risikobeiträge durch Flugrouten oder Flughafenanflugrouten innerhalb 4 km vom Standort oder kommt es zur Verwendung des Luftraums innerhalb einer 30 km Zone des Standorts für militärische Trainingsflüge?*
- *Ist es gerechtfertigt alle Flugzeugabstürze vom Typ 3 („Abstürze am Standort aufgrund von Flugverkehr in den wichtigsten Flurverkehrskorridoren des regulären Flugverkehrs und Verkehrs in den militärischen Flugzonen") auszuschließen, wenn man folgendes berücksichtigt:*

  - *Art. 30. (1) der Bulgarischen Verordnung BNRA (2008) der zufolge Quellen für vom Menschen verursachte Gefährdungen mit einer Eintrittshäufigkeit von über oder gleich 10^{-6} Ereignissen pro Jahr nicht unberücksichtigt bleiben dürfen,*
  - *laut IAEA (2002) der ungefähre Richtwert für das Screening Probability Level bei 10^{-7}/a liegt,*
  - *die abgeleitete Jahreshäufigkeit für Flugzeugabstürze $5.66x10^{-7}$ (auf einem Areal von 0,5 km²) und von $1.13x10^{-6}$ (auf einem Areal von 1 km²) basierend auf den Verkehrsdaten innerhalb der 30 km-Zone um den Standort beträgt?*
- *Welche Lasten sollen vom Design abgedeckt werden (z. B. mechanische Auswirkungen in der Form von Last-Zeit Kurven, thermische Auswirkungen als Konsequenzen des brennenden Treibstoffs?) Welche Systeme, die für den Erhalt der wesentlichen Sicherheitsfunktionen benötigt werden, sollen durch adäquate Designwiderstandsfähigkeit des jeweiligen Gebäudes geschützt werden und welche durch Redundanz in Kombination mit physischer Separation der jeweiligen Gebäude?*

Austritt von gefährlichen Flüssigkeiten und Gasen

Die Schlussfolgerungen des UVP-Berichts (2013, CHAP. 6.2.3 UND 6.2.4) zu möglichen Folgen eines Austritts aus den Anlagen des KKW Kosloduj und den Gas-Pipelines sind nicht zur Gänze nachvollziehbar, da relevante Informationen in Dokumenten enthalten sind, die allerdings nicht zur Verfügung stehen.

Im UVP-Bericht werden bei den Explosionen im Lagergebäude Nr. 106 keine Ergebnisse für den Fall angeführt, dass die administrativen Brandschutzmaßnahmen nicht (vollständig) befolgt werden. Es wird nicht beschrieben, ob eine Wahrscheinlichkeits – Risikobewertung für Explosionen in dieser Anlage durchgeführt worden ist.

Der UVP-Bericht (2013, CHAP. 6.2) enthält keine Überlegungen zur Entstehung von Explosionsdruckwellen aus Explosionen außerhalb der Eingrenzung des KKW und deren möglichen Auswirkungen auf die Gebäude des NNU. Der Bericht lässt die Frage offen, ob relevante Auswirkungen aus in der Nähe des Standorts transportierten Explosiva berücksichtigt werden müssen. Das widerspricht den Vorgaben laut IAEA (2002).

Der UVP-Bericht erwähnt nicht, ob die NNU ein Basisdesign gegen das Auftreffen von Explosionsdruckwellen aus externen Explosionen haben sollen.

Zu den möglichen Auswirkungen von gefährlichen Flüssigkeiten und Gasen stellen sich die folgenden Fragen:

Fragen

- *Wäre es möglich Informationen über die durchgeführten Analysen und deren prinzipielle Zugangsweise bei den Anlagen am Standort des KKW Kosloduj und die geplanten Gas-Pipeline zur Verfügung zu stellen?*
- *Könnte darüber informiert werden, ob nur Einzelereignisse betrachtet wurden (z. B: einfaches Versagen eines Lagergebäudes) oder auch Kombinationen von Ereignissen wie aufeinanderfolgende Kaskaden von Zerstörungen und darauf folgende Explosionen (z. B. Freisetzung von explosivem Gase aufgrund vorangegangener Brände oder lokaler Explosionen) in Hinblick auf die im UVP-Bericht aufgelisteten Ereignisse (2013, CHAP. 6.2.3)?*

- *Wäre es möglich mehr Informationen über die probabilistische Einschätzung einer Verletzung der administrativen Brandschutzregeln im Lagergebäude Nr. 106 zu erhalten?*
- *Wurden Analysen durchgeführt um festzustellen, ob es relevante Auswirkungen von Explosiva geben könnte, die in der Nähe des Standorts transportiert (z. B. Schiffe auf der Donau oder LKW) und in Betracht gezogen werden müssen?*
- *Wurden Analyse zur Entstehung von Explosionsdruckwellen und deren mögliche Auswirkung auf Gebäude des NNU, ausgelöst durch Explosionen außerhalb der Eingrenzung des KKW (z. B. durch die Pipelines oder den Transport von Explosiva) angestellt?*
- *Wird vom Basisdesign des NNU erwartet Explosionsdruckwellen zu widerstehen? Wenn dem so ist: wäre es möglich die Designwerte dazu bekannt zu geben?*

<u>Brand</u>

Die Schlussfolgerungen des UVP-Berichts (2013, CHAP. 6.2.8) betreffend möglicher Folgen externer Brände sind nicht vollständig nachvollziehbar, da sich relevante Information in anderen Dokumenten befindet, die allerdings nicht zur Verfügung stehen. Daher stellt sich die folgende Frage:

Frage

- *Könnte mehr Information über die durchgeführten Analysen und deren prinzipielle Zugangsweise betreffend Anlagen des KKW Standorts und der geplanten Gas-Pipeline zur Verfügung gestellt werden?*

Andere externe Ereignisse

<u>Off-site Hochwasser</u>

Aufgrund der Informationen in BG-NR (2011) erscheint die Schlussfolgerung im UVP-Bericht (2013, CHAP. 6.2.6), dass der Standort des KKW Kosloduj hochwassersicher ist, als fundiert.

Darüber hinaus stellen BG-NR (2011) und der Peer review country report ENSREG (2012) fest, dass in manchen Gebäuden des bestehenden KKW das niedrigste Niveau der Regenwasser – oder Abwasserkanalisation auf 32,93 m liegt und ein Wassereintritt von außen möglich ist. Daher stellt sich folgende Frage:

Frage

- *Ist in der Planung vorgesehen einen Wassereintritt in die sicherheitsrelevanten Gebäude des NNU über Regenwasser – oder Abwasserkanalisation zu verhindern, indem adäquate Vorkehrungen im Design getroffen werden?*

<u>Extremer Wind und Tornados</u>

Der UVP-Bericht (2013, CHAP. 6.2.7) enthält keinerlei Information über die Designbasiswerte gegen Windlasten. Daher ist es nicht klar, ob auch Lasten aus Tornados abgedeckt werden sollen, z. B. durch ein Design gegen andere Auswirkungen (z. B. Luftdruckwellen).

Andere extreme meteorologische Auswirkungen außer Wind und Tornados werden im UVP-Bericht nicht behandelt.

Zu den möglichen Auswirkungen von Tornados und anderen Wetterbedingungen stellen sich folgende Fragen:

Fragen

- *Werden die Lasten aus Tornados abgedeckt werden, z. B. mit einer Designmaßnahme gegen andere Auswirkungen (z. B. Luftdruckwellen)?*
- *Welche Designwerte werden für das NNU für das volle Spektrum der meteorologischen Auswirkungen angenommen (d. h. Auswirkungen, die von den ENSREG stress tests diskutiert wurden)? Was sind die jeweiligen Wiederkehr-Wahrscheinlichkeiten?*

Unfallanalyse

Die Unfälle (Auslegungsstörfälle und schwere Unfälle) werden im UVP-Bericht (2013) sehr allgemein behandelt. Eine Reihe von relevanten Informationen wird nicht zur Verfügung gestellt, z. B. fehlt eine Auflistung der Auslegungsstörfälle, die betrachtet wurden, die Wirksamkeit spezieller Vorkehrungen des NNU zur Prävention und Mitigation schwerer Unfälle und Szenarien schwerer Unfälle.

Laut UVP-Bericht wurden große Mengen an technischer Information und Daten untersucht und analysiert. Allerdings wird keiner der Punkte, die explizit in der Einleitung zu Kapitel 6 des UVP-Berichts angeführt werden, später noch behandelt. Es findet sich auch keine Information darüber, wie die Lektionen von Fukushima berücksichtigt wurden.

Betreffend den Quellterm für Auslegungsstörfälle kann die Aussage bezugnehmend auf die EUR, dass der zugrundliegende Unfall eine Eintrittshäufigkeit von etwa 10^{-6}/a hat, nicht eindeutig von den EUR abgeleitet werden und ist daher noch genauer zu erläutern.

Die Informationen im UVP-Bericht ermöglichen es nicht die potentiellen radiologischen Konsequenzen eines schweren Unfalls zu bewerten. Zusätzliche Information über den technischen Hintergrund des Quellterms für den schweren Unfall sind nötig. Daher kann man nicht bestätigen, dass es sich bei dem im UVP-Bericht (2013, CHAP. 6.1.3.3) angeführten Quellterm für schwere Unfälle um den oberen Grenzwert handeln würden. Zum Quellterm für Auslegungsstörfälle, wäre eine Antwort auf folgende Frage hilfreich:

Frage

- *Worin liegt der genaue Zusammenhang zwischen der Aussage des UVP-Berichts, dass der zugrundeliegende Unfall eine Eintrittswahrscheinlichkeit von etwa 10^{-6}/a hat und EUR?*

Zur Ableitung des Quellterms für schwere Unfälle und die Frage ob es sich dabei um den oberen Grenzwert handelt, stellen sich folgende Fragen – wenn die Antworten spezifisch für einen Reaktortyp sein sollten, so sollte für jeden in Betracht gezogenen Reaktor eine Antwort gegeben werden:

Fragen

- *Welche auslösenden Ereignisse wurden zur Bestimmung möglicher Kernschäden betrachtet? Wurden Kernschäden betrachtet, die aus Ereignissen mit Containment-Bypass entstanden? Welche Auslegung überschreitenden*

Bedingungen (z. B. externe auslegungsüberschreitende Ereignisse) wurden betrachtet?

- *Welche Häufigkeiten gelten für die jeweiligen Kernschäden und welche statistische Glaubwürdigkeit gilt für diese Häufigkeiten?*
- *Wie wurden die im NRC (1995) angeführten Freisetzungsraten bei der Ableitung des Quellterms verwendet? Wie wurde die Möglichkeit berücksichtigt, dass die im NRC (1995) abgeleiteten Quellterme nicht für Nuklearbrennstoff mit hohen Abbrand-Raten (über 40 GWD/MTU) anwendbar sind?*
- *Welche Anforderungen werden den potentiellen Lieferanten der Nuklearanlage betreffend der Definition des Quellterms schwerer Unfälle gestellt? Wie wurden diese Anforderungen bei der Bestimmung des Anteils der Radionuklide verwendet, die aus dem Containment in die Umwelt freigesetzt werden?*
- *Wie effektiv und robust sind die Sicherheitssysteme und die Maßnahmen zur Prävention und Mitigation schwerer Unfälle im Fall der unterschiedlichen Bedingungen der Auslegung (z. B. externe Auslegungsstörfall überschreitende Bedingungen)?*
- *Welche Auslegungsstörfälle und Auslegungsstörfall überschreitenden Unfallszenarien wurden betrachtet?*
- *Was sind die Häufigkeiten für Szenarien mit großen frühen Freisetzungen?*
- *Welche Werte wurden für die Wirksamkeit bei der Rückhaltung radioaktiver Nuklide innerhalb des Kraftwerks angenommen? Welche technische Begründung für diese Werte gibt es?*
- *Wurden die angenommenen Freisetzung für Cs-137 (30 TBq) direkt aus "Regulation on Ensuring the Safety of Nuclear Power Plants" BNRA (2008) übernommen?*
- *Welche Unfallszenarien und welche Kraftwerkszustände bzw. Zustände des Containment wurden als praktisch ausgeschlossen angenommen?*
- *Welche Argumente garantieren das notwendige hohe Vertrauen in die Szenarien der Bedingungen von Kraftwerk bzw. Containment, die als praktisch ausgeschlossen angesehen werden?*
- *Auf welche Weise wurden die Lektionen von Fukushima berücksichtigt?*

Grenzüberschreitende Auswirkungen

Kapitel 11.4 des UVP-Berichts (2013) behandelt die grenzüberschreitenden Auswirkungen eines schweren Unfalls auf die Republik Österreich. Laut dem UVP-Bericht zeigen die Analysen eines schweren Unfalls mit einem Cs-137 Quellterm von 30 TBq, dass für die Republik Österreich keine Strahlenrisiken bestehen.

Nur Resultate einer detaillierten Sicherheitsbewertung für den betrachteten Reaktortyp des geplanten NNU würden es ermöglichen einen Quellterm von über 30 TBq auszuschließen – wenn es gelingt außer Zweifel zu stellen, dass keine größeren Quellterme möglich sind („praktischer Ausschluss“). Solche Resultate liegen allerdings noch nicht vor. Daher sollte ein Quellterm für z. B. ein frühzeitiges Containmentversagen oder Containment-Bypass-Szenario als Teil der UVP analysiert werden.

Berechnungen eines schweren Unfalls am Standort KKW Kosloduj mit den Quelltermen, die im FLEXRISK (2013) Projekt oder der Studie der Norwegischen Strahlenschutzbehörde (NRPA 2012) verwendet wurden, zeigen allerdings mögliche Folgen für Österreich, wohingegen die Freisetzung von 30 TBq Cs-137 keine solchen Konsequenzen haben würde.

Bei einer potentiellen Freisetzung von 54.460 TBq Cs-137(wie im FLEXRISK Projekt) verwendet, würde es unter spezifischen Wetterbedingungen zur einer nicht unwesentlichen Kontamination des österreichischen Territoriums kommen. Die meisten Gebiete Österreichs zeigen Depositionen von über 10 kBq/m². Der zentrale Teil des Landes würde mit 100 bis 200 kBq/m² kontaminiert. Die Ergebnisse zeigen, dass selbst wenn der Quellterm um den Faktor 20 geringer ist – wie er in der Berechnung der Norwegischen Strahlenschutzbehörde (NRPA 2012) verwendet wurde (2.800 TBq) – große Gebiete Werte von über 1 kBq/m² Cs-137 Deposition aufweisen würden. Damit erreichen sie den Interventionswert für die Landwirtschaft in Österreich.

Die österreichischen Experten empfehlen die Konsequenzen eines schweren Unfalls mit hohen Freisetzungen zu berechnen, zusätzlich zu dem Szenario mit den limitierten Freisetzungen im UVP-Bericht (2013), da die Auswirkungen weitreichend und lang anhaltend sein können, auch in nicht an Bulgarien direkt angrenzenden Ländern, wie Österreich. Ebenso empfohlen wird Informationen über das Modell zur Verfügung zu stellen, mit dem die Ausbreitungsrechnungen (ESTE EU Kozloduy) gerechnet werden.

Zusammengefasst ermöglicht es die im UVP-Bericht präsentierte Information nicht die Auswirkungen möglicher Unfälle am Standort des KKW Kosloduj auf das Gebiet Österreichs zuverlässig abzuschätzen. Die Analyse des Worst Case Scenario würde es ermöglichen diese Lücke zu schließen und eine Diskussion zu den Folgen auf Österreich zu beginnen. Dies sollte im weiteren Verlauf des UVP-Verfahrens berücksichtigt werden.

Fragen

- *Laut UVP-Bericht (2013) enthält die ESTE EU Kozloduy Datenbank Quellterme zu Abklingbecken und Unfällen mit unterschiedlichen Beschädigungen des Containments (Lecks im Containment). Für die österreichischen Experten wären diese Quellterme von großem Interesse. Wäre es möglich diese Quellterme zur Verfügung zu stellen?*
- *Wäre es möglich Quellterme für Unfallszenarien zusätzlich zu dem ESTE EU Kozloduy zur Verfügung zu stellen, die auch Unfälle in den Abklingbecken je nach Reaktortyp, der für die NNU in Betracht gezogen wird, mit Häufigkeiten für große Freisetzungen (LRF) unter 1*10E-7 beinhalten?*
- *Wäre es möglich Informationen über das verwendete Programm ESTE EU Kozloduy zur Verfügung zu stellen? Warum werden das Programm ESTE EU Kozloduy und die verwendeten Eingangsparameter (einschließlich der Wetterszenarien) als für die Berechnungen der langfristigen Effekte auf Österreich geeignet betrachtet?*
- *Wäre es möglich mehr Informationen über die Resultate der Ausbreitungsrechnung zu erhalten? Warum werden z. B. nur Ergebnisse für die Entfernung von 200 km präsentiert, während die zurückgelegte Distanz beim Transport radioaktiver Stoffe nach 48 Stunden mit einer Windgeschwindigkeit von 2 m/s oder 5m/s bei 346 km bzw. 864 km liegt?*
- *Wird beabsichtigt alle vier Criteria for Limited Impact of EUR wie von EUR angestrebt umzusetzen? Warum werden die spezifischen Criteria for Limited*

Impact of EUR nicht in der Tabelle 6.1-7 des UVP-Berichts (2013) betrachtet, sondern nur das Kriterium für die wirtschaftliche Auswirkung?

- *Warum sind die berechneten Dosen im Fall eines schweren Unfalls im KKW Temelin 3&4 dieselben wie die im UVP-Bericht (2013) für das NNU?*

Management radioaktiver Abfälle

Das Staatsunternehmen für Atommüll (SE-RAW) ist für das Management des radioaktiven Abfalls in Bulgarien verantwortlich. Die konkreten Pläne für das Management des radioaktiven Abfalls sind in der „Strategie für das Management der abgebrannten Brennstäbe und radioaktiven Abfalls bis 2030“ beschrieben, daher wird der Inhalt des UVP-Berichts zu den radioaktiven Abfällen nicht detailliert bewertet.

Gemäß der Richtlinie 2011/92/EU Annex IV a ist die Beschreibung des Projekts, einschließlich einer Einschätzung der erwarteten Rückstände und Emissionen aus dem Betrieb des geplanten Projekts, aufgegliedert nach Art und Quantität, eine verbindliche Anforderung für einen UVP-Bericht.

Der UVP-Bericht informiert über die geschätzte Menge an abgebranntem Nuklearbrennstoff. Da die Menge an abgebranntem Nuklearbrennstoff stark vom noch nicht bestimmten Reaktormodell abhängt, variiert die Menge an abgebranntem Nuklearbrennstoff stark.

Es gilt das gleiche für die Menge an LILW (Niedrig – und Mittelaktivem Abfall) – konditionierter LILW in einem Umfang von 180 m³ bis 250 m³ wird anfallen. Keine Information liegt darüber vor, welcher Reaktortyp welche Menge an LILW erzeugt oder wie dies der EUR entspricht, die eine Erzeugung von nicht mehr als 50 m^3 LILW pro 1.000 MW pro Jahr vorsieht.

Der UVP-Bericht informiert vor allem über die bereits bestehenden Anlagen – wesentlich weniger Informationen werden über das NNU mitgeteilt, dem eigentlichen Gegenstand der UVP. D. h. die Frage nach einem Zwischen- und Endlager für abgebrannten Nuklearbrennstoff für das NNU wird zur späteren Beantwortung offen gelassen. Obwohl ein offener Brennstoffzyklus angestrebt wird, wird gleichzeitig ein geschlossener nicht für unmöglich erklärt.

Die österreichischen Experten vertreten die Meinung, dass mehr Informationen über die zu erwartenden Mengen an radioaktiven Abfällen angeführt werden sollen – offene Fragen zum abgebrannten Nuklearbrennstoff sind entweder zu beantworten oder ein Zeitplan bekannt zu geben, zu dem diese Antworten gegeben werden können.

Fragen

- *Wann wird die Entscheidung für einen offenen oder einen geschlossenen Brennstoffkreislauf getroffen werden?*
- *Zwischenlagerung von abgebrannten Brennstäben im Fall eines offenen Brennstoffzyklus: Wird das bestehende Trockenlager für abgebrannte Brennstäbe (DSNFSF) erweitert werden um auch die abgebrannten Brennstäbe aus dem NNU aufnehmen zu können oder wird eine eigene Anlage genutzt werden? Wird/kann auch das bestehende Nasslager (Abklingbecken des SNFSF) für das NNU genutzt werden?*

- *Langfristige Lagerung von hochradioaktivem Abfall: Wie sieht der aktuelle Status der geplanten Errichtung eines langfristigen Endlagers mit administrativer Kontrolle von mindestens 100 Jahren für hochradioaktivem Abfall und mittelaktiven Abfall der Kategorie 2b wie im UVP-Bericht erwähnt aus (2013, Chap. 2.3.3)?*
- *Reichen die Kapazitäten des bestehenden Zwischenlagers für niedrig – und mittelaktiven Abfall um auch den niedrig- und mittelaktiven Abfall aus dem NNU unterzubringen?*
- *Welche Mengen an konditioniertem niedrig- und mittelaktivem Abfall werden von den unterschiedlichen Reaktortypen mit welchen Aktivitätsniveaus erzeugt werden?*

Wesentliche Schlussfolgerungen

Das Expertenteam gelangte zu folgenden wesentlichen Schlussfolgerungen

Reaktortyp

- Informationen über die Methoden und Resultate der Sicherheitsanalysen für die in Betracht gezogenen Reaktortypen als auch über die Sicherheitsanforderungen (einschließlich der Berücksichtigung der Post-Fukushima Lektionen und soweit anwendbar auch die Verwendung des Konzepts des praktischen Ausschlusses) für das NNU fehlen.

Standortprüfung

- Die seismische Gefährdung des Standorts ist gering. Allerdings wurde die Studie über die seismische Gefährdung vor 20 Jahren ausgearbeitet.
- Der UVP-Bericht trifft keine klaren Aussagen über das Ausmaß, zu dem das NNU unterstellten Abstürzen großer Passagier – oder Militärflugzeuge widerstehen würde.
- Austritte von gefährlichen Flüssigkeiten und Gasen/Brand: Die Schlussfolgerung des UVP-Berichts zu diesen Fragen ist nicht vollständig nachvollziehbar, da relevante Informationen in anderen Dokumente enthalten sind, die dem Expertenteam allerdings nicht vorliegen. Es gibt keine Aussage darüber, ob relevante Auswirkungen von in der Nähe des Standorts transportierten Explosiva berücksichtigt werden müssen.
- Die Informationen im BG-NR (2011) ermöglichen die gut unterlegte Schlussfolgerung im UVP-Bericht, dass der Standort des KKW Kosloduj vor Hochwasser geschützt ist.
- Im UVP-Bericht gibt es keine Information über die Auslegungswerte gegen Windlasten. Daher ist unklar, welche Lasten aus Tornados abzudecken sind. Andere extreme meteorologische Auswirkungen neben Wind und Tornados werden im UVP-Bericht nicht behandelt.

Unfallanalyse/grenzüberschreitende Auswirkungen

- Die Informationen im UVP-Bericht sind nicht ausreichend, um die potentiellen Strahlenfolgen eines schweren Unfalls zu bewerten. Zusätzliche Information ist nötig, z. B. eine Auflistung der betrachteten Auslegungsstörfälle, die Wirksamkeit spezieller Vorkehrungen des NNU zur Prävention und Mitigation schwerer Unfälle und Szenarien schwerer Unfälle als auch Informationen über den technischen Hintergrund des Quellterms für die schweren Unfälle.

- Laut dem UVP-Bericht belegen die Analysen schwerer Unfälle mit einem Cs-137 Quellterm von 30 TBq, dass kein Strahlenrisiko für die Republik Österreich vorliegt. Die österreichischen Experten empfehlen jedoch die Konsequenzen eines schweren Unfalls mit einer großen Freisetzung zu berechnen, zusätzlich zu dem Szenario mit der begrenzten Freisetzung des UVP-Berichts.

РЕЗЮМЕ

Информация

АЕЦ „Козлодуй“ е единствената работеща в България атомна електроцентрала – намира се на разстояние от приблизително 700 км от Австрия. Към момента има два работещи реактора: „Козлодуй-5“ и „Козлодуй-6“, като и двата са реактори с вода под налягане от типа VVER V-320 с брутна електрическа мощност от 1000 MW_e. Инвестиционното предложение (ИП) на „АЕЦ Козлодуй – Нови мощности“ ЕАД визира изграждането на нов ядрен блок от последно поколение (III или III+) с инсталирана електрическа мощност от около 1200 MW на площадката на АЕЦ „Козлодуй“ („Козлодуй-7“ или нов ядрен блок (НЯБ)).

Оценка на въздействието върху околната среда

През юни 2013 г. Република България уведоми Австрия за планираното изграждане на нов ядрен енергиен блок на площадката на атомната електроцентрала „Козлодуй“. Компетентното българско министерство за оценката на въздействието върху околната среда (ОВОС) е Министерството на околната среда и водите.

Във връзка с чл. 7 от Директива 2011/92/ЕС за ОВОС и чл. 3 на Конвенцията в Еспоо, Австрийското федерално министерство на земеделието, горите, околната среда и водите информира България, че Австрия изявява желание да вземе участие в трансграничната оценка на въздействието върху околната среда, тъй като не могат да бъдат изключени евентуални трансгранични влияния на проектите върху Австрия (писмо от 26 юни 2013 г.).

През октомври 2013 г. Българското министерство на околната среда и водите изпрати доклад за ОВОС на инвестиционното предложение „Изграждане на нов ядрен блок от последно поколение на площадката на АЕЦ „Козлодуй““. Пълният доклад и приложенията към него са достъпни на английски език (отчет за ОВОС 2013 г). Освен това нетехническо резюме и глава 11 от доклада за ОВОС (трансгранични въздействия) са достъпни на немски език.

Приложителят на инвестиционното предложение е компанията „АЕЦ Козлодуй – Нови мощности“ ЕАД. Приложителят е възложил разработването на доклада за ОВОС на консорциума „Дикон – Аксиона Инж.“.

Umweltbundesamt (Австрийската агенция по околната среда) беше назначена от Австрийското федерално министерство на земеделието, горите, околната среда и водите и от провинция Долна Австрия за координирането на това експертно становище и оказване на помощ при организационни въпроси. Австрийският екологичен институт (Österreichisches Ökologie-Institut), в съдействие с Хелмут Хърш, Адхипати-Юдхистира Индрадининграт, Ода Бекер и Матиас Бретнер, получи назначение от Umweltbundesamt за изготвянето на експертното становище.

Целта на това експертно становище е да прецени дали доклада за ОВОС позволява съставянето на надеждни заключения относно потенциалните трансгранични въздействия на австрийска територия. Поради тази причина се обсъждат най-вече функции за безопасност, управление в случай на тежки аварии и анализи на инциденти с фокус върху въздушнопреносимите трансгранични емисии и потенциалното въздействие върху Австрия. Формулирани са въпроси за обсъждане по време на консултирането в рамките на процедурата по ОВОС.

Описание на проекта

Докладът за ОВОС предоставя информация относно изискванията за безопасност, които ще бъдат приложени към новия ядрен блок. Той разяснява изискванията на българското законодателство в областта на атомната енергия, като се вземат под внимание изискванията на Международната агенция за атомна енергия (МААЕ) и Европейските комунални изисквания (EUR). Не е ясно дали относно НЯБ ще бъдат взети под внимание документи от Асоциацията на западноевропейските органи за ядрено регулиране (WENRA) (в частност целите за безопасност относно новите реактори и допълнителната работа на работната група за хармонизиране на реактори WENRA-RHWG по новите реактори). От гледна точка на австрийските експерти важността на документите от WENRA налага те да бъдат взети под внимание. Ако случаят вече е такъв, то този факт трябва да бъде уточнен.

В областта на атомната безопасност след инцидента във Фукушима са направени промени относно изискванията и целите за безопасност. Предоставената в доклада за ОВОС информация не позволява да се направи заключение дали и до каква степен уроците от инцидента във Фукушима ще бъдат взети под внимание относно изискванията и анализите за безопасност на типовете реактори, които са разглеждани за новия ядрен блок, както и до каква степен те може вече да са покрити от дизайна на кандидатстващите типове реактори. От гледна точка на австрийските експерти трябва да се предостави повече информация относно това до каква степен ще бъдат взети под внимание уроците от инцидента във Фукушима.

В доклада за ОВОС като възможни площадки за планирания НЯБ са посочени четири различни местоположения при АЕЦ „Козлодуй“. Предоставена е информация за всяка площадка относно характеристиките на терена и съществуващата инфраструктура. Но от гледна точка на австрийските експерти също така трябва да се предостави информация относно анализите и оценките спрямо до каква степен разликите между различните площадки също може да засегне безопасността на новия ядрен блок по време на работата и извеждането му от експлоатация, както и информация относно характеристиките и ефекта на мерките за безопасност в условията на авария.

Въпроси

- *Ще се вземат ли са под внимание документите от WENRA за нови реактори и референтните нива за безопасност от WENRA относно изискванията за безопасност на НЯБ?*

- *До каква степен усвоените от инцидента във Фукушима уроци ще се вземат под внимание относно изискванията и анализите за безопасност на НЯБ?*
- *До каква степен усвоените от инцидента във Фукушима уроци са покрити от дизайна на кандидатстващите типове реактори?*
- *Възможно ли е да се предостави повече информация за анализите и оценките, чието провеждане е или ще бъде планирано за целите на сравняването на четирите алтернативни площадки, представени в доклада за ОВОС, най-вече онези, които са свързани с безопасността на НЯБ?*

Тип реактор

Посоченото в доклада за ОВОС описание на типовете реактори, които са взети под внимание, предоставя само основна и обща информация за реакторите, която се отнася най-вече за функциите и основните компоненти. Не са разисквани надеждността и ефективността на системите за безопасност в условията на авария и няма препратки към анализи или оценки в тази връзка. От гледна точка на австрийските експерти трябва да се предостави повече информация относно системите за безопасност на типовете реактори, разглеждани за новия ядрен блок. Във връзка с оценяването на тяхната надеждност и ефективност ще бъдат от специален интерес мерки или системи за безопасност, като например системи за пасивно охлаждане на активната зона на реактора, система за пасивно охлаждане на предпазната обвивка на ядрения реактор, вътрешносъдови мерки за задържане за AP-1000, както и уловител на сърцевина за AES-92 и AES-2006. Също така е от интерес за австрийския екип от експерти да получи по-подробна информация относно сравнението на различията между моделите реактори V-392 M и V-491 на AES-2006.

В доклада за ОВОС са представени стойности на честотите на повреди в активната зона (ЧПАК) и честотата за голямо ранно освобождаване (ЧГРО) за всеки тип реактор. Но не е указано какъв мащаб покриват тези стойности, променливостта на стойностите не е обсъждана и също така няма пояснения относно анализите за аварии, които са извършени за разглежданите типове реактори. Също така от предоставената в доклада за ОВОС информация не може да се установи дали концепцията за практическо елиминиране е приложена към изискванията за безопасност на новия ядрен блок в контекста на тежки аварии.

Като цяло информацията относно методите и резултатите от анализите за безопасност на разглежданите типове реактори и също относно изискванията за безопасност (включително вземането под внимание на научените след Фукушима уроци и използването на концепцията за практическо елиминиране, когато последното е приложимо) по отношение на новия ядрен блок е все още недостатъчна. От гледна точка на австрийските експерти трябва да бъде предоставена по-подробна информация относно тези аспекти.

Въпроси

- *Ще има ли възможност да се предостави по-подробна информация относно системите за безопасност на разглежданите типове реактори, особено относно системата за пасивно охлаждане на активната зона, системата за пасивно охлаждане на предпазната обвивка, вътрешносъдовите мерки за задържане за AP-1000, както и уловителите на сърцевина за на AES-92 и AES-2006?*
- *Ще има ли възможност да се предостави информация относно мащаба на вероятностните анализи (в частност включените състояние на централата и категории събития), както и за третирането на променливите фактори в тези анализи?*
- *Ще има ли възможност да се предоставят повече данни относно разликите между двата разглеждани типа на AES-2006?*
- *Концепцията за практическо елиминиране приложена ли е към изискванията за безопасност на новия ядрен блок?*
- *Като се изхожда от позицията, че концепцията за практическо елиминиране е приложена към изискванията за безопасност на новия ядрен блок, кои точни критерии са използвани да се определи, че дадени състояния или аварийни последователности са практически елиминирани?*
- *Ще има ли възможност да се предостави информация за оценките или анализите относно надеждността и ефективността на системите за безопасност на разглежданите типове реактори?*

Оценка на площадката

Оценка на сеизмични опасности

Изследването за сеизмични опасности за площадката на АЕЦ „Козлодуй“ (изследването е посочено в доклада за ОВОС, но препратката липсва) е извършено през 1991-1992 г. Докладът за ОВОС описва сеизмичната дейност в България и граничните региони и очертава най-важните сеизмични райони. Историята не помни земетресения в рамките на 30 км от площадката. Според геоложките и геофизичните оценки няма доказателство за възможно големи разседи в рамките на 30 км от площадката. Обобщено погледнато, сеизмичната опасност на площадката може да се разглежда като ниска. Има наличие на земетресения, възникващи на разстояние от над 80 км от площадката с доста по-силни трусове.

Бяха извършени детерминирана и вероятностна оценка на площадката на АЕЦ „Козлодуй“ въз основа на общи принципи. Накратко описаната детерминирана процедура отразява международните практики. За вероятностния анализ беше използвана стандартна програма (EQRISK). Бяха взети под внимание непостоянни фактори в модела с помощта на логическо дърво – каквато е обичайната практика при вероятностното оценяване на сеизмични опасности.

Общата приложена методология при оценяването на сеизмични опасности отговаря на международните практики. Все пак само PGA стойността е използвана за характеризиране на сеизмичната опасност, без да се извърши препратка към спектрите на реагиране. Спектрите на реагиране са важни, понеже те съдържат информацията относно въздействието в зависимост от честотата на сеизмичните събития.

Изследването за сеизмични опасности е извършено преди 20 години. Поради това възниква въпросът дали резултатите все още покриват действителните максимални фактори при оценяването на сеизмични опасности за ядрени съоръжения.

Възникват следните въпроси относно оценяването на сеизмичните опасности.

Въпроси

- *Кое изследване за сеизмични опасности (препратка) е използвано като основа за оценката на въздействието върху околната среда?*
- *Какви полеви проучвания са предприети и кои методи са приложени в подробности за идентифициране на основните геоложки структури и за оценяването на неогенски и кватернерни дейности?*
- *Какъв е хоризонталният спектър на отговори за годишната вероятност от превишаване от 10^{-4} и коя спектрална форма е приложена? Използвани ли са нормализирани стандартни спектри, мащабирани до 0,2 g?*
- *Използвана ли е една спектрална форма за всички сеизмични източници или са използвани различни за близки и далечни разстояния?*
- *Има ли възможност да ни се предоставят стойностите на вертикалното сеизмично движение, разглеждани за площадката?*
- *Извършена ли е оценка, за да се гарантира, че оценяването на сеизмичните опасности от 1991-1992 г. все още покрива действителните максимални фактори при оценяване на сеизмични опасности за ядрени съоръжения (например относно параметри на модела, спектри на отговор, вземане под внимание на променливи фактори и оценяване на локални странични ефекти)?*
- *Какви оценки са били извършени по време на периодичните актуализации на вероятностния анализ на сеизмичната безопасност и в периодичния преглед на безопасността въз основа на наличната и проверена информация относно необходимостта от повторно оценяване на сеизмичните опасности на площадката?*
- *Съществуват ли текущи планове за повторно оценяване на сеизмичните опасности на площадката на Козлодуй, било то в рамките на периодичния преглед на безопасността за съществуващите блокове или конкретно за новия блок?*
- *Потвърдено ли е, че новите данни относно сеизмичната и тектонична дейност (получени през последните 20 години) не оказват значително влияние върху резултатите за сеизмичните опасности?*
- *Сеизмичната опасност е представена във върхови земни ускорения за годишна вероятност от превишаване от 10^{-2} и 10^{-4}. Резултатните ускорения са 0,1 g и 0,2 g. Към кои квантилни стойности на кривата за опасности се отнасят тези ускорения (например средни, 50% квантилни)?*

- *По какъв начин се вземат под внимание локалните странични ефекти (вземане под внимание на усилване поради почвен резонанс) и какви са профилите на скорост на еластични вълни на площадките?*
- *Докладът за ОВОС сочи, че като допълнение са дадени „трикомпонентни акселерограми (продължение на 61 s), измерващи геоложките условия на площадката“. Как се използват тези акселерограми и те регистрации на истински земетресения ли представляват, или синтетични времеви хронологии? По какъв начин са получени?*

Външни събития, породени от човешко влияние

Катастрофи на летателни апарати

Докладът за ОВОС (2013 г., глава 6.2.1 и ГЛАВА 2.3) не предоставя ясна информация относно степента, до която НЯБ ще е проектиран за издържане на предполагаемо разбиване на голям пътнически или военен летателен апарат.

Възникват следните въпроси относно възможността от катастрофи на летателни апарати и съответното проектиране на новия ядрен блок.

Въпроси

- *Съществуват ли съответни допринасящи за риска фактори поради наличие на въздушни пътища или подходи към летища в рамките на 4 км от площадката или на използване на въздушното пространство за целите на военно обучение в рамките на 30 км от централата?*
- *Оправдано ли е да се заключи, че катастрофи на летателни апарати от тип 3 („катастрофа на площадката поради въздушния трафик в основните пътни коридори на редовната гражданска авиация и трафика във военните летателни зони“) могат да се изключат, когато се вземе под внимание следното*
  - *член 30. (1) от българската наредба BNRA (2008 г.), съгласно която не е позволено да се пренебрегват източници на породени от човешки действия опасности с риск за възникване по-голям или равен на 10^{-6} събития на годишна база,*
  - *ориентировъчната стойност от 10^{-7}/a за ниво на вероятно екраниране, посочена от МААЕ (2002 г.), и*
  - *получената годишна честота на катастрофи на летателни апарати от $5{,}66x10^{-7}$ (на площ от 0,5 км²) и от $1{,}13x10^{-6}$ (на площ от 1 км²) въз основа на данни за трафика в рамките на 30 км от площадката?*
- *До каква степен новият ядрен блок ще е проектиран да издържа на вероятно разбиване на голям пътнически или военен летателен апарат?*
- *Какви натоварвания ще бъдат покрити от дизайна (например механични въздействия под формата на криви за времево натоварване, термично въздействие като следствие от горящо гориво)? Кои системи, които са необходими за предоставянето на основните функции за безопасност, ще бъдат защитени чрез адекватна сила на проектирането на съответните постройки и кои от излишък в комбинация с физическо отделяне на съответните постройки?*

Изтичания на опасни течности и газове

Заключенията в доклада за ОВОС (2013 г., глави 6.2.3 и 6.2.4) относно потенциални въздействия поради съоръжения в АЕЦ „Козлодуй“ и газови тръбопроводи не са напълно разбираеми, понеже съответната информация се съдържа в отделни документи, които не са налични.

Относно експлозиите в съоръжение за съхранение № 106 в доклада за ОВОС не са представени резултати за в случай, че административните правила за противопожарна защита не се следват (напълно). Няма налична информация дали е извършена вероятностна оценка на риска от експлозии в това съоръжение.

Докладът за ОВОС (2013 г., глава 6.2) не съдържа съображения относно формирането на ударни вълни под налягане, причинени от експлозии извън периметъра на АЕЦ, и тяхното потенциално въздействие върху постройките на новия ядрен блок. Докладът за ОВОС също не пояснява дали са взети под внимание съответните въздействия, причинени от транспортирани в близост до площадката експлозиви. Това не е в съответствие с изискванията на МААЕ (2002 г.).

Докладът за ОВОС не споменава дали НЯБ трябва да има основен дизайн срещу ударни вълни под налягане, причинени от външни експлозии.

Възникват следните въпроси относно възможните въздействия, породени от опасни течности и газове.

Въпроси

- *Ще има ли възможност да се предостави информация относно проведените анализи и техния основен подход по отношение на съоръженията на площадката на АЕЦ „Козлодуй“ и планираните газови тръбопроводи?*
- *Ще има ли възможност да се предостави информация относно това дали са разгледани само единични събития (например единична неизправност на съоръжение за съхранение), или също така и комбинации от събития като взаимосвързани поредици от повреди и последващи експлозии (например освобождаване на експлозивни газове поради пожари или локални експлозии) по отношение на събитията, които са изброени в доклада за ОВОС (2013г., глава 6.2.3)?*
- *Ще има ли възможност да се предостави информация относно вероятностната оценка за нарушаването на административните правила за противопожарна безопасност в съоръжение за съхранение № 106?*
- *Извършени ли са анализи, за да се прецени дали са възможни съответни въздействия от транспортирани в близост до площадката експлозиви (например. чрез камиони или кораби по река Дунав) и трябва да бъдат взети под внимание?*
- *Проведени ли са анализи относно формирането на ударни вълни под налягане и тяхното възможно въздействие върху постройките на НЯБ поради експлозии извън неговия периметър (например поради тръбопроводи или транспортиране на експлозиви)?*

- *Основният дизайн на новия ядрен блок проектиран ли е за издържането на ударни вълни под налягане? Ако случаят е такъв: ще има ли възможност да се посочат стойностите на дизайна?*

<u>Пожари</u>

Заключението в доклада за ОВОС (2013 г., глава 6.2.8) относно потенциалното въздействие, породено от външни пожари, не е напълно разбираемо, понеже съответната информация се съдържа в отделен документ, който не е наличен. Поради тази причина възниква следният въпрос:

Въпрос

- *Ще има ли възможност да се предостави повече информация относно проведените анализи и техния основен подход по отношение на съоръженията на площадката на АЕЦ „Козлодуй" и планираните газови тръбопроводи?*

Други външни събития

<u>Външни наводнения</u>

Въз основа на информацията, предоставена в BG-NR (2011 г.), направеното заключение в доклада за ОВОС (2013 г., глава 6.2.6), че площадката на АЕЦ „Козлодуй" е защитена срещу наводнения, се счита за добре обосновано.

Като допълнение BG-NR (2011 г.) и равнопоставеният държавен доклад от ENSREG (2012 г.) посочват, че е възможно външно проникване на вода в някои постройки на съществуващата АЕЦ, където най-ниското кота на дъждовна вода или канализация се намира под 32,93 м. Поради тази причина възниква следният въпрос.

Въпрос

- *Изисква ли планирането да се изключи проникването на вода в съответните постройки на НЯБ чрез дъждовна вода или канализация, като се предприемат адекватни мерки при проектирането?*

<u>Екстремни ветрове и торнада</u>

Докладът за ОВОС (2013 г., глава 6.2.7) не представя информация относно базисните стойности на дизайна срещу вятърно натоварване. Поради тази причина не е ясно дали ще бъдат покрити и натоварвания, причинени от торнада, например поради проектиране срещу други въздействия (като въздушни вълни под налягане).

В доклада за ОВОС не се обсъждат други екстремни метеорологични въздействия, освен породените от ветрове и торнада.

Възникват следните въпроси относно възможните въздействия, причинени от торнада и други метеорологични условия.

Въпроси

- *Ще бъдат ли покрити натоварвания, причинени от торнада, например поради проектиране срещу други въздействия (като въздушни вълни под налягане)?*
- *Какви стойности на дизайна ще бъдат приети за новия ядрен блок относно пълния спектър метеорологични въздействия (например въздействията, отнесени към стрес теста на ENSREG)? Каква е съответната вероятност за превишаване?*

Анализ на аварии

Третирането на аварии (покрити от проектирането и тежки аварии) в доклада за ОВОС (2013 г.) е много общо. Не е предоставена значителна част от съответната информация, като например списъка с разгледани покрити от проектирането аварии, ефективността на специалните функции на НЯБ относно предотвратяването и смекчаването на последиците от тежки аварии, както и сценарии за тежки аварии.

Докладът за ОВОС посочва, че е изследван и анализиран голям обем техническа информация и данни. Въпреки това не присъства по-нататъшно пояснение на точките, които са изрично посочени във въведението на глава 6 от доклада за ОВОС. Също така няма предоставена информация относно начина, по който са взети под внимание усвоените от Фукушима уроци.

Относно количеството освободен материал за покрити от проектирането аварии, становището с препратка към EUR, че съответната авария има вероятност за възникване с приблизителна стойност от 10^{-6} на годишна база, не може недвусмислено да се заключи от EUR. Поради това трябва да се предостави по-нататъшно пояснение.

Предоставената в доклада за ОВОС информация не е достатъчна за оценка на потенциалните радиационни последствия, причинени от тежки аварии. Необходима е допълнителна информация относно техническата обосновка на количеството освободен материал при тежка авария. Поради тази причина не е възможно да се потвърди, че количеството освободен материал при тежки аварии, представено в доклада за ОВОС (2013 г., глава 6.1.3.3), представлява горна граница. Трябва да се предостави отговор на следния въпрос относно количеството освободен материал при покрити от проектирането аварии:

- *Каква е точната връзка между становището в доклада за ОВОС, че съответната авария има вероятност за възникване със стойност от приблизително 10^{-6} на годишна база, и EUR?*

Относно отклонението от количеството освободен материал при тежки аварии и въпросът дали то представлява горна граница възникват следните въпроси – доколкото отговорите са конкретни за даден тип реактор, те трябва да бъдат предоставени за всеки разглеждан тип реактор:

Въпроси

- *Какви инициирващи събития са разгледани по време на определянето на възможни състояние за повреда на активната зона? Разгледани ли са състояние на повреда на активната зона, възникващи поради събития със заобикаляне на предпазната обвивка? Какви разширителни за проектирането условия (например външни събития отвъд проектираната база) са разгледани?*
- *Какви са честотите на съответните състояния на повреда на активната зона и нивото на статистическа правдоподобност на тези честоти?*
- *Как приложени предоставените в NRC (1995 г.) степени на освобождаване към отклонението от количеството освободен материал? По какъв начин е взета под внимание вероятността, че количествата освободен материал, посочени в NRC (1995 г.) може да не са приложими за гориво, облъчено до високи нива на изгаряне (в излишък от около 40 GWD/MTU)?*
- *Какви изисквания са приложени към потенциалните доставчици на ядреното съоръжение по отношение на дефинирането на количеството освободен материал при тежка авария? По какъв начин са използвани тези изисквания са определянето на дела на нуклиди, освободени в околната среда?*
- *Колко ефективни и издръжливи са системите за безопасност, както и мерките за предотвратяване и смекчаване на последиците от тежки аварии в случай на различни разширителни за проектирането условия (например външни събития отвъд проектираната база)?*
- *Какви заложени в проектираната база и отвъд нея сценарии за аварии са разгледани?*
- *Каква е честотата на сценариите с голяма степен на ранно освобождаване?*
- *Какви стойности са предположени относно ефективността на задържането на радиоактивни нуклиди в централата? Каква е техническата обосновка за тези стойности?*
- *Предположеното освобождаване на Cs-137 (30 TBq) взето ли е директно от „Наредба за осигуряване на безопасността на атомните електроцентрали" BNRA (2008 г.)?*
- *Какви сценарии за аварии и съответно какви състояния на задържане в централата са преценени за практическо елиминиране?*
- *Какви аргументи гарантират необходимата висока степен на увереност за сценариите или за състоянията на централата, съответно състояния за задържане, които са преценени за практическо елиминиране?*
- *По какъв начин са взети под внимание усвоените от Фукушима уроци?*

Трансгранични въздействия

Глава 11.4 от доклада за ОВОС (2013 г.) се отнася за трансграничните въздействия върху Република Австрия, които са причинени от сериозни аварии. Според доклада за ОВОС анализите на тежки аварии с количество освободен материал Cs-137 от 30 TBq потвърждават отсъствието на радиационни рискове за Република Австрия.

Само резултати от подробните оценки на безопасността за разгледания тип реактор на предложения НЯБ ще позволят изключването на количество освободен материал, по-голямо от 30 TBq – в случай че може да се докаже извън съмнение, че не може да възникне по-голямо количество освободен материал („практическо елиминиране“). Все още няма налични подобни резултати. Следователно количеството освободен материал за например сценарий с неуспех при ранно задържане или заобикаляне на задържането трябва да се анализира като част от ОВОС.

Изчисленията за тежки аварии на площадката на АЕЦ „Козлодуй“ с количества освободен материал, използвани в проекта FLEXRISK (2013 г.) или в проучване от Норвежкия орган по радиационна защита (NRPA 2012 г.), показват възможните последици за Австрия, докато освобождаването на 30 TBq Cs-137 не се очаква да причини подобни последици.

При потенциално освобождаване на Cs-137 в размер 54 460 TBq (както е използвано в проекта flexRISK) и спрямо конкретни метеорологични условия ще възникне значително замърсяване на австрийска територия. Повечето области на Австрия показват отлагания над 10 kBq/м². Централната част на страната ще бъде замърсена със 100 до 200 kBq/м². Резултатите показват че дори ако количеството освободен материал е по-малко от фактор от 20 – както е използвано в изчисленията на Норвежкия орган за радиационна защита (2800 TBq) – изчислените отлагания на Cs-137 върху големи области показват стойности над 1 kBq/м², като по този начин достигат прага за задействане на мерки за интервенция в земеделието на Австрия.

Австрийските експерти препоръчват да се изчислят последствията от тежка авария с голяма степен на освобождаване като допълнение към сценария с ограничено освобождаване, представен в доклада за ОВОС (2013 г.), понеже ефектите могат да са дългосрочни и с широко разпространение и могат да засегнат дори държави като Австрия, които не граничат директно с България. Също така препоръчват да се предостави подробна информация относно програмата, която е използвана за изчисляването на дисперсията (ESTE EU Kozloduy).

Като цяло информацията, която се съдържа в доклада за ОВОС (2013 г.) не позволява смислена оценка на ефектите, които възможните аварии на площадката на АЕЦ „Козлодуй“ ще имат върху територията на Австрия. Анализът на възможно най-лошия сценарий ще затвори тази празнина и ще позволи дискутирането на възможния ефект за Австрия. Това трябва да се вземе под внимание в по-нататъшното развитие на процедурата по ОВОС.

Въпроси

- *Докладът за ОВОС (2013 г.) споменава, че базата данни ESTE EU Kozloduy съдържа количества освободен материал, свързани с отработеното гориво и аварии при различни нива на повреди на защитната обвивка (течове в защитната обвивка). От гледна точка на австрийските експерти тези количества освободен материал са от голям интерес. Ще има ли възможност за предоставянето на количествата освободен материал?*
- *Ще има ли възможност да се предоставят количествата освободен материал при сценарии на аварии в допълнение към онези, използвани в ESTE EU Kozloduy, което ще включи аварии със съхраняването на отработеното гориво за разглежданите типове реактори на НЯБ с изчислена честота на голямо освобождаване (ЧГО) под 1*10E-7?*
- *Може ли да се предостави информация за използваната програма ESTE EU Kozloduy? Защо програмата ESTE EU Kozloduy и използваните входни параметри (включително метеорологични сценарии) са считани за подходящи за изчисляването на дългосрочните ефекти върху Австрия?*
- *Може ли да се предостави повече информация относно резултатите от изчисляването на дисперсията? Например защо са предоставени само резултати за разстояние от 200 км, докато разстоянието за пренасяне на радиоактивни субстанции за 48 часа със скорост на вятъра от 2 м/сек или 5 м/сек е съответно около 346 км или 864 км?*
- *Предвидено ли е да се приложат всичките четири критерия за ограничено въздействие на EUR, както е предназначено в EUR? Защо конкретните критерии за ограничено въздействие на EUR не са цитирани при трите разгледани случая в таблица 6.1-7 в доклада за ОВОС (2013 г.), а само критерият за икономическо въздействие?*
- *Защо изчислените дози в случай на тежка авария на АЕЦ „Темелин“ 3 и 4 са същите като представените в доклада за ОВОС (2013 г.) за новия ядрен блок?*

Управление на радиоактивни отпадъци

Държавното предприятие „Радиоактивни отпадъци“ (ДПРО) е отговорно за управлението на радиоактивни отпадъци в България. Конкретните планове за управлението на радиоактивни отпадъци е описано в българската „Стратегия за управлението на отработеното ядрено гориво и радиоактивни отпадъци до 2030 г.“, поради което съдържанието на доклада за ОВОС, което засяга радиоактивните отпадъци, не е анализирано в подробности.

Съгласно Директива 2011/92/ЕС, приложение IV а, описанието на проекта, включващо приблизителна оценка по тип и количество на очакваните остатъци и емисии вследствие на работата на предлагания проект, е задължително изискване за доклада за ОВОС.

Докладът за ОВОС предоставя информация относно прогнозните количества на отработено ядрено гориво (ОЯГ). Понеже количеството на отработеното ядрено гориво във висока степен зависи от типа реактор, който все още не е избран, количествата на отработеното ядрено гориво варират драстично.

Същото важи и за количествата кондиционирани ниско- и средноактивни отпадъци – ще бъдат произвеждани ниско- и средноактивни отпадъци от 180 м³ до 250 м³ на година. Не е предоставена информация относно това кои типове реактори произвеждат съответно кои количества ниско- и средноактивни отпадъци или как това съответства на EUR, които изискват генериране на не повече от 50 $м^3$ ниско- и средноактивни отпадъци на 1000 MW на годишна база.

Докладът за ОВОС предоставя информация относно за съществуващите съоръжения – далеч по-малко информация е предоставена за новия ядрен блок, който е действителната тема на самия доклад за ОВОС. Например решението на въпроса за временното и окончателното съхранение на отработеното ядрено гориво от НЯБ е оставено за по-късно; въпреки че е визиран отворен горивен цикъл, все още не е изключен и затворен горивен цикъл.

От гледна точка на австрийските експерти трябва да се предостави повече информация за очакваните количества на радиоактивните отпадъци – трябва или да се отговори на отворените въпроси относно отработеното гориво, или да се предостави времева рамка, в която ще бъде отговорено на тези въпроси.

Въпроси

- *Кога ще бъде взето решението дали в бъдеще ще се внедри отворен или затворен горивен цикъл?*
- *Временно съхранение на отработеното ядрено гориво в случай на отворен горивен цикъл: Ще бъде ли разширено съществуващото сухо хранилище за отработено ядрено гориво (СХОЯГ), за да поеме отработеното ядрено гориво от новия ядрен блок, или ще се използват отделни съоръжения? Може ли също така да се използва и ще се използва ли съществуващото мокро хранилище за временно съхранение (хранилище за отработено ядрено гориво на ХОЯГ) за новия ядрен блок?*
- *Дългосрочно съхранение на високоактивни отпадъци: Какво е текущото състояние на планираното изграждан на дългосрочно хранилище с период за административен контрол, който не е по-къс от 100 години за високоактивни отпадъци, и категория за средноактивни ядрени 2b, споменато в доклада за ОВОС (2013 г., глава 2.3.3)?*
- *Капацитетът на текущото хранилище за временно съхраняване на ниско- и средноактивни отпадъци достатъчен ли е, за да поеме и ниско- и средноактивните отпадъци от новия ядрен блок?*
- *Какви количества кондиционирани ниско- и средноактивни отпадъци ще бъдат произвеждани от различните типове реактори/с кои нива на активност?*

Основни заключения

Експертният екип достигна до следните основни заключения:

Тип реактор

- Информацията относно методите и резултатите от анализите за безопасност на разглежданите типове реактори и също относно изискванията за безопасност (включително вземането под внимание на научените след Фукушима уроци и използването на концепцията за практическо елиминиране, когато последното е приложимо) по отношение на новия ядрен блок е недостатъчна.

Оценка на площадката

- Сеизмичната опасност при площадката е ниска. Освен това проучването за сеизмични опасности е извършено преди 20 години.
- Докладът за ОВОС не предоставя ясна информация относно определянето до каква степен НЯБ ще е проектиран за издържане на предполагаемо разбиване на голям пътнически или военен летателен апарат.
- Пожари и изтичания на опасни течности и газове: Заключенията в доклада за ОВОС, които се отнасят към тези теми, не са напълно разбираеми, понеже съответната информация се съдържа в отделни документи, до които експертният екип няма достъп. Няма становище дали са взети под внимание съответните въздействия, причинени от транспортирани в близост до площадката експлозиви.
- Въз основа на информацията, която е предоставена в BG-NR (2011 г.), заключението в доклада за ОВОС, че площадката на АЕЦ „Козлодуй“ е защитена срещу наводнения, изглежда добре обосновано.
- В доклада за ОВОС няма предоставена информация за базовите стойности на проектирането срещу вятърно натоварване. Поради тази причина също така не е ясно дали ще бъдат покрити натоварвания, причинени от торнада. В доклада за ОВОС не се обсъждат други екстремни метеорологични въздействия, освен породените от ветрове и торнада.

Анализ на аварии/трансгранично въздействие

- Предоставената в доклада за ОВОС информация не е достатъчна за оценка на потенциалните радиационни последствия, причинени от тежки аварии. Необходима е допълнителна информация, включително списък с разгледаните покрити от проектирането аварии, ефективността на специалните функции на новия ядрен блок относно предотвратяването и смекчаването на последиците от тежки аварии, както и информация относно техническата обосновка на количеството освободен материал при тежка авария.
- Според доклада за ОВОС анализите на тежки аварии с количество освободен материал Cs-137 от 30 TBq потвърждават отсъствието на радиационен риск за Република Австрия. Въпреки това австрийските експерти препоръчват да се изчислят последствията от тежка авария с голяма степен на освобождаване като допълнение към сценария с ограничено освобождаване, представен в доклада за ОВОС.

1 INTRODUCTION

Background

Kozloduy NPP is the only nuclear power plant operating in Bulgaria. The NPP is located in the Northwest of the country near the town of Kozloduy and the Romanian border on the bank of the Danube River - at a distance of approximately 700 km from Austria.

At the site of Kozloduy, a total of six reactors (Kozloduy-1 to Kozloduy-6) went into operation between 1974 and 1991. Because of commitments made by Bulgaria in connection with its accession to the EU, the first four reactors were shut-down before the expiry of their design lifetime (two units went offline in 2002, two units in 2006).

So currently, two reactors are in operation: Kozloduy-5 and Kozloduy-6 are both Pressurized Water Reactors of the VVER V-320 type with a gross electrical capacity of 1,000 MW. (Both reactors are currently under procedure for operational lifetime extension and possibly capacity increase.)

The Investment Proposal (IP) of the "Kozloduy NPP – New Build EAD" envisages the construction of a new nuclear unit of the latest generation (III or III+) with installed electrical power of about 1,200 MW at the Kozloduy NPP site (Kozloduy-7 or new nuclear unit "NNU").

Environmental Impact Assessment

In June 2013, the Republic of Bulgaria notified Austria of the planned construction of a new nuclear energy unit at the nuclear power plant Kozloduy. Competent Bulgarian Ministry for the Environmental Impact Assessment (EIA) is the Ministry of Environment and Water.

With reference to Art. 7 EIA Directive 2011/92/EU and Art. 3 Espoo Convention, the Austrian Federal Ministry of Agriculture and Forestry, Environment and Water Management informed the Bulgarian side that Austria would take part in the transboundary Environmental Impact Assessment as the possibility of significant transboundary impacts of the projects on Austria cannot be ruled out. Furthermore, with regard to the scope of the EIA, Austria expressed its expectation that the EIA-Report would contain a comprehensive analysis and assessment of severe accidents with long range impacts in the environmental report. (letter of 26 June 2013).

In October 2013, the Bulgarian Ministry of Environment and Water sent the **EIA-Report** of the investment proposal "Construction of a new latest generation nuclear unit at Kozloduy NPP site" to Austria – which is the main document of the **main proceedings of the EIA**. The full report including annexes is available in English (EIA-REPORT 2013), moreover, a non-technical summary and chapter 11 of the EIA-Report (Transboundary Impacts) are available in German.

The applicant of the investment proposal is the company "Kozloduy NPP – New Build EAD". The applicant has assigned the Consortium "Dicon – Acciona Ing." with the development of the EIA-Report.

The Umweltbundesamt (Environment Agency Austria) was commissioned by the Austrian Federal Ministry of Agriculture and Forestry, Environment and Water Management and the Province of Lower Austria to coordinate this expert statement and assist in organizational matters.

The Austrian Institute of Ecology (Österreichisches Ökologie-Institut) in cooperation with Helmut Hirsch, Adhipati-Yudhistira Indradiningrat, Oda Becker and Mathias Brettner was assigned by the Umweltbundesamt to prepare the expert statement at hand.

The **goal of the expert statement at hand** is to assess if the EIA-Report allows for making reliable conclusions about the potential impact of transboundary emissions. Therefore, particularly safety features, severe accident management and the accident analysis with a focus on airborne transboundary emissions and the potential impact to Austria are discussed. Questions were formulated which need to be discussed during the consultation process within the EIA-procedure.

2 COMPLETENESS OF DOCUMENTATION

The transboundary EIA procedure is regulated within different legal bases. On the level of international law, the Espoo Convention is applied – Bulgaria ratified the Espoo Convention in 1995, the 1st and 2nd amendments in 2007.[1]

Furthermore, the EIA Directive 2011/92/EU is valid, which aims at standardizing its member countries' EIA laws. The Directive had to be translated into national law by each EU member country.

The EIA Directive as well as the Espoo Convention contain a number of provisions concerning the content of EIA-Reports.

The expert statement at hand does not aim at carrying out a comprehensive assessment on whether or not the EIA-Report contains all the necessary information according to the aforementioned regulations - only the fulfillment of selected criteria is evaluated. The following table gives an overview on the legal requirements and whether or not the topic is covered in the expert statement. If it is, the table refers to the chapters of the expert statement which deal with the topic in question or gives a short answer to the topic right away.

Criterion	Espoo-Konvention Annex II	Directive 2011/92/EU Annex IV	Chapter
Description of the project	a) A description of the proposed activity and its purpose	1. A description of the project, including in particular the physical characteristics and an estimate, by type and quantity, of expected residues and emissions resulting from the operation of the proposed project	Chapter 3 Chapter 4 Chapter 5 Chapter 8
Alternatives und Zero Alternative	b) A description, where appropriate, of reasonable alternatives (for example, locational or technological) to the proposed activity and also the no-action alternative	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	see text below this table
State of the Environment	c) Description of the environment likely to be significantly affected by the proposed activity and its alternatives	3. A description of the aspects of the environment likely to be significantly affected by the proposed project	not considered within the expert statement
Environmental Impact	d) A description of the potential environmental impact of the proposed activity and its alternatives and an estimation of its significance	4. A description of the likely significant effects of the proposed project on the environment resulting from e.g. the emission of pollutants or the use of natural resources	only concerning accidents and transboundary impacts: Chapter 5 Chapter 6 Chapter 7
Mitigation measures	e) A description of mitigation measures to keep adverse environmental impact to a minimum	6. A description of the measures envisaged to prevent, reduce and where possible offset any significant adverse effects on the environment.	only concerning accidents and transboundary impacts: Chapter 5 Chapter 6 Chapter 7

[1] http://www.unece.org/env/eia/ratification/convmap.html

Criterion	Espoo-Konvention Annex II	Directive 2011/92/EU Annex IV	Chapter
Methods	f) An explicit indication of predictive methods and underlying assumptions as well as the relevant environmental data used	5. The description by the developer of the forecasting methods used to assess the effects on the environment referred to in point 4.	only concerning technical solution/accidents/ transboundary impacts: Chapter 5 Chapter 6 Chapter 7
Gaps in knowledge and uncertainties	g) An identification of gaps in knowledge and uncertainties encountered in compiling the required information	8. An indication of any difficulties (technical deficiencies or lack of know-how) encountered by the developer in compiling the required information.	not considered within the expert statement
Monitoring	h) Where appropriate, an outline for monitoring and management programmes and any plans for post-project analysis		not considered within the expert statement
Non-technical summary	i) A non-technical summary including a visual presentation as appropriate (maps, graphs, etc.).	7. A non-technical summary of the information provided under headings 1 to 6.	A non technical summary has been provided
Transboundary Impacts		Art. 7 Par. 1a of the EIA Directives stipulates that together with the description of the project, any available information on its possible transboundary impact has to be given.	Chapter 7

Alternatives und Zero-Alternative

The EIA-REPORT (2013, CHAP. 2.1-2.4) describes the considered alternatives in terms of location (chapter 2.1), the considered alternatives for associated infrastructure during the construction and operation phase (chapter 2.2), the alternative options for building the NNU (chapter 2.3) and the zero alternative (chapter 2.4).

Four alternative **locations** at the NPP Kozloduy site are under consideration – chapter 2.2 shows how these sites differ in relation to infrastructure requirements. A final alternative of the site hasn't been selected yet, but site 2 is stated the priority option (EIA-REPORT 2013, CHAP. 12). While the differences of the four considered locations at NPP Kozloduy are discussed, no alternative sites are mentioned as other nuclear sites than Kozloduy are deemed a mere theoretical alternative. Questions regarding the different site are discussed in chapter 3 "Description of the project". EIA-REPORT (2013, CHAP. 2.3) on the alternative options for building the NNU is evaluated in chapter 4 "Reactor type" of the expert statement at hand.

The electrical power of the new unit has been determined, at least roughly ("about 1,200 MW"). However, the reactor type has not been selected yet. The description provided in the EIA-Report regarding the reactor types considered for the NNU only gives basic and general information on the reactors. Therefore, there are open questions concerning the "**description of the project**" required by the EIA-Directive and the Espoo Convention (see chapter 4.4).

Regarding the **zero alternative**, two alternative options are described as theoretically available:

1. Try to find another site for construction of the required nuclear capacity elsewhere in the country;
2. Completely put an end to all surveys and activities for building new nuclear capacity anywhere in the country.

Alternative 1 is only a purely theoretical alternative according to the EIA-Report as NPP Kozloduy is the only operating site in Bulgaria and the Belene NPP project has been cancelled for the time being in favor of the construction of a new unit in Kozloduy.

Alternative 2 (the zero alternative) would, according to the EIA-Report, contradict the objectives laid down in the country's National Energy Strategy for launching new nuclear capacities and increasing the share of electric energy generated by nuclear power plants by 2020. The needed new energy capacity would most likely have to be provided by thermal power stations of 1,000-2,000 MW at new sites instead. The key environmental consequence mentioned by the EIA-Report would be the increase of greenhouse gas, SO_2, NO_x and dust emissions. Therefore, option 2 is considered not advisable by the EIA-Report.

As a detailed evaluation of Bulgaria's energy policy is not a topic of the expert statement at hand, the statement that the needed new energy capacity would most likely have to be provided by thermal power stations cannot be judged.

3 DESCRIPTION OF THE PROJECT

3.1 Treatment in the EIA-Report

A new nuclear unit (NNU) is planned to be built at the Kozloduy site. The NNU is expected to be a pressurized light-water reactor of Generation III or III+ with 1,200 MW electric power. Regarding the safety aspect of the NNU project, it is stated that requirements of the Bulgarian legislation in the field of nuclear energy, requirements of the IAEA and the European requirements described in the EUR will be applied (EIA-REPORT, CHAP.1.2.1).

Geographical characteristics of the Kozloduy site are described at the beginning of Chapter 1.3 of the EIA-Report. Four locations in the area of Kozloduy NPP are introduced as possible sites for the NNU. Positions of these four sites at the Kozloduy area are shown in the Figure 1.3-1 in the EIA-Report together with the borderline of the precautionary action zone of the Kozloduy NPP. Geographical conditions and existing infrastructure at each site are described. It is stated that all the main and auxiliary buildings and facilities, the equipment required for the operation, as well as all the local treatment facilities and waste water treatment plant (WWTP) will be located within the borders of the proposed sites (EIA-REPORT, CHAP. 1.3.1).

Sub-chapter 1.3.2 outlines the necessary areas for the construction and operation of the NNU. The criteria used to determine the necessary areas are listed. Layouts of the planned NNU on the proposed sites with each alternative of the reactor types being considered are illustrated in the figures 1.3-2 to 1.3-4 in the EIA-Report. Reactor types being considered are AP-1000, AES-92 and AES-2006 (EIA-REPORT, CHAP. 1.3.2).

Chapter 1.4 of the EIA-Report describes the basic characteristics of the envisaged reactor technology (PWR Generation III/III+). Main technological characteristics of the NNU are listed. Passive and specific protection provisions, such as core-catcher, are mentioned as the most significant advantage of the Generation III/III+ reactor compared to the previous generation (EIA-REPORT, CHAP.1.4.1). Basic information on the electricity production process and RAW management (for gaseous, liquid, and solid RAW) as well as the systems and components of a PWR is elaborated. Regarding the I&C system, it is stated that in compliance with the requirements currently in force, "…the NNU will also be equipped with instruments for monitoring the parameters for accidents with exceptionally low probability of occurrence related to fuel meltdown" (EIA-REPORT, CHAP. 1.4.1). It is also stated that "[t]he process of design, construction, commissioning and decommissioning of the new nuclear unit will be carried out in compliance with the legislative requirements, specified mainly in the Act on Safe Use of Nuclear Energy (ASUNE) and the regulations thereby related", and that "[t]he design of the nuclear unit shall comply with the European requirements, specified in the European Utility Requirements for LWR Nuclear Power Plants" (EIA-REPORT, CHAP. 1.4.1).

Nuclear fuel (NF) is treated in the chapter 1.4.2.2 of the EIA-Report. It is mentioned that "...any NF to be used must comply with the design bases for the maximum discharge burn-up of the fuel, stipulated by the EUR" (EIA-REPORT, CHAP. 1.4.2.2.1). The Fresh nuclear fuel envisaged to be used by the NNU is elaborated in chapter 1.4.2.2.2. Regarding the NF developed by the Russian producers for the WWER technology (AES-92 and AES-2006), it is stated that there is a tendency to increase the efficient use of the fuel by increasing the level of average enrichment. This implies higher burn-up. For the AES-2006, average discharge burn-up is given as 55.5 MWd/kgU. It is also stated that "[t]here is data showing that 63 MWD/kgU per fuel assembly can be reached and 72 MWD/kgU per HRE" (EIA-REPORT, CHAP. 1.4.2.2.2). Regarding the latter number, the acronym HRE is not explained in the EIAR, but it probably refers to the maximum burn-up of a fuel rod.

3.2 Discussion

In the EIA-Report, it is explained that there are four alternative locations at the area of Kozloduy NPP which are envisaged to be used as the site for the NNU. The information provided in the EIA-Report includes existing infrastructures on each site, terrain characteristics of each site, and which reconstruction works are needed to be performed on the sites to build the NNU. But there is no information about whether there are differences between the conditions of these four alternative sites which may also cause significant differences in the effort to ensure the safety of the NNU. For example, it is not discussed whether the conditions in some of the sites can make the implementation of accident mitigation measures more difficult than in other alternative sites. In Table 2.2-1 presented in the EIA-Report, a short analysis of these four sites with respect to the connections with outdoor switchgears is provided (EIA-REPORT, CHAP. 2.2.1). The table compares the position between each alternative site and the outdoor switchgear. It is stated that for Site 1 and Site 3, the connection to the outdoor switchgear will be much more difficult compared to the other two sites. The connection between Site 3 and the outdoor switchgear is said to be most complicated, because the connection by overhead power lines (OPL) to the outdoor switchgear will intersect the OPLs of Unit 5 and Unit 6. In the context of the safety of the NNU, it is also relevant to assess, to which extent these differences could affect the availability of off-site power sources in accident conditions. However, there are no discussions in the EIA-Report on this aspect, and there also no references to assessments or analyses which deal with this topic.

Concerning safety requirements for the NNU, it is stated several times in the EIA-Report that requirements of the Bulgarian legislation in the field of nuclear energy, requirements of the IAEA and the European requirements described in the European Utility Requirements (EUR) will be taken into consideration. Especially the application of EUR in the NNU is emphasized in several parts of the EIA-Report (EIA-REPORT, CHAP. 1 Introduction / CHAP. 1.2.1 / CHAP. 1.4.1 / CHAP. 2.3.2). Furthermore, a list of regulations is provided in Annex 4 of the EIA-Report, presented as the legislative framework applied for the NNU.

But it is notable that there are no references to the work of the Western European Nuclear Regulators' Association (WENRA). In the last years, WENRA has published documents specifically for new power reactors. In addition, the WENRA safety reference levels for existing NPP also have relevance for new projects.

There is no information provided in the EIA-Report, on whether the WENRA documents for new reactors and the safety reference levels will also be taken into consideration for the NNU project. From the regulatory point of view, the WENRA documents have a significant importance in the field of nuclear safety because they reflect the view of its members, which are the heads of national nuclear regulatory bodies in the European Union (plus Switzerland), and they are drafted by experts from the safety authorities. The following documents which are already published by WENRA can be relevant to the safety requirements for the NNU:

- WENRA Reactor Safety Reference Levels (WENRA-RHWG, January 2008)
- Safety Objectives for New Power Reactors (WENRA-RHWG, December 2009)
- WENRA Statement on Safety Objectives for New Nuclear Power Plants (WENRA, November 2010)
- Report on Safety of new NPP designs (WENRA-RHWG, March 2013)

In the field of nuclear safety, the lessons learned from the accident in Fukushima in the year 2011 have brought forward new views and points of consideration concerning the safety requirements for NPPs, concerning issues such as long-term loss of power and/or ultimate heat sink, multi-unit accidents, accidents in spent fuel pools, the need to plan for the use of mobile equipment and the consideration of extreme natural hazards etc. These issues have been identified in the course of the stress tests performed on European nuclear power plants (see, for example, ENSREG 2012) and in other international fora. In Europe, they are being followed up in the framework of National Action Plans (ENSREG 2013).

The importance of the lessons learned from the Fukushima accident is shown by the fact that they are addressed in the WENRA-RHWG Report on the Safety of new NPP designs (see above). Furthermore, the WENRA Safety Reference Levels are presently being revised in the light of the Fukushima accident. An updated version of the WENRA SRL, which also should be taken into consideration in further progress of the NNU project, has been published for stakeholder comments in November 2013 (WENRA 2013).

The information provided in the EIA-Report, which has been drafted more than two years after the accident, hardly gives any indication about to which extent the lessons learned from Fukushima will be taken into consideration for the new plant, for example, whether there are safety requirements regarding the issues mentioned above, to which extent they are already covered by the design of the reactor types under consideration for the NNU, and which special, new provision have to be taken.

To obtain a full picture of the safety provisions for the NNU, and to fully comprehend the regulatory framework for this plant, more detailed information on the safety requirements should be provided.

3.3 Conclusions/Recommendations

From the information provided in the EIA-Report, it is not clear whether WENRA documents (in particular, the safety objectives for new reactors and the additional work of WENRA-RHWG on new reactors) will be taken into account with regard to safety requirements for the NNU. From the Austrian experts' point of view, due to their significant importance, WENRA documents should be taken into consideration, and if this is already the case, then this should be clarified.

It is also unclear, whether and to which extent the lessons learned from the Fukushima accident will be taken into account in requirements and safety analyses of the reactor types considered for the NNU, and to which extent they might already be covered by the design of the candidate reactor types. From the Austrian experts' point of view, more information should be provided about the question to which extent the lessons learned from the Fukushima accident will be taken into consideration.

Regarding the discussion on the four possible sites presented in the EIA-Report, it is also relevant to provide more information on analysis and assessments about the extent to which the differences between the possible sites could affect the safety of the NNU during its operation and decommissioning, and the performance of safety measures in accident conditions.

3.4 Questions

- *Are WENRA documents for new reactors and the WENRA safety reference levels also to be taken into consideration with regard to the safety requirements for the NNU?*
- *To which extent are the lessons learned from the Fukushima accident to be taken into account in the safety requirements and safety analyses for the NNU?*
- *To which extent are the lessons learned from Fukushima already covered by the design of the candidate reactor types?*
- *Is it possible to provide more information on analysis and assessments which have been or are planned to be performed to compare the four alternative sites presented in the EIA-Report, especially those related to the safety of the NNU?*

4 REACTOR TYPE

4.1 Treatment in the EIA-Report

The options of technology considered for the NNU are treated in chapter 2.3 of the EIA-Report. As already mentioned in the previous chapter, the NNU is envisaged to be a pressurized water reactor (PWR) of Generation III or III+ with installed electrical power of approximately 1,200 MW. It is mentioned that according to the Customer's Term of Reference, there are two possible options for the NNU which are compliant with the contemporary requirements for safe operation (EIA-REPORT, CHAP. 2.3). The first option, referred as A-1 in the EIA-Report, is a so-called Hybrid option, which means a maximum usage of the nuclear island equipment ordered for NPP Belene, and the turbine island from another supplier. The second option, referred as A-2 in the EIA-Report, is the implementation on an entirely new design.

The option A-1 is elaborated in sub-chapter 2.3.1. The sub-chapter begins with a short description of NPP Belene. NPP Belene has been designed with a WWER-1000/V466B reactor type, based on a standard design for AES-92 reactor, which in 2006 passed all analysis stages for compliance with the EUR. Main differences with the design of previous WWER are listed. A description of the systems and components of the NPP is provided. NPP Belene has been designed to withstand a Safe Shutdown Earthquake (SSE) with a^{max} value of 0.24 g and a probability of occurrence of 1 in 100,000 years. Its external containment was designed to withstand external forces, incl. a crash of large passenger or military craft. The coolant circulation system of the reactor, which has four circulation loops, is elaborated.

Concerning the fuel, the WWER-1000/V466B can use TVSA fuel type, or alternatively TVS-2. Specific characteristics of each fuel type are presented. The spent fuel pool (SFP) is located inside the containment (EIA-REPORT, CHAP. 2.3.1.5).

Safety systems of the reactor (AES-92) are listed and elaborated in the sub-chapter 2.3.1.6. The description of the safety systems is divided into two categories: active safety systems (EIA-REPORT, CHAP. 2.3.1.6.1) and passive safety systems (EIA-REPORT, CHAP. 2.3.1.6.2). Functions and components of each system are briefly explained. It was also stated that the AES-92 design enables reactor operators to cool down the core melt catcher in the event of an RPV failure (EIA-REPORT, CHAP. 2.3.1.6).

The other option (A-2), which envisages the installation of an entirely new PWR of Generation III or III+, is dealt with in the sub-chapter 2.3.2. It is again stated in the chapter that the reactor models under consideration should comply with the safety criteria determined by the Bulgarian legislation, IAEA documents, and EUR (EIA-REPORT, CHAP. 2.3.2). The reasoning for choosing PWR types for the NNU is briefly given. One of the aspects of consideration is the existing experience in Bulgaria with PWR (WWER) since 1974, and the knowledge resulting from this many years of experience.

It is mentioned that a project for "Techno-economic analysis to justify the construction of a new nuclear capacity at the site of NPP Kozloduy" (TEA) is carried out parallel to the EIA project. The envisaged capacity of 1200 MW is stated to be one of the requirements set up by the TEA Terms of Reference documents, because a number of regulatory documents recommend that the installed capacity of a single unit doesn't exceed 10% of the total installed capacity in Bulgaria (12,200 MW). A summary of PWR Generation III/III+ types according to interim results of the TEA is presented in Table 2.3-1 of the EIA-Report. The reactor types presented in the summary are EPR, EU-APWR, APR-1400, AES-2006, ATMEA1, and AP-1000. It is then pointed out that according to Terms of Reference for the EIA of the investment proposal for the planned NNU, only the reactor types AES-2006 and AP-1000 are considered as examples (EIA-REPORT, CHAP. 2.3.2). For both reactor types, it is mentioned that there are projects already under construction.

It is also stated that "[f]or the purposes of the EIA-Report, the so-named conservative approach has been chosen, meaning that the values which result in the least favorable environmental effects will be considered throughout the assessment" (EIA-REPORT, CHAP. 2.3.2).

AP-1000

Sub-chapter 2.3.2.1 of the EIA-Report describes the reactor type AP-1000. The sub-chapter begins with description of AP-1000 basic characteristics, such as thermal and electrical output, availability, fuel cycle, licensing state, etc., and actual state of construction experience in the world. The reactor has a heat output of 3415 MW, with net electric output in the range of 1,117 – 1,154 MW. The availability of AP-1000 is expected to be around 93%. The advantages of AP-1000 in comparison with the power plants of the current generation are elaborated, e.g.: more compact design due to reduced amount of equipment and piping, 55% less pipe connections to the containment, and relatively large pressurizer.

Basic information on the components of the AP-1000 coolant circulation system and its functions is given. Concerning the reactor vessel, it is mentioned that the probability of leaks from the vessel that may lead to exposure of the core is eliminated, because the reactor design doesn't provide openings under the level of the reactor core (EIA-REPORT, CHAP. 2.3.2.1).

Aspects of the defense-in-depth concept in AP-1000 are listed and briefly explained. It is stated that the passive systems of AP-1000 are designed to automatically activate and maintain the cooling function and preserve the core integrity for 72 hours following maximal DBA, limited single failure, lack of operator action and unavailability of local and external AC sources (EIA-REPORT, CHAP. 2.3.2.1.1.3).

The in-vessel retention measure is briefly explained. It is also stated that after the occurrence of core damage with an intact containment, assuming no recovery action has been taken, a large release of radioactivity is expected to happen after more than 100 hours, which provides enough time for undertaking accident management measures to mitigate the consequences and prevent containment failure (EIA-REPORT, CHAP. 2.3.2.1.3).

Passive safety systems of AP-1000 are introduced in the chapter 2.3.2.1.4 of the EIA-Report. These include a passive core cooling system, a passive containment cooling system, an emergency inhabitancy system for the unit control room, and isolation functions. Short descriptions of the functions and components of each of these passive safety systems are provided.

Main technical specifications of the AP-1000 are presented. It is stated that the AP-1000 has a core damage frequency of 5.11×10^{-7} per year and a large early release frequency of 5.94×10^{-8} per year (EIA-REPORT, CHAP. 2.3.2.1.4). It is not specified which types of events and plant states were included in the analyses yielding these numbers.

Electrical equipment and power sources are treated in the chapter 2.3.2.1.7 and chapter 2.3.1.8 of the EIA-Report. According to the EIA-Report, the reactor is designed to cope with 100% loss of load. In such a case, the turbine generator will continue to deliver house load power in sustainable manner. Each reactor cooling pump is powered from two class 1E breakers connected in series, which belong to seismic category 1 and can withstand the design basis earthquake (DBE) without loss of their safety function.

In the case that all other power sources are not available, power to class 1E systems for post-accident monitoring, lighting and ventilation systems in control room, for filling the main water tanks and the spent fuel pond is provided by two auxiliary DGs situated in a separate building. However, these generators are not required during the first 72 hours after a complete loss of all external power sources (EIA-REPORT, CHAP. 2.3.2.1.8.1).

The DC and uninterruptible power supply (UPS) systems for Class 1E loads provides DC power to the loads important to safety as well as uninterrupted DC and AC power in rated and accident conditions. The components of this system are situated in structures belonging to seismic resistance Category 1. The Class 1E loads will be loaded for 24 hours or 72 hours depending on their safety functions. Battery charges can also be powered from the back-up diesel generators as each one has the capacity to charge a fully discharged battery for 24 hours (EIA-REPORT, CHAP. 2.3.2.1.8.3).

AES-2006

The reactor type AES-2006 is described in chapter 2.3.2.2 of the EIA-Report. AES-2006 is designed based on operational experience of WWER-1000 and the design of AES-92. It is already licensed in Russia. On-going construction projects of two versions of AES-2006 in Leningrad (V-491) and Novovoronezh (V-392M) are mentioned. Several important differences between the reactor model V-392M and the reactor model V-491 are pointed out, which are as follows:

- Incorporation of passive containment heat removal system and passive steam generators heat removal system in V-491
- Incorporation of passive core flooding system in V-392M
- Incorporation of active emergency coolant injection systems (high and low pressure) in V-491
- Differences in the systems for management of BDBA

- Differences in the control and management systems, the feed water system, design of control room, etc.
- Differences in the estimated CDF

The AES-2006 has both active and passive systems to perform safety functions. It is stated that for AES-2006, the structural protection against large aircraft crash is concentrated in the external containment and the fresh fuel storage facility.

Main components of the coolant circulation system and the reactor pressure vessel are introduced. The function and components of the reactor vessel are elaborated in chapter 2.3.2.2.1 of the EIA-Report.

The concept of defense-in-depth implementation in AES-2006 is explained. Means to ensure resistance to internal and external impacts that may lead to general failure are listed, e.g.: certification of the safety related systems and equipment in accordance with the Russian standards and with the International Electrotechnical Commission (IEC) series of standards. The single failure criterion is also applied on the design of AES-2006. The safety systems of AES-2006 have four completely independent trains. Each safety system train is physically separated from others by fire-proof barriers. It is stated that "[t]he technical solutions used in the AES-2006 design with WWER-1200 preclude the occurrence of major beyond design basis accidents in case of occurrence of several single failures and subsequent failures of the safety system components" (EIA-REPORT, CHAP. 2.3.2.2.2).

The passive and active safety systems of the two different models of AES-2006 mentioned previously are listed and briefly described. The safety systems of V-392M are treated in chapter 2.3.2.2.2.1, and the safety systems of V-491 are introduced in chapter 2.3.2.2.2.2 of the EIA-Report. It can be said that a large number of passive safety systems are used for the reactor model V-392M, while the design of V-491 is based mainly on the implementation of active safety systems (IAEA 2011). Dual containments and core melt catcher are provided in both reactor models.

The following table contains some of the main technical specifications of AP-1000 and AES-2006, which are presented in the EIA-Report.

Table 4-1: Mechanical specifications of AP-1000 and AES-2006

	AP-1000	**AES-2006**
Output, gross [MWe]	1200	1170
Output, net [MWe]	1117÷1154	1082
Heat Output [MW]	3400	3200
Efficiency [%]	33÷34	34
Availability	> 93	> 90
Design service life [years]	60	60
Construction period [months]	54	54
CDF [1/year]	$5{,}11 \times 10^{-7}$	$< 1 \times 10^{-6}$
LERF [1/year]	$5{,}94 \times 10^{-8}$	$< 1 \times 10^{-7}$
MDE[*)] [g]	0,3	0,25

	AP-1000	AES-2006
Number of main circulation loops (primary circuit)	2 hot / 4 cold	4
Fuel rod assemblies	157	163
Maximum fuel enrichment [%]	4,8	5
Average discharge burnup [MWd/kg]	60	60
Fuel	UO_2 or MOX	UO_2
Duration of burnup campaign [months]	18÷24	12÷24
Fuel amount [t UO_2]	95,97	87

**) This acronym is not explained but it probably refers to the maximum design earthquake.*

Spent nuclear fuel (SNF) of the NNU is dealt with in the chapter 2.3.3. The chapter describes basic information of the SNF storage and management. Basic information on spent fuel pool of each reactor type option (AES-92, AP-1000, and AES-2006) is provided. The information includes location of the SFP, number of places in the SFP, etc. It is stated that the strategy of the Republic of Bulgaria concerning spent nuclear fuel and RAW management envisages an *open fuel cycle* or *once-through fuel cycle*. It is explained that after the fuel has been used, it is deposited in storage facilities, without any further processing other than packaging to provide better insulation of the radioactive substances from the biosphere. For more information, see chapter 8 of this expert statement.

4.2 Discussion

The description provided in the EIA-Report regarding the reactor types considered for the NNU, which are AES-92 (option A-1), AP-1000 and AES-2006 (option A-2), only gives basic and general information on the reactors. The safety systems are described briefly, mainly with information on the functions and the main components. The reliability and effectiveness of the safety systems in accident conditions are not elaborated and there are no references to analyses or evaluations in this regard. Such information would be necessary to be able to assess the characteristics and the respective advantages and disadvantages of the reactor types more comprehensively. With regard to evaluations of their reliability and effectiveness, safety systems or measures such as passive core cooling systems, passive containment cooling system, in-vessel retention measures for AP-1000 as well as core catcher for AES-92 and AES-2006 would be of special interest to the Austrian expert team. It is also of interest for the Austrian expert team to receive more detailed information on the comparison of differences between the reactor models V-392 M and V-491 of the AES-2006.

Information on the values of Core Damage Frequency (CDF) and Large Early Release Frequency (LERF) of each reactor type under consideration are provided in the EIA-Report. However, the scope which is covered by these results is not specified. For example, it is not clear to which extent internal hazards or external events have been included, and whether all plant states have been considered or only full-power operation. Furthermore, there is no elaboration on the accident analyses which have been performed for the reactors (see section 6.2 of this expert statement for further elaboration of this point). A discussion of the general validity of the CDF and LERF values is lacking.

It has to be taken into account that the CDF and LERF are calculated values which result from probabilistic safety analysis (PSA). It is unavoidable that the CDF and LERF values are subject to uncertainties. Not all types of uncertainties can be numerically measured and included in the calculation. There are factors which cannot, or can only partially be taken into account in probabilistic safety analysis, which are for example: unexpected loads caused by internal events, poor safety culture, some types of common cause failure, and unforeseen external impact. There are examples of events which have occurred in existing NPPs which confirm this aspect (HIRSCH 2012), and also show that the significance of probabilistic values, such as CDF and LERF, for the assessment of the safety of a reactor type is limited. In any case, there is no discussion of the uncertainties of the probabilistic results presented in the EIA-Report, and no quantitative measures for the uncertainties which can be quantified are provided.

The EIA-Report doesn't provide information whether the concept of practical elimination is applied in the safety requirements for NNU in the context of severe accidents. If the concept of practical elimination is applied for the NNU, the limitations of probabilistic studies have to be taken into account, and more information should be provided about the criteria that are used to define that a certain accident condition is practically eliminated. This issue is treated more profoundly in section 6.2 of this expert statement.

It was mentioned in the previous chapter (Description of the Project) that lessons learned from the Fukushima accident have significant importance in the field of nuclear safety, and have brought forward some changes in safety objectives and requirements of NPPs. Below, examples of specific issues arising from post-Fukushima lessons learned that can be relevant in discussions with regard to safety requirements for new NPP are given:

- A comprehensive consideration of natural hazards, also possible combinations of hazards (incl. extreme weather conditions).
- Diversity of emergency power, and protection of the emergency power against external hazards.
- Sufficient battery power and possibility of recharging
- Provisions for the use of mobile equipment
- Measures in the case of Loss of Ultimate Heat Sink
- Hydrogen management, taking into account problems in connection with containment venting and with the migration of hydrogen to other buildings
- Provisions for multi-unit accidents
- Provisions for accidents in the spent fuel pool
- Provision of a Supplementary Control Room or equivalent location
- Provisions for management of liquid releases

More information should be provided on the question whether the specific post-Fukushima factors (lessons learned) will be taken into consideration in the safety requirements for the NNU, and in the selection of the reactor type for the NNU.

4.3 Conclusions/Recommendations

From the Austrian experts' point of view, more information on the safety systems of the reactor types considered for the NNU which elaborates the reliability and effectiveness of the systems should be provided. With regard to evaluations of their reliability and effectiveness, safety systems or measures such as passive core cooling systems, passive containment cooling system, in-vessel retention measures for AP-1000 as well as core catcher for AES-92 and AES-2006 would be of special interest to the Austrian expert team. It is also of interest for the Austrian expert team to receive more detailed information on the comparison of differences between the reactor models V-392 M and V-491 of the AES-2006.

In general, information on the methods and results of safety analyses of the reactor types under consideration, and also concerning the safety requirements (including the consideration of post-Fukushima lessons learned and, as far as applicable, the use of the concept of practical elimination) for the NNU are still lacking. From the Austrian experts' point of view, more detailed information on these aspects should be provided.

4.4 Questions

- *Would it be possible to provide more detailed information on the safety systems of the reactor types under consideration, especially concerning passive core cooling system, passive containment cooling system, in-vessel retention measures for AP-1000 as well as the core catchers of the AES-92 and the AES-2006?*
- *Would it be possible to provide information on the scope of the probabilistic analyses (in particular, plant states and event categories included) and the treatment of uncertainties in these analyses?*
- *Would it be possible to provide more details regarding the differences between the two types of AES-2006 under consideration?*
- *Is the concept of practical elimination applied in the safety requirements for the NNU?*
- *Assuming that the concept of practical elimination is applied in the safety requirements for the NNU, which exact criteria are used to define that a condition or accident sequence is practically eliminated?*
- *Would it be possible to provide information on assessments or analysis concerning the reliability and effectiveness of the safety systems of the reactor types under consideration?*

Further questions concerning probabilistic analyses and safety systems are listed in section 6.4 of this expert statement, which also contains questions concerning accident analyses.

5 SITE EVALUATION

5.1 Treatment in the EIA-Report

5.1.1.1 Reports and Studies

In the EIA-REPORT (2013, CHAP. 3.4.3 and 11.2.6) an overview of seismic hazard related studies regarding the NPP Kozloduy is given. In June 1990, an IAEA expert mission recommended to perform studies in accordance with actual seismic safety standards. Following the recommended activities, geological and geomorphological studies were performed between 1991 and 1992, followed by further studies until 1995. The main purpose of these studies was to localize and identify main geological structures and Neogene-Quarternary activities and the evaluation of seismic potentials from capable faults. Within the same time period the seismicity in the region has been studied by the Geophysical Research Institute of the Bulgarian Academy of Science. It is stated, that a re-evaluation of the seismic hazard for the NPP site in Kozloduy was performed from 1991–1992. The study is cited within the EIA-Report, but the reference is missing.

5.1.1.2 Seismicity

To make the following text about seismicity easier to read, two figures from publications not contained in the EIA-Report have been added for illustration.

The NPP Kozloduy is situated in the south-western part of the geologically stabile part of the Moesian platform (see figure Figure 5-1) characterized by a very low seismicity. The Northern and Southern borders of the Moesian platform are visible very clearly as potent fault zones, which are partly tectonically active. The EIA-Report does not contain a figure on the distribution of seismicity and the localization of seismic source zones. Therefore, in Figure 5-2 the historical seismicity of Bulgaria and boarder regions is shown. This figure is an excerpt from LEYDECKER ET AL. (2008) and provides also a delineation of seismic source zones. It is noted that these zones are not necessarily the same as used in the hazard study for NPP Kozloduy, however, they give a general orientation about the location of seismic sources mentioned in the EIA-Report. In Figure 5-2, the macroseismic epicentral intensity is given for the earthquakes, which is a measure for the observed effects on the earth surface. The intensity values (here in the text indicated in roman numbers) are to be distinguished from magnitude values that are a measure for the earthquake energy released at the focal depth.

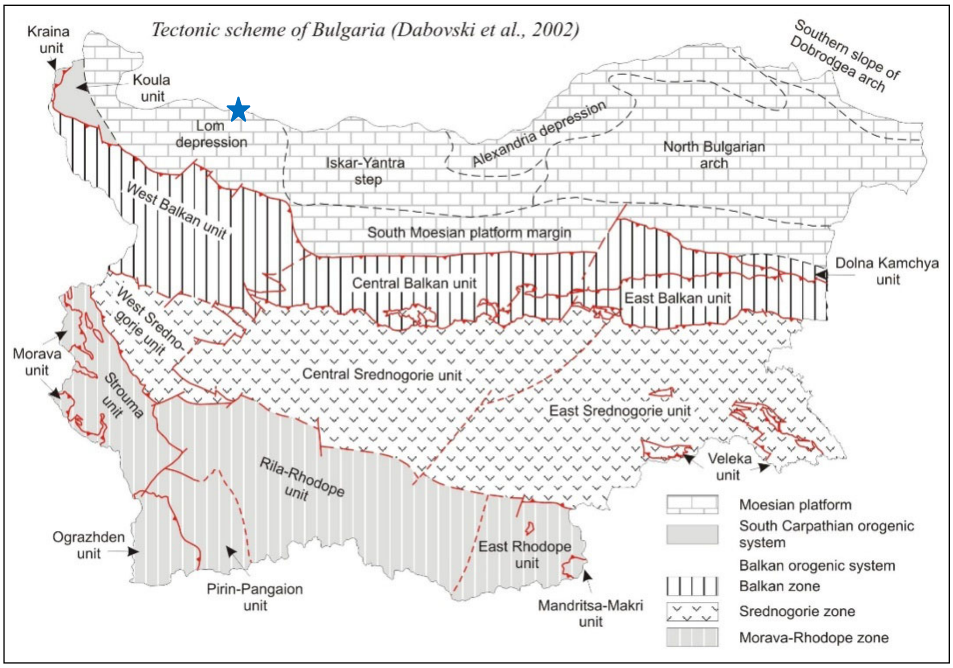


Figure 5-1: Scheme of the regional geological structure in Bulgaria and location of the site of the NPP Kozloduy (after DABOVSKI et al. (2002)); star: location of NPP Kozloduy.

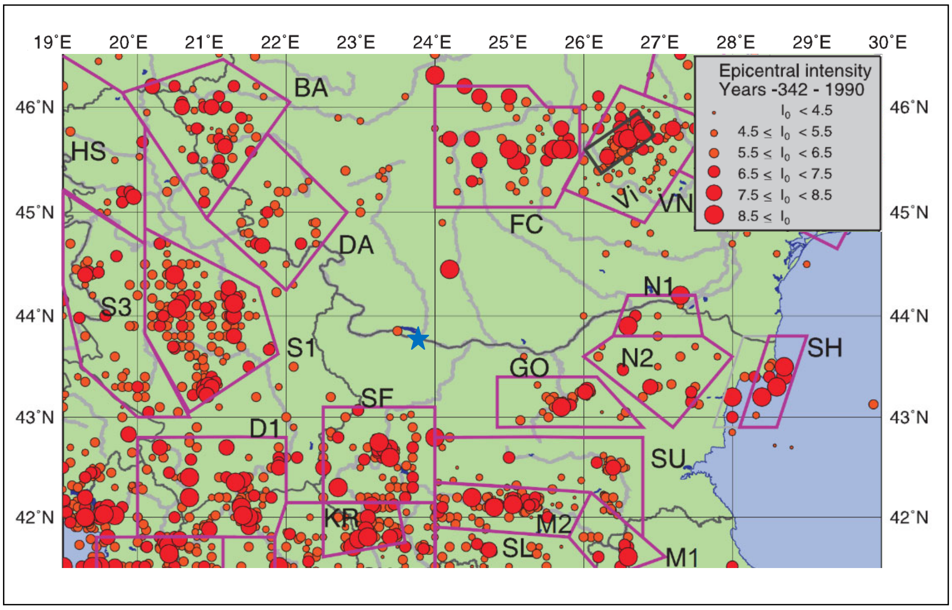


Figure 5-2: Earthquake epicenter map (I0 = epicentral intensity, MSK scale) with the seismic source zones; excerpt out of LEYDECKER et al. (2008), added with location of NPP Kozloduy (star).

Figure 5-2 illustrates that Kozloduy is located in an area of very low seismic activity surrounded by earthquake prone areas at distances of more than about 80 km from the site. The closest source zone south of Kozloduy is the Sofia zone (SF).

The strongest historical earthquakes in that zone had intensities of IX MSK (1641 and 1858), but according to the EIA-REPORT (2013, CHAP. 3.4.3.2.1 and 11.2.6) caused only an intensity of III MSK in Kozloduy. Further relevant seismic areas as described in the EIA-Report are: Gorna Orjahovitza (GO), East Serbia (S1), Kresna (KR), Marica (MR), Negotinska Krajina as a part of east Serbia (S1 in Figure 5-2), the area of Dulovo (zones N1 and N2 in Figure 5-2), northern Greece and the Vrancea region (Vi) in Romania, about 240 km away from the site, with strong earthquakes at great depth. The EIA-REPORT (2013, CHAP. 3.4.3.2.1) states that the strong Vrancea earthquakes contribute the most to the seismic hazard at Kozloduy. The seismicity in the Vrancea region consists of two depth domains: normal depth (less than 60 km) and intermediate depth (60-180 km) earthquakes. Due to extreme irregularities of the isoseismals of intermediate depth earthquakes their effects on seismic hazard were treated separately in the hazard study. The maximum observed intensity at the site from the strongest historical earthquakes is VII MSK, caused by the strong Vrancea earthquake in 1977. According to the EIA-Report, the strongest impacts from other regions that caused a site intensity of VI MSK are from earthquakes in the regions Kresna and Gorna Orjahovitza.

In 1997, a local seismic network was installed to localize seismic activity (including small earthquakes) in the site vicinity. During 15 years of monitoring no earthquake was detected within an area of 30 km around the site. In the years between 1976 and 1998 regional seismometer stations localized three earthquakes within the 30 km zone around Kozloduy: two earthquakes with a magnitude smaller than 2.0 and one having a magnitude of 3.6. In the area around the site no historical earthquakes are known.

5.1.1.3 Seismic Hazard Assessment and Results

According to the EIA-REPORT (2013, CHAP. 3.4.3.1), the seismic hazard study was performed in the years 1991-1992. The seismic hazard was assessed in a deterministic and also in a probabilistic hazard analysis. The basis for the hazard study is the earthquake catalogue and a seismotectonic regionalization. The EIA-Report states that the catalogue has been "unified and standardized". This is understood as unified according to the magnitude scale, removing of double events and removing of fore- and aftershocks like described on page 89 that refers to the catalogue used for the new national seismic hazard map of Bulgaria. For the seismic hazard assessment of the NPP Kozloduy site, seismotectonic regions were delineated analyzing "geological, geophysical, seismological and other data". The evaluation of the seismotectonic model is based on the information for the regionalization for the national seismic hazard map in 1987. Results are presented with reference to BONČEV ET AL. (1982). The seismotectonic regionalization represents seismic source zones. For each of the source zones a maximum magnitude was estimated and the frequency distribution of earthquakes was calculated. The seismic impact at the site was calculated using different ground-motion attenuation functions that were supposed to be appropriate for Bulgaria. For the very special attenuation of the intermediate deep Vrancea earthquakes, separate attenuation functions based on Vrancea earthquake data were used. The EIA-Report notes that a minimum of two different attenuation functions were used for each case (Vrancea and all other seismic sources) to consider uncertainties.

In the deterministic hazard assessment, for each seismic source the effect of its maximum considered earthquake was calculated assuming the nearest distance to the site. This general procedure reflects the common practice in deterministic seismic hazard assessment and is in compliance with IAEA regulations. The probabilistic seismic hazard assessment was performed with the program EQRISK that is based on the total probability theorem from Cornell. This theory is the standard methodology applied worldwide. Model uncertainties were considered using a logic tree approach. The seismic hazard curve for the site was calculated in terms of maximum peak ground acceleration (PGA). The seismic hazard is given for an annual probability of exceedance of 10^{-2} (operating earthquake) and 10^{-4} (design earthquake), corresponding to recurrence periods of 100 years and 10,000 years. PGA for an annual probability of 10^{-2} is given to 0.1 g and for 10^{-4} to 0.2 g. The free-field response spectra (described as "Design wrapping reaction spectre") are not given in the EIA-Report.

5.1.2 External Human Induced Events

Further external events are treated in EIA-REPORT (2013, CHAP. 6.2) "Assessment of the parameters of human induced impacts at the site of the plant".[2] In EIA-REPORT (2013) several types of impacts are considered:

- aircraft crash,
- leaks of hazardous fluids and gases with subsequent impacts as fire, explosions and toxic threats to the personnel,
- off-site flooding,
- extreme winds and tornadoes,
- non-radiation hazards during the construction phase,
- non-radiation hazards during the NNU operation phase,
- non-radiation hazards during the NNU decommissioning phase.

The last three hazards are not further discussed in this report as they are not relevant with respect to a potential negative impact to Austria.

<u>Aircraft crash</u>

Concerning impacts due to an aircraft crash the EIA-Report states that incidental aircraft crash within the perimeter of the plant and premeditated steering of an aircraft to a particular facility at the site of the plant can be distinguished. In EIA-REPORT (2013, CHAP. 6.2.1) only incidental aircraft crashes at the site are treated, mainly with respect to their expected frequency. Three types of aircraft crashes are considered in EIA-REPORT (2013, CHAP. 6.2.1):

- Type 1: A crash at the site deriving from General Aviation in the area of the site.
- Type 2: A crash at the site as a result of a take-off or landing operation at a nearby airport.
- Type 3: A crash at the site owing to air traffic in the main traffic corridors of regular Civil Aviation and traffic in the military flight zones.

---

[2] In EIA-REPORT (2013, CHAP. 6.2) also off-site flooding and extreme winds and tornadoes are considered which are natural impacts which are only to some extent influenced by human activities (in particular, climate change, construction of dams etc.).

According to EIA-REPORT (2013, CHAP. 6.2.1.1) type 1 of air traffic is generated mainly by agricultural aviation. It consists of flights of light aircraft / light aviation at a low altitude. The EIA-Report states that these flights are not subject to control by the Air Traffic Services Authority State Enterprise (unless they enter aircraft zones and air traffic corridors). Therefore, sufficient reliable information on this type of traffic in the area of the Kozloduy NPP is not available. It is concluded in EIA-REPORT (2013, CHAP. 6.2.1.1) that the parameters of the impact on the facilities at the site (mechanical shock, vibration impact and fire) for aviation of type 1 will be significantly lower than those for type 3.

Concerning aviation of type 2, the requirements and information in the IAEA safety guide on "External human induced events in site evaluation for nuclear power plants IAEA (2002) are reflected in EIA-REPORT (2013, CHAP. 6.2.1.2). According to the EIA-Report, there are no large civil airports within 30 km of the Kozloduy NPP - the airport closest to the site, with a distance of 68 km, is the airport in Craiova. Based on the applied screening distance value approach and the number of flight operations it is concluded in EIA-REPORT (2013, CHAP. 6.2.1.2) that civil airports cannot generate a hazard of Type 2 aircraft crash for the sites under consideration.

With respect to the hazard of an aircraft crash of type 3, it is stated in EIA-REPORT (2013, CHAP. 6.2.1.3) that it depends on the intensity of air traffic (the number of flights) in the area around the site and the frequency of aircraft accidents. Based on a prognosis on the annual growth of the air traffic over Bulgaria of 4% for the 2010-2030 period, it is derived that approximately 28 million aircraft are expected to pass within 100 km of the site during 60 years of operation of the NNU, or an average of 460.000 per year. An annual frequency of incidental aircraft crashes during flight of 4x10-8 is derived on the basis of statistical numbers about aircraft crashes during flights for the years 1959 to 2011. According to EIA-REPORT (2013, CHAP. 6.2.1.3), the resulting annual frequency for aircraft crashes on the sites under consideration (on an area of 0.5 km²) is 5.66×10^{-7} based on traffic data within 30 km of the site and 2.53×10^{-7} based on traffic data within 100 km of the site.

It is further stated in EIA-REPORT (2013, CHAP. 6.2.1.3) that according to IAEA (2002) some states have decided to design all nuclear facilities against aircraft crash impact in case the annual frequency of such an event calculated for an area of 1 to 4 km² is equal to or greater than 10^{-6}. Applying this criterion, the values for the annual frequencies are in the range of 1.13×10^{-6} to 4.52×10^{-6} based on traffic data within 30 km of the site and 5.86×10^{-7} to 2.34×10^{-6} based on traffic data within 100 km of the site. Concerning the safety relevance of these numbers, the following conclusion is drawn in EIA-REPORT (2013, CHAP. 6.2.1.3):

"National legislation does not define minimum values for a Screening Probability Level (SPL) of an aircraft crash type of impact which, when exceeded, should warrant giving consideration to the design bases for the nuclear facility. According to the REGULATION on Ensuring the Safety of Nuclear Power Plants (2004), sources of human induced hazards may not be neglected if their frequency of occurrence is greater than or equal to 1×10^{-6}. The IAEA documents mentions a tentative value for SPL of 10^{-7} per reactor-year. Consequently, due to the low probability, an aircraft crash impact is not expected."

Leaks of hazardous fluids and gases

According to EIA-REPORT (2013, CHAP. 6.2.2), leaks of hazardous (explosive, flammable, corrosive and toxic) fluids and gases near the site could cause different safety relevant problems as the formation of explosive clouds (entering ventilation system intakes) or toxic gases threatening the life of plant personnel.

With reference to IAEA documents, the EIA-Report states that consideration must be given to all possible sources of hazardous fluids and gases for which the SDV (screening distance value) is less than 8-10 km. The following potential sources of hazardous gases within 10 km of the potential sites are listed:

- facilities at the Kozloduy NPP site,
- UGS Chiren – Kozloduy – Oryahovo Gas Pipeline (planned),
- South Stream Gas Pipeline (planned),
- Nabucco Gas Pipeline (planned).

Concerning facilities at the Kozloduy NPP site, it is stated in EIA-REPORT (2013, CHAP. 6.2.3) - with reference to a separate document - that the following incidents can be singled out:

- Gas release as a result of an accident involving the stationary tank for nitric acid at the Chemical Cleanup Facility to Electroproduction-1;
- Gas release as a result of an accident involving a hydrazine hydrate drum during its transportation;
- Gas pollution of the environment with toxic products upon the interaction of inter-reacting substances;
- Release of hazardous fluids within the perimeter of the NPP.

However, it is stated that the respective "hazards of occurrence of emergencies have a low degree of probability and, therefore, no impact is expected."

Concerning explosions due to leaks of gas pipelines, it is stated in EIA-REPORT (2013, CHAP. 6.2.4) with reference to separate analyses that the gas cloud formed will rapidly ascend due to the high pressure in the pipeline. It is claimed that this process will continue until the complete atmospheric dispersion of the cloud. It is concluded: "In no situation can the gas reach the ground surface and linger on it and, therefore, an impact is not expected."

Concerning possible impacts due to incidents at facilities at the Kozloduy NPP site, the following conclusions are drawn in EIA-REPORT (2013, CHAP. 6.2.5.2 to 6.2.5.4):

- explosion in the hydrazine hydrate storage facility: no impact is expected due to the comparably high ignition temperature of hydrazine hydrate (59°C)
- explosion in storage facility No. 106: in case the fire protection rules for availability of means to suppress fires of combustible materials or other hazardous substances are observed, the impact will be local, confined to the site of the storage facility, temporary, short-term and reversible.
- explosion in an on-site filling station: The impact will be local, confined to the site of the filling station, short-term and reversible.

Fire

In EIA-REPORT (2013, CHAP. 6.2.8.1) it is reported that considerable quantities of flammable liquids are stored within the perimeter of the NPP, which, under certain conditions, could spill out of the tanks, ignite and lead to the occurrence of fires. It is stated that as largest possible fire within the perimeter of the NPP, a fire of diesel fuel which has leaked from a tank of a capacity of 2000 m³ at the oil station has been considered. According to the EIA-Report, it has been assumed that the integrity of one of the tanks is breached and the entire quantity of diesel fuel spills, the diesel fuel ignites and the combustion spreads to the entire surface of the spill. Based on the results of a separate document it is concluded that the fire will pose a hazard only to the oil station but not to the rest of the neighbouring installations and that a negative impact on the NNU is not to be expected.

Concerning the planned Nabucco and South Stream gas pipelines two types of fires are discussed in EIA-REPORT (2013, CHAP. 6.2.8.2): fireballs and torch combustions of natural gas. With respect to possible consequences the EIA-Report concludes that none of the two types of combustion poses a hazard to the potential sites of the NNU.

5.1.3 Other External Events

Off-site flooding

In EIA-REPORT (2013, CHAP. 6.2.6) several sources of potential off-site flooding like the maximum possible natural water levels of the river Danube or a rupture of the dam walls of the Iron Gates hydropower project are stated. It is pointed out that the analyses conducted in the context of the ENSREG stress tests for nuclear power plants, as documented in the national progress report of Bulgaria, confirm that the requirements of the Regulation on Ensuring the Safety of Nuclear Power Plants have been met. The analyses demonstrate that the Kozloduy NPP site is flood-proof.

Extreme winds and tornadoes

In EIA-REPORT (2013, CHAP. 6.2.7) values for the maximum wind speed dependent on the respective annual probability of exceedance (10^{-2} and 10^{-4}) are given. The value for an annual probability of exceedance of 10^{-4} is 45 m/s, which is considered as extreme. Also, some results of an analysis concerning an evaluation of 16 tornadoes observed in the 1986-2009 period with respect to an area of 178 km in radius around the Kozloduy NPP are presented: maximum speed 332 km/h (92.2 m/s); rotating speed 263 km/h (73.1 m/s); forward speed 69 km/h (19.2 m/s); radius corresponding to the maximum rotating speed of the air column: 45.7 m/s. It is deduced that the annual frequency of occurrence of a tornado with these characteristics in a 12,500 km² area around the Kozloduy NPP is 6.3×10^{-7} and of a tornado with a speed exceeding 332 km/h is 1.26×10^{-8}. It is concluded “that an impact is not expected because the future design of a NNU will take into account these impacts on building structures and facilities ensuring nuclear and radiological safety.”

5.2 Discussion

5.2.1 Seismic Hazard Assessment

The seismic hazard study for the NPP Kozloduy site (not referenced in the EIA-Report) was performed in the years 1991-1992 according to EIA-REPORT (2013, CHAP. 3.4.3.1). The EIA-Report does not give further information on this study. The EIA-Report describes the seismicity in Bulgaria and border regions and outlines the most important seismic areas. The strongest historical earthquakes that affected the site are presented. The report gives a correct overview of the seismicity. The site is located in the south-western part of the Moesian platform, a geologically stable area with very low seismicity. This region belongs to the most seismically quiet areas in Bulgaria. Within a 30 km zone around the site no historical earthquake is known and only three small earthquakes were registered since 1976, the period of instrumental observation. The maximum magnitude for local earthquakes is estimated to M = 4.0. according to geological and geophysical assessments, there is no evidence of major capable faults within the 30 km zone of the site. Regions with much stronger earthquakes are located at distances of more than 80 km away from the site. The main contribution to the overall seismic hazard at the site is caused by strong earthquakes in the Vrancea region in Romania, about 240 km away. The strongest of these earthquakes had magnitudes greater than 7 and show very low ground motion attenuation towards north-east and south-west (direction to Kozloduy). The maximum observed impact in Kozloduy was intensity VII, caused by the Vrancea earthquake in 1977 with an epicentral intensity of VIII MSK. The moment magnitude of this earthquake is estimated to 7.5 and the focal depth to 94 km (LEYDECKER ET AL. 2008).

The seismic hazard for the site was assessed by a deterministic analysis as well as a probabilistic analysis. For many years, the probabilistic seismic hazard assessment has been the standard procedure applied. The probabilistic analysis evaluates the earthquakes statistically and allows to calculate probabilities of exceedance for arbitrary ground motion levels (e.g. for different acceleration thresholds). Because the deterministic analysis regards single earthquake scenarios and does not consider recurrence periods of earthquakes, a direct comparison with the probabilistic result is not possible. It is noted in the EIA-Report that the peak ground acceleration determined by the deterministic method is 1.35 to 1.7 times lower than the probabilistic evaluation (depending on the probability of exceedance). This is not surprising, since usually the deterministic method does not consider the variation of ground-motion attenuation formulas, whereas in the probabilistic method the ground-motion variation is integrated in the hazard calculation, described by the standard deviation.

In the EIA-Report, the results of the hazard assessment are given only in terms of peak ground acceleration (PGA). For the safety earthquake, PGA is 0.2 g for an annual probability of exceedance of 10^{-4} (equivalent to a recurrence period of 10,000 years). In the probabilistic assessment model, uncertainties were taken into account using a logic tree approach, resulting in many branches of different hazard curves. It is not specified to which fractile 0.2 g belongs. Possibly, it refers either to the mean or the median (50% fractile) of all calculated variations of the seismic hazard. The respective fractile is important as the seismic hazard strongly depends on it.[3] The results are given for the horizontal ground motion, information of the vertical ground motion is not provided. For seismic design, earthquake loads are given by a response spectrum. The response spectrum represents the maximum response of an arbitrary building to a seismic excitation, giving maximum ground motion (e.g. acceleration) for different oscillation frequencies or periods. PGA corresponds to the acceleration at period 0 in the response spectrum. In the EIA-Report, no response spectra are given. As the hazard is only characterized in terms of PGA, possibly a normalized response spectrum shape has been applied and the spectra are determined by scaling the spectrum shape with the calculated PGA value.

In EIA-REPORT (2013, CHAP. 3.4.3.2.2), two seismic design levels are defined according to IAEA safety guidelines (NS-G-1.6 respectively the new guideline SSG9). IAEA guidelines define two seismic levels: “SL-2 level is associated with the most stringent safety requirements, while SL-1 corresponds to a less severe, more probable earthquake level that normally has different implications for safety.” In the EIA-Report, SL-1 level is described as “design earthquake” and SL-2 as “maximum estimated earthquake”. These descriptions are confusing since SL-2 is often called “design earthquake” and the “maximum estimated earthquake” usually is understood as the maximum magnitude considered for a seismic source region. The seismic hazard at a site usually is not represented by just one earthquake scenario, like the hazard assessment for Kozloduy shows. In the IAEA guidelines no specific probability of exceedance is recommended for SL-1 and SL-2 level. The probability of exceedance for these seismic levels can differ among IAEA member states. For the SL-2 design earthquake, usually the probability of exceedance is requested between 10^{-4}/ year and 10^{-5}/ year. The Bulgarian regulation BNRA (2008) requires the characterization of the input ground motion for the safe shutdown earthquake with frequency of 10^{-4} events per year at the zero level of the site. The corresponding fractile is not specified.

5.2.2 External Human Induced Events

Aircraft crash

The EIA-Report states that aircraft crashes of type 3 (“a crash at the site owing to air traffic in the main traffic corridors of regular Civil Aviation and traffic in the military flight zones”) are not to be expected. This statement is comprehensible if the derived annual frequencies for aircraft crashes on the sites under consideration (on an area of 0.5 km²) are compared to the requirements of the Bulgarian regulation. It is not comprehensible in light of the frequencies derived for a larger impact area and the tentative value for a Screening Probability Level stated in IAEA (2002):

- It is stated in EIA-REPORT (2013, CHAP. 6.2.1.3) that some states have decided to design all nuclear facilities against aircraft crash impact in case the annual frequency of such an event calculated for an area of 1 to 4 km² is equal to or greater than 10^{-6}. Applying this criterion, the values for the annual frequencies are in the range of 1.13×10^{-6} to 4.52×10^{-6} based on traffic data with-

[3] The transition from the median to the 84% fractile roughly corresponds to an increase of the seismic impact (e.g. the PGA value) of a factor of two.

in 30 km of the site and $5.86x10^{-7}$ to $2.34x10^{-6}$ based on traffic data within 100 km of the site. It is further mentioned that according to the Regulation on Ensuring the Safety of Nuclear Power Plants (2004), sources of human induced hazards may not be neglected if their frequency of occurrence is greater than or equal to $1x10^{-6}$. It is not further discussed how the calculated numbers > 10^{-6}/a compare to the cited requirements.

- On the one hand, it is stated in EIA-REPORT (2013, CHAP. 6.2.1.3) that IAEA documents mention a tentative value for a Screening Probability Level (SPL) of 10^{-7} per reactor-year. On the other hand, annual frequencies for aircraft crashes on the sites under consideration (on an area of 0.5 km²) of $5.66x10^{-7}$ based on traffic data within 30 km of the site and of $2.53x10^{-7}$ based on traffic data within 100 km of the site are derived. Therefore, the tentative value for a Screening Probability Level is reached. This issue is not further discussed in the EIA-Report.

Concerning aircraft crashes of type 2 ("a crash at the site as a result of a take-off or landing operation at a nearby airport") it has been shown in the EIA-Report that large civil airports are far enough away. Two other factors for potential aircraft crashes of type 2 which are mentioned in EIA-REPORT (2013, CHAP. 6.2.1) – airways or airport approaches pass within 4 km of the site and air space usage within 30 km of the plant for military training flights – are not further discussed. It is not clarified in the EIA-Report whether these two factors are relevant for the NNU.

With respect to aircraft crashes of type 1 ("a crash at the site deriving from General Aviation in the area of the site") it is stated in EIA-REPORT (2013, CHAP. 6.2.1) that the parameters of the impact on the facilities at the site for aviation of type 1 will be significantly lower than those for type 3. However, as it also stated that aircraft crashes of type 3 are not to be expected, the consequences of the statement concerning aircraft crashes of type 1 remain unclear.

In the course of the description of the option A-1 (hybrid) in EIA-REPORT (2013, CHAP. 2.3.1) it is mentioned that the external containment of the WWER AES-92 power plant, on which the WWER-1000/V466B type is based, has been designed to withstand external forces such as crash of large passenger or military aircraft or external explosion waves. Concerning the option A-2 protection against aircraft crash is not mentioned for the AP-1000 in EIA-REPORT (2013, CHAP. 2.3.2.1). For the AES-2006, it is stated that the structural protection against large aircraft crash is concentrated in the external containment and the fresh fuel storage facility (CHAP. 2.3.2.2). In the chapter about aircraft impact, EIA-REPORT (2013, CHAP. 6.2.1), it is stated that an aircraft crash impact is not expected due to low probability. In summary, there are indications that the NNU might be designed to withstand a supposed crash of large passenger or military aircraft, but there is no authoritative, detailed information given in this respect.

Premeditated steering of an aircraft to a particular facility at the site is not discussed in the EIA-Report and therefore no information is available on how this scenario is taken into account.

Leaks of hazardous fluids and gases

The conclusion in EIA-REPORT (2013, CHAP. 6.2.3) concerning potential impact due to facilities at the Kozloduy NPP is based on a separate document. This document is not available. No information about the conducted analyses and their basic approach is given. It is only stated that four scenarios have been singled out because of their low probability. No values for the respective probabilities are provided. On the basis of the information provided in EIA-REPORT (2013, CHAP. 6.2.3), it is also not discernable whether only single events have been considered (e.g. a single failure of a storage facility) or also combinations of events like an interconnected cascade of destructions and subsequent explosions (e.g. a release of explosive gases because of foregoing fires or local explosions).

The conclusion in EIA-REPORT (2013, CHAP. 6.2.4) concerning potential impact due to gas pipelines (an impact is not expected) is also based on separate documents and analyses. Again, these are not available. No detailed information about the conducted analyses and their basic approach is available.

Concerning explosions in storage facility No. 106 it is stated in EIA-REPORT (2013, CHAP. 6.2.5.3) that the impact will be local, confined to the site of the storage facility, temporary, short-term and reversible as far as the fire protection rules for availability of means to suppress fires of combustible materials or other hazardous substances are observed. Results concerning the case that these administrative rules are not (fully) followed are not presented in the EIA-Report. It also not stated whether a probabilistic risk assessment has been conducted for explosions in this facility.

As far as can be understood from EIA-REPORT (2013, CHAP. 6.2.2) mainly potential impacts inside the plant, in the case that explosive clouds enter ventilation system intakes and explode in a particular nuclear facility or facility responsible for safety, have been considered. Anyway, no considerations about the formation of pressure shock waves and their possible impact on buildings of the NNU because of explosions outside the perimeter of the NPP are contained in EIA-REPORT (2013, CHAP. 6.2.). However, according to the requirements contained in IAEA (2002), such analyses are required. In table II it is stated that among other factors explosion pressure waves, projectiles, smoke, gas and dust due to explosions (deflagration, detonation) have to be taken into account. In EIA-REPORT (2013, CHAP. 6.2.) it is not stated whether relevant impacts due to explosives transported next to the site (ships on the Danube or trucks) have to be taken into account. This is not in compliance with IAEA (2002), sine at least transports at the Danube, which passes the site within the SDV value of 10 km should have been discussed in the EIA-Report:

"If there is a potential for explosions within the SDV [SDV: screening distance value] on transport routes, the potential effects should be estimated. If these effects are significant, the frequency of shipments of explosive cargoes should be determined. The probability of occurrence of an explosion within the SDV should be derived from this, and if it is less than the SPL [SPL: screening probability value] no further consideration should be given. Particular attention should be paid to the potential hazards associated with large explosive loads such as those transported on railway freight trains or in ships." (IAEA 2002)

<u>Fire</u>

According to EIA-REPORT (2013, CHAP. 6.2.8.1), the conclusion that no negative impact on the NNU is to be expected due to flammable liquids stored within the perimeter of the NPP facilities is based on a worst case consideration (fire due to diesel fuel which has leaked from a tank of a capacity of 2,000 m³ at the oil station). However, details of the analyses are contained in a separate document which is not made available. Therefore, no further information about the conducted analyses and the presumed boundary conditions is available. The same applies for the conclusions in EIA-REPORT (2013, CHAP. 6.2.8.2) concerning the two types of combustion possible for gas leaks at the planned Nabucco and South Stream gas pipelines (no hazard to the potential sites of the NNU).

5.2.3 Other External Events

Off-site flooding

In EIA-REPORT (2013, CHAP. 6.2.6) it is pointed out with reference to analyses conducted in the context of the ENSREG stress tests for nuclear power plants that the Kozloduy NPP site is flood-proof. This statement is in accordance with the fact that the site is situated at a level of 35 m while the actual design basis value for external flooding (MWL: maximum water level) is 32.93 m as explained in BG-NR (2011). According to BG-NR (2011), the combination of Danube natural extreme water levels with an annual exceedance probability of 10^{-7} and the rupture of the water supply system "Iron Gate" 1 and 2 would lead to a water level of 33.42 m which is still well below the level of the site.

The ENSREG peer review country report ENSREG (2012) confirms that the definition of the flood requirement is broadly consistent with international standards and that the plant is in compliance with the current design basis. It is also stated that the plant robustness to deal with floods beyond the design basis is demonstrated in the Bulgarian National Report.

One point concerning possible water ingress into safety relevant buildings that is stated in BG-NR (2011) and in the peer review country report ENSREG (2012) is not mentioned in the EIA-Report. According to these reports, water penetration from outside into some buildings of the existing NPP, where the lowest elevation of rainwater or domestic sewer is below 32.93 m, may be possible: "Some function can be lost because some locations can be flooded by water coming from sewer collectors (loss of alternative makeup of spray pools for unit 5 and 6, alternative for spent fuel cooling via SG, with fuel in the reactor for Unit 3 and 4). BNRA should further consider the sensitivity of equipment to flooding, in particular regarding the sensitivity of actuators, electrical devices and Instrumentation and Control (I&C) systems to excessive humidity. A cautious approach should be considered when the safety related equipment in a flooded location can be lost. A modification of the drain and sewage system is planned." ENSREG (2012)

Extreme winds and tornadoes

In EIA-REPORT (2013, CHAP. 6.2.7) it is stated that tornadoes with wind speeds up to 332 km/h have a low annual frequency (6.3×10^{-7} in a 12,500 km² area around the Kozloduy NPP).[4] It is concluded that an impact "is not expected because the future design of a NNU will take into account these impacts on building structures and facilities ensuring nuclear and radiological safety." However, no information on the design basis values for the NNU is presented.

[4] For tornados with a speed exceeding 332 km/h, the value is 1.26×10^{-8}/a.

The values for wind speeds and tornadoes presented in the EIA-Report are identical with those stated in the Bulgarian national report for the ENSREG stress test BG-NR (2011). It is pointed out in BG-NR (2011) that according to the requirements for loads from external events the current extreme value for wind loads at Kozloduy NPP is 1.24 kN/m² (corresponding to a wind speed of 45 m/s). The dynamic pressure of wind speeds of 92.2 m/s (maximum observed tornado wind speed) amounts to 5.2 kN/m². It is not clear from the presentation in the EIA-Report whether this higher value should be used as design basis for the NNU or whether wind loads should be covered by a design against other impacts (e.g. air pressure waves)[5].

Other extreme meteorological impacts than wind and tornadoes or not discussed in the EIA-Report.

5.3 Conclusions/Recommendations

5.3.1 Seismic Hazard Assessment

In the EIA-Report, the general approaches of the seismic hazard study for the site of the NPP in Kozloduy are presented. Concrete information about parameters, formulas and procedures are out of the scope of the EIA-Report. Therefore, this review of the report can only be a check if the described approaches are in compliance with international practices and regulations (represented by IAEA guidelines). For the site of the NPP Kozloduy a deterministic and a probabilistic assessment was performed on the basis of common principles. The briefly described deterministic procedure reflects international practices. For the probabilistic analyses a standard program (EQRISK) was used, based on the theory of Cornel that is the international standard approach. The consideration of uncertainties in the hazard model is important, especially model uncertainties (also called “epistemic uncertainties”). In the EIA-Report it is stated, that model uncertainties were considered using a logic-tree. This approach is the typical practice in probabilistic seismic hazard assessment. The complete seismic load assumptions in terms of response spectra for the horizontal and the vertical seismic actions are not given in the EIA-Report. The only values provided are the maximum peak ground accelerations (PGA) for an annual probability of 10^{-2} and 10^{-4}. The PGA value for 10^{-4}/year is 0.2 g. A defined safety level of 10^{-4}/year is quite common, but no information is given to which fractile this value corresponds.

The general applied methodology of seismic hazard assessment is conform to international practices. However, the response spectra are not given and possibly normalized standard spectra were used, scaled to 0.2 g. The use of normalized standard spectra would not conform to the present state of the art in seismic hazard assessment for nuclear facilities. Instead, the seismic hazard is calculated separately for different frequencies.

5 According to BG-NR (2011) design of the civil structure of the reactor building of unit 5 and unit 6 takes into account the external effects of air shock wave with pressure fronts of 30 kN/m² for 1s time.

The seismic hazard study was performed 20 years ago. So the question arises whether the results still fulfill the actual state-of-the-art in seismic hazard assessment for nuclear facilities. One aspect of this is whether a normalized response spectrum shape was applied and the spectra were determined by scaling the spectrum shape with the calculated PGA value.

According to the country peer review report of the ENSREG stress test ENSREG (2012), it was stated during the country visit that throughout the periodic updates of the seismic PSA and in the PSR, on the basis of the information available and verified, evaluations are made of the need of re-assessment of the seismic hazard on site. It is recommended in the country peer review report that this approach should continue in the future.

The Bulgarian National Action Plan BNRA (2012, SECTION 1.1) states that no need of additional measures was identified in the area of natural hazards and that the assessments of natural hazards are included in the periodic safety reviews, without providing specifics. Thus, the current state of the plans for seismic re-assessments in Bulgaria is not clear.

5.3.2 External Human Induced Events

Aircraft crash

It does not become clear from the presentation in EIA-REPORT (2013, CHAP. 6.2.1 AND CHAP. 2.3) to which extent the NNU will be designed to withstand a supposed crash of large passenger or military aircraft.

Leaks of hazardous fluids and gases

The conclusion in EIA-REPORT (2013, CHAP. 6.2.3) concerning potential impact due to facilities at the Kozloduy NPP is not fully comprehensible as relevant information is contained in a separate document which is not available.

The conclusion in EIA-REPORT (2013, CHAP. 6.2.4) concerning potential impact due to gas pipelines is also not fully comprehensible as relevant information is contained in a separate document which is not available.

Concerning explosions in storage facility No. 106 no results for the case that administrative fire protection rules are not (fully) followed are presented in the EIA-Report. It is not stated whether a probabilistic risk assessment has been conducted for explosions in this facility.

No considerations about the formation of pressure shock waves due to explosions outside the perimeter of the NPP and their possible impact on buildings of the NNU are contained in EIA-REPORT (2013, CHAP. 6.2.). In EIA-REPORT (2013, CHAP. 6.2.) there is no statement whether relevant impacts due to explosives transported next to the site (ships on the Danube or trucks) have to be taken into account. This is not in compliance with the requirements contained in IAEA (2002).

It is not stated in the EIA-Report whether the NNU should have a basic design against pressure shock waves due to external explosions. This is not understandable as it is stated in BG-NR (2011) that some buildings of Kozloduy 5 and 6 are designed to withstand the pressure on the front from an explosive shock wave equal to 30 kN/m² with up to 1 s duration. More information about the characteristic of the assumed shock wave is not available, the design values mentioned in BG-NR (2011) for Kozloduy 5 and 6 may be lower than the values which have been required for the design of German NPPs against the impact of shock waves due to chemical explosions BMI (1976).[6]

Fire

The conclusion in EIA-REPORT (2013, CHAP. 6.2.8) concerning potential impact due to external fires is not fully comprehensible as relevant information is contained in a separate document which is not available.

5.3.3 Other External Events

Off-site flooding

Based on the information provided in BG-NR (2011) the conclusion in EIA-REPORT (2013, CHAP. 6.2.6) that the Kozloduy NPP site is flood-proof is considered to be well-founded.

Additionally, it is stated in BG-NR (2011) and in the peer review country report ENSREG (2012) that in some buildings of the existing NPP, where the lowest elevation of rainwater or domestic sewer is below 32.93 m, water penetration from outside may be possible.

Extreme winds and tornadoes

In EIA-REPORT (2013, CHAP. 6.2.7) no information on the design basis values against wind load is presented. Therefore, it becomes not clear whether also loads due to tornadoes shall be covered, e.g. due to a design against other impacts (e.g. air pressure waves).

Other extreme meteorological impacts than wind and tornadoes or not discussed in the EIA-Report.

5.4 Questions

5.4.1 Seismic Hazard Assessment

Concerning the assessment of the seismic hazard, the following questions arise:

- *Which seismic hazard study (reference) was used as a basis of the environmental impact assessment?*
- *Which field studies were undertaken and which methods were applied in detail to identify main geological structures and to evaluate Neogene-Quarternary activities?*

[6] A linear rise of the overpressure at the building wall up to 45 kN/m^2 within 100 ms is assumed in BMI (1976).

- *What is the horizontal response spectrum for annual exceedance probability of 10^{-4} and which spectral shape has been applied? Have normalized standard spectra, scaled to 0.2 g, been used?*
- *Was one spectral shape used for all seismic sources or different ones for close and far distances?*
- *Would it be possible to provide us with the values of the vertical seismic motion considered for the site?*
- *Was an evaluation conducted to make sure that the seismic hazard assessment from 1991-1992 still fulfills the actual state-of-the-art in seismic hazard assessment for nuclear facilities (e.g. regarding model parameters, response spectra, consideration of uncertainties and assessment of local site effects)?*
- *Which evaluations have been performed in the course of the periodic updates of the seismic PSA and in the PSR, on the basis of the information available and verified, concerning the need of a re-assessment of the seismic hazard on the site?*
- *Are there current plans for re-assessment of seismic hazards at the Kozloduy site – either within the scopes of the periodic safety review for the existing units, or specifically for the new unit?*
- *Was it made sure, that new data about seismicity and tectonics (obtained in the last 20 years) could have not have a considerable influence on the seismic hazard results?*
- *The seismic hazard is given in peak ground accelerations for an annual exceedance probability of 10^{-2} and 10^{-4}. The resulting accelerations are 0.1 g and 0.2 g. To which fractile values of the hazard curve do these accelerations correspond (e.g. mean, 50% fractile)?*
- *How are local site effects taken into account (considering amplification due to soil resonance) and what are the shear wave velocity profiles at the sites?*
- *The EIA-Report states that "Three-component accelerograms (continuation 61 s), measuring the geological conditions on the site" are given in addition. How are these accelerograms used and are these accelerograms real earthquake registrations or synthetic time-histories? How are they obtained?*

5.4.2 External Human Induced Events

Aircraft crash

Concerning the possibility of aircraft crashes and the respective basic design of the NNU, the following questions arise:

- *Are there relevant risk contributions due to airways or airport approaches passing within 4 km of the site or air space usage within 30 km of the plant for military training flights?*
- *Is it justifiable, to conclude that aircraft crashes of type 3 ("crash at the site owing to air traffic in the main traffic corridors of regular Civil Aviation and traffic in the military flight zones") can be excluded when considering*
  - *Art. 30. (1) of the Bulgarian Regulation BNRA (2008) according to which it is not allowed to neglect sources of human induced hazards with a frequency of occurrence greater than or equal to 10^{-6} events per year,*

  - *the tentative value of 10^{-7}/a for a Screening Probability Level stated in IAEA (2002) and*
  - *the derived annual frequency for aircraft crashes of 5.66×10^{-7} (on an area of 0.5 km²) and of 1.13×10^{-6} (on an area of 1 km²) based on traffic data within 30 km of the site?*
- *To which extent will the NNU be designed to withstand a supposed crash of large passenger or military aircraft?*
- *Which loads shall be covered by the design (e.g. mechanical impacts in form of load-time curves, thermal impact as a consequence of burning fuel)? Which systems necessary for providing the basic safety functions shall be protected by adequate design strength of the respective buildings and which by redundancy in combination with physical separation of the respective buildings?*

Leaks of hazardous fluids and gases

Concerning the possible impacts due to hazardous fluids and gases, the following questions arise:

- *Would it be possible to provide information on the conducted analyses and their basic approach with respect to facilities at the Kozloduy NPP site and the planned gas pipelines?*
- *Would it be possible to provide information whether only single events were considered (e.g. a single failure of a storage facility) or also combinations of events like an interconnected cascade of destructions and subsequent explosions (e.g. a release of explosive gases because of foregoing fires or local explosions) with respect to the events listed in the EIA-REPORT (2013, CHAP. 6.2.3)?*
- *Would it be possible to provide information on the probabilistic assessment for the violation of administrative fire protection rules in storage facility No. 106?*
- *Were analyses conducted to find out whether relevant impacts from to explosives transported next to the site are possible (e.g. ships on the Danube or trucks) and need to be taken into account?*
- *Have analyses on the formation of pressure shock waves and their possible impact on buildings of the NNU due to explosions outside the perimeter of the NPP been conducted (e.g. due to pipelines or transportation of explosives)?*
- *Will the basic design of the NNU be required to withstand pressure shock waves? If this is the case: Would it be possible to specify the design values?*

Fire

Concerning the possible impacts due to external fire, the following question arises:

- Would it be possible to provide more information on the analyses conducted and their basic approach with respect to facilities at the Kozloduy NPP site and the planned gas pipelines?

5.4.3 Other External Events

Off-site flooding

Concerning the possible impacts due off-site flooding, the following question arises:

- Does the planning require to exclude an ingress of water into safety relevant buildings of the NNU via rainwater or domestic sewers by taking adequate design provisions?

Extreme winds and tornadoes

Concerning the possible impacts due to tornadoes and other meteorological conditions, the following questions arise:

- Will loads due to tornadoes be covered, e.g. due to a design against other impacts (e.g. air pressure waves)?
- Which design values will be assumed for the NNU concerning the full spectrum of meteorological impacts (i.e. the impacts treated within the ENSREG stress test)? What are the respective probabilities of exceedance?

6 ACCIDENT ANALYSIS

6.1 Treatment in the EIA-Report

The radiological consequences of accidents are treated in chapter 6 "Characteristics of the environmental risks from potential accidents and incidents" of the EIA-Report. In EIA-REPORT (2013), two types of accidents are considered:

- design basis accidents
- severe accidents involving significant core degradation

According to EIA-REPORT (2013, CHAP. 6), information and data provided by the Client have been studied and analyzed regarding:

- Analysis of the stability of the project in events involving a total loss of an ultimate heat sink and total loss of off-site power, reckoning with the requirements of ENSREG to stress tests in the light of the events in Fukushima;
- Evaluation of the probability of core degradation (with severe core damage frequency for the new reactor lower than 1.10-5 events per NPP per year);
- Evaluation of the probability of large radioactive releases (the frequency of large radioactive releases being lower than 1.10-6 events per NPP per year);
- Assessment of the performance of the unit in severe accidents, so that changes in core geometry would be limited, ensuring conditions for long-term fuel cooling;
- Description of the technical measures for emergency response;
- Comparative analysis of the proposed sites from the point of view of nuclear safety and radiation protection;
- Analysis of the proposed sites from the point of view of nuclear safety and radiation protection"

Subchapter 6.1.1.1 about emergency conditions starts with some general considerations about emergency conditions, design basis accidents and severe accidents. It is stated that "the requirements applied to the design of new power plants differ substantially from the old projects in terms of the expanded use of defence-in-depth both to prevent severe accidents and to mitigate their effects. A severe accident may occur only after a multiple failure of the systems of the power plant or of the personnel at the various independent levels of defence-in-depth, e.g. upon failure of the primary coolant system followed by a persistent failure of off-site and, after that, of on-site power as well." EIA-REPORT (2013, CHAP. 6.1.1.1)

It is mentioned in EIA-REPORT (2013, CHAP. 6.1.1.1) that new-generation nuclear power plants are equipped with special systems for management of severe accidents and are designed in such a way that the frequency of their occurrence should be less than 10^{-5} per reactor-year.

Concerning the integrity of the containment in case of a severe accident the EIA-Report points out that the containment is equipped with special systems to prevent the loss of its integrity due to different phenomena like hydrogen explosions, generation of internal missiles or overpressure. Heat removal from the degraded core and the containment ensures containment integrity for a long time after the onset of the accident. Furthermore it is stated that the types of reactors in question meet the criterion of limiting the frequency of a large radioactive release to the environment to values of less than 10^{-6} per reactor-year by an at least tenfold redundancy. According to EIA-REPORT (2013, CHAP. 6.1.1.1), the safety requirements to be applied to new reactors ensure that the radiological consequences of severe accidents are limited and do not require an evacuation of the populated area in the nearest environment of the NPP nor other urgent protective actions (sheltering, iodine prophylaxis) outside the emergency planning zones of the plant.

In chapter 6.1.1.2, the INES event classification scale is introduced and the number of events that occurred at the Kozloduy NPP site and were reported to the NRA in the years 2007 to 2011 is provided.

Chapter 6.1.2 treats the characteristics of the environmental risk of radiation and provides an overview of the different possibilities of exposure after a release of radioactive substances from a nuclear facility. Also, different kinds of protective actions are discussed. Finally, several types of interventions as different measures for dose limitation or prohibition of human settling depending on respective dose limits are presented.

Chapter 6.1.3 provides some information about the accident evaluation methods. The nuclide vector of the source (i.e. the quantity, isotopic composition and distribution in time of the radioactive substances which have escaped from the containment into the environment: source term) is qualitatively discussed. The general approach for the determination of the source term is described as follows: "The universally accepted conservative approach to safety analysis requires that the source be determined in such a way as the radiological effects corresponding to that source would be worse by a sufficient margin than the effects which, with an allowance for a certain uncertainty, would result from the later safety analyses for a specific reactor for the NNU. That is why the assumption of the radiological effects for the purposes of the environmental impact assessment may be more general, considering that it is made with a sufficient margin and that such an assessment for the specific project solution will be made in the Preliminary Safety Report."

The most important nuclides of the source term are presented in chapter 6.1.3.2 and their respective relevance for DBA and severe accidents is discussed. With respect to radioactive releases in the course of severe accidents, it is stated that the liberation of decay products from the molten fuel depends above all on their chemical and physical form. According to EIA-REPORT (2013, CHAP. 6.1.3.2) it is assumed that at the high temperature of the molten fuel, it liberates in the containment up to 75 – 100% radioactive noble gases, iodine and cesium (much less in case of a DBA). On the other hand, the release fraction of the rest of the radionuclides from the molten fuel into the containment is in the order of tenths of a percentage point to tens of percentage points.

The magnitude of radioactive releases to the environment in case of a severe accident strongly depends on the containment integrity. According to EIA-REPORT (2013, CHAP. 6.1.3.3) the quantitative determination of the source term assumes integrity of the containment: "The quantitative determination of the nuclide vector of the source proceeds from the prerequisite of preserved containment integrity, with an allowance for escapes through admissible design leakiness and the so-called bypass containments. This prerequisite is justified by the fact that in all units under consideration the containment is equipped with special systems so as to prevent a loss of its integrity even in severe accidents caused by any of the relevant phenomena."

For the determination of the radiological effects it is assumed that the radioactive release to the environment takes place at a constant rate in the course of six hours after the accident. The nuclides I-131 and Cs-137 are chosen as representatives for the whole source term (additionally Xe-133 for severe accidents).

According to EIA-REPORT (2013, CHAP. 6.1.3.3), the source term for Design Basis Accidents is based on the European Utility Requirements (EUR) for LWR Nuclear Power Plants applicable to a third-generation nuclear power plant. It is claimed that, according to EUR, the accident in question has a probability of occurrence approximating the value of 10^{-6}/year.

Table 6-1: Source term for design basis accidents

High-altitude emission (100 m)		**Ground level emission (45 m)**	
Radionuclide	**TBq**	**Radionuclide**	**TBq**
I-131	150	I-131	10
Cs-137	20	Cs-137	1.5

Concerning the source term for severe accidents it is pointed out in EIA-REPORT (2013, CHAP. 6.1.3.3) that account has been taken of the proportion of the inventory of radionuclides which has escaped from the damaged fuel in the containment according to the provisions of the U.S. Nuclear Regulatory Commission NUREG-1465 NRC (1995). According to EIA-REPORT (2013, CHAP. 6.1.3.3), the fraction of the nuclides that is released from the containment to the environment has been determined by using the requirements applied to the potential suppliers of the nuclear facility. The limit values for Xe-133, I-131 and Cs-137 have been determined on the basis of these requirements.

Table 6-2: Source term for severe accidents

Ground level emission (45 m)	
Radionuclide	**TBq**
Xe-133	770,000
I-131	1,000
Cs-137	30

For design basis accidents and severe accidents it is assumed that no excessive heat rise of the released particles above the assumed height of release (45 m and 100 m) occurs.

Further assumptions and results concerning the analyses to evaluate the spread of the released radioactive materials and the subsequent doses to the public are presented and discussed in chapter 7 of this report.

6.2 Discussion

The treatment of accidents (design basis accidents and severe accidents) in EIA-REPORT (2013) is very general. A significant amount of relevant information is not provided e.g.:

- List of design basis accidents considered,
- Effectiveness of special features of the NNU concerning prevention and mitigation of severe accidents,
- Scenarios for severe accidents.

It is claimed in the EIA-Report that a lot of technical information and data have been studied and analyzed. However, none of the points explicitly mentioned in the introduction to chapter 6 of the EIA-Report are subsequently further addressed. Especially no information is provided concerning

- -events involving a total loss of theultimate heat sink and total loss of off-site power, reckoning with the requirements of ENSREG to stress tests in the light of the events in Fukushima;
- -Evaluation of the probability of core degradation;
- -Evaluation of the probability of large radioactive releases;
- -Assessment of the performance of the unit in severe accidents;
- -Description of the technical measures for emergency response.

Also, no information is provided on how the lessons learned from Fukushima – beyond events involving a total loss of the ultimate heat sink and total loss of off-site power – have been taken into account. For example, there is no information on

- analysis of cliff-edge effects in case of natural hazards,
- provisions for use of mobile equipment,
- multi-unit accidents (only one new unit is to be built, but there are other units already at the site),
- accidents in SFP, possible parallel to reactor accidents,
- consideration of large-scale destruction of infrastructure, possibly for a longer time; this does not only concern power supply, but also accessibility of site for personnel etc.

In summary, the EIA-Report provides no comprehensible technical basis for an evaluation of design basis accidents and severe accidents.

The methodology for the quantification of the source terms in EIA-REPORT (2013, CHAP. 6.1.3.3) is explained only in a very general manner. Concerning the source term for design basis accidents it is claimed - with reference to the EUR - that the underlying accident has a probability of occurrence approximating the value of 10^{-6}/year. The term “approximating the value of 10^{-6}/year” cannot be unambiguously deduced from the EUR, therefore this statements is unclear.

With respect to possible consequences for Austria, primarily the source term for severe accidents is of interest. The source term for design basis accidents should be comparably small and in Austria no significant radiological impact has to be expected for DBA. The situation could be different for severe accidents. It depends on the details of the considered scenarios and especially on the integrity of the containment respectively on the effectiveness of the confinement function whether significant radioactive releases to the environment can be avoided or not.

Concerning the release of nuclides to the containment in case of severe accidents, it is stated in EIA-REPORT (2013, CHAP. 6.1.3.3) that results of NUREG-1465 (NRC 1995) have been used. Details on how this was done are not given. It remains unclear how the restraint explicitly stated in NRC (1995) that the source terms derived (particularly gap activity) may not be applicable for fuel irradiated to high burnup levels (in excess of about 40 GWD/MTU) has been taken into account.

There is no information on which severe accident scenarios have been considered and which severe accidents form the basis for the source term. E.g. it is unclear whether external events (e.g. earthquakes) beyond the design basis and the related conditional probabilities for equipment failures have been assessed. Furthermore, it is not stated whether core melt scenarios because of airplane crashes have to be taken into account (see also chapter 5 of this report). Aside from the general statement that the types of reactors in question meet the criterion of limiting the frequency of a large radioactive release to the environment to values of less than 10^{-6} per reactor-year by an at least tenfold redundancy, there is also no information on the frequency of different scenarios.

The source term for severe accidents presented in the EIA-Report seems fairly consistent with the assumption of an intact containment. The assumed release of 30 TBq of Cs-137 roughly corresponds to less than 0.01% of the total inventory of the reactor core of a 1,000 MWe unit. The release height of 45 m corresponds to a release from the reactor or an auxiliary building (not via the chimney). Together with the assumed zero value for the excessive heat rise of particles it favours a deposition of radioactive materials in the vicinity of the NNU. Concerning possible impacts to Austria a higher release height and/or non-zero excessive heat rise would be disadvantageous. However, release and excessive heat rise would have to be consistent with the considered severe accident scenarios. No information about these scenarios is given in the EIA-Report.

It is stated in EIA-REPORT (2013, CHAP. 6.1.3.3) that the source term is derived under the boundary condition that containment integrity is assured with an allowance for escapes through admissible design leakiness and the so-called bypass containments. It is further stated that this assumption is justified by the fact that in all units under consideration the containment is equipped with special systems to prevent a loss of its integrity, even in severe accidents caused by any of the relevant phenomena.

In general, it is plausible that source terms for reactors of newer-generation should be smaller than for older generations. The background behind this is that the newer designs are optimized with respect to the principal layout of safety systems as well as measures for prevention and mitigation of severe accidents. However, in the EIA-Report there is no information about the effectiveness of these measures. Also, it is not stated whether some phenomena have been judged to be irrelevant (e.g. reactor pressure vessel failure at high pressure). Furthermore, it remains unclear whether core melt scenarios originating from events with containment-bypass (e.g. steam generator tube rupture) were taken into account.

According to the analyses presented in NUREG-1465 (NRC 1995) around 75% of Cs inventory could be released to the containment in case of a core melt accident with low system pressure failure of the reactor pressure vessel. In this case, the release of less than 0.01% of the Cs-137 inventory that is assumed in the EIA-Report corresponds to a retention factor of > 7500. However, this retention factor is not further discussed in the EIA-Report. It is plausible for the case of intact containment; however, it is rather dubitable whether it is applicable for all scenarios which are not practically eliminated (see below).

The statement in EIA-REPORT (2013, CHAP. 6.1.3.3) that the release from the containment to the environment has been determined by using the requirements applied to the potential suppliers of the nuclear facility is not comprehensible as the respective requirements are not stated. However, it is notable that the source term for Cs-137 (30 TBq) corresponds exactly to the limit for a Cs-137 release in case of a severe accident according to the Bulgarian “Regulation on Ensuring the Safety of Nuclear Power Plants” BNRA (2008). This regulation is quoted at the beginning of chapter 6 of the EIA-Report, but the release limit for Cs-137 is not mentioned.

In summary, the technical basis for the source term remains unspecified.

The source term for severe accidents provided in EIA-REPORT (2013, CHAP. 6.1.3.3) can only be accepted as upper limit in case severe accident scenarios with higher releases (in particular, accident scenarios for which containment integrity is lost or with containment bypass) could be judged as practically eliminated in the sense of IAEA Specific Safety Requirements No. SSR-2/1 (IAEA 2012) (“The possibility of certain conditions occurring is considered to have been practically eliminated if it is physically impossible for the conditions to occur or if the conditions can be considered with a high level of confidence to be extremely unlikely to arise.”). A more detailed discussion of the term “practical elimination” and an outline for a demonstration of practical elimination are contained in the RHWG Report “Safety of new NPP designs” (RHWG 2013). There it is also stated that “practical elimination of an accident sequence cannot be claimed solely based on compliance with a general cut-off probabilistic value. Even if the probability of an accident sequence is very low, any additional reasonably practicable design features, operational measures or accident management procedures to lower the risk further should be implemented.”

As no information concerning

- accident scenarios and their frequency,
- the effectiveness of measures for prevention and mitigation of severe accidents and
- arguments to guarantee the necessary high confidence

is provided in the EIA-Report, radioactive releases larger than the source term in EIA-REPORT (2013, CHAP. 6.1.3.3) cannot be judged as practically eliminated at the moment.

6.3 Conclusions/Recommendations

Concerning the source term for design basis accidents, the statement with reference to the EUR that the underlying accident has a probability of occurrence approximating the value of 10^{-6}/year cannot be unambiguously deduced from the EUR. Therefore, it should be further explained.

The information provided in the EIA-Report is not sufficient for an assessment of potential radiological consequences due to severe accidents. Additional information concerning the technical background of the severe accident source term is necessary. Therefore, it cannot be confirmed that the source term for severe accidents presented in EIA-REPORT (2013, CHAP. 6.1.3.3) represents an upper limit.

6.4 Questions

Concerning the source term for design basis accidents, the following question arises:

- *What is the precise connection between the statement in the EIA-Report that the underlying accident has a probability of occurrence approximating the value of 10^{-6}/year and the EUR?*

Concerning the derivation of the source term for severe accidents and the question, whether it represents an upper limit, the following questions arise - as far as the answers are reactor-type specific they should be provided for each reactor type under consideration:

- *Which initiating events have been considered in the determination of possible core damage states? Have core damage states originating from events with containment-bypass been considered? Which design extension conditions (e.g. external events beyond the design basis) have been considered?*
- *What are the frequencies of the respective core damage states and the statistical confidence level of these frequencies?*
- *How have the releases rates provided in NRC (1995) been applied for the derivation of the source term? How has the possibility that the source terms derived in NRC (1995) may not be applicable for fuel irradiated to high burn-up levels (in excess of about 40 GWD/MTU) been taken into account?*
- *Which requirements have been applied to the potential suppliers of the nuclear facility with respect to the definition of the severe accident source term? In which way have these requirements been used for the determination of the fraction of nuclides released from the containment to the environment?*
- *How effective and robust are safety systems as well as measures for prevention and mitigation of severe accidents in case of different design extension conditions (e.g. external events beyond the design basis)?*
- *Which design basis and beyond design basis accident scenarios have been considered?*
- *What are the frequencies of scenarios with large early releases?*

- *Which values have been assumed concerning the efficiency of the retention of radioactive nuclides inside the plant? What is the technical justification for these values?*
- *Has the assumed release of Cs-137 (30 TBq) been taken directly from the “Regulation on Ensuring the Safety of Nuclear Power Plants” BNRA (2008)?*
- *Which accident scenarios and which plant respectively containment states have been judged to be practically eliminated?*
- *Which arguments guarantee the necessary high confidence for the scenarios or for the plant states respectively containment states which are judged to be practically eliminated?*
- *In which manner have the lessons learned from Fukushima been taken into account?*

7 TRANSBOUNDARY IMPACTS

7.1 Treatment in the EIA-Report

In chapter 11 of the EIA-REPORT (2013) the possible transboundary impacts of the project are treated. This chapter mostly deals with the transboundary impact on Romania, because the NNU will be located in close proximity to the territory of Romania (EIA-REPORT 2013, CHAP. 11.3). Chapter 11.3.3 summarizes the potential radiation risk in the Romanian part of the 30 km surveillance zone in the event of an accident.

In Chapter 6.1.3 the analyses of accident consequences are described in more detail. It is explained that the methodology of evaluation of an accident consists of the following steps: identification of the source term and subsequent calculation of the spread and environmental impact of the radioactive material (EIA-REPORT 2013, CHAP. 6.1.3). The identification of the source term is described and discussed in chapter 6 of the expert statement at hand.

In the EIA-REPORT (2013, CHAP. 6.1.3.4) it is mentioned that the projections of the radiological effects of accidents are based on the calculations made in the HAVAR-RP program. Two meteorological conditions have been chosen for the calculations. According to the EIA-REPORT (2013, CHAP. 6.1.3.4 and 11.3.3), these scenarios were chosen in such a manner that the modeled version would have the worst radiological outcomes. The scenarios that vary in wind speed, weather category and rain intensity are listed in table 7-1.

Table 7-1: Weather scenarios for the calculation of transboundary impacts on the Romanian territory

Weather scenario	**1**	**2**
Wind speed [m/s]	5	2
Atmosphere stability class	D	F
Rain [mm/h]	10	0

According to the EIA-REPORT (2013, CHAP. 6.1.3.5), weather scenario 1 has been selected for the assessment of the impact of a design basis accident. Both weather scenarios have been selected for modeling the effect of a severe accident, with long-term measures being modeled on the basis of scenario 1 involving precipitation which aggravates the short-range impact.

In the EIA-REPORT (2013, CHAP. 6.1.2) it is explained that the risk related to the potential effects of an uncontrolled release of radioactive material to the environment can be assessed according to the scope of the protective actions and to the extent of contamination of the affected environment. A distinction is made between urgent and long-term protective actions:

- Urgent protective actions are applied in the first hours and days after the occurrence of an accident (including sheltering and iodine prophylaxis).
- Longer-term protective actions are applied in the course of weeks, months or years after the accident (including temporary relocation or permanent resettlement, restriction of the consumption of food).

It is clarified that no intervention is made when the additional annual effective dose for the population is a) less than or equal to 1 mSv or b) less than or equal to 5 mSv, under the special circumstances that the annual effective dose will not exceed 1 mSv during the next five consecutive years. The intervention measures for different annual effective doses are described. In case the annual effective dose for the population is

- greater than the minimum intervention level but less than 10 mSv: measures are applied to limit the dose and to protect the population depending on the specific situation and circumstances;
- equal to or greater than 10 mSv, but less than 20 mSv: an intervention is undertaken to limit public exposure;
- greater than 20 mSv and less than or equal to 50 mSv: settling is not allowed and the permanent habitation of children and persons of reproductive age in the zone is prohibited;
- greater than 50 mSv: permanent habitation is prohibited.

In the EIA-REPORT (2013, CHAP. 6.1.4.2) the emergency planning zones around the Kozloduy NPP site are described as follows:

- On-site Emergency Planning Zone, the site of Kozloduy NPP EAD;
- Precautionary Action Planning Zone (PAZ), with a radius of 2 km and a geometric center between the ventilation stacks of Units 5 and 6:
- Urgent Protective Action Planning Zone (UPAZ) with a provisional radius of 30 km.

According to the EIA-Report, the designs of a reactor model for the NNU must be assessed against the requirements of EUR, taking account of several parameters:

- No emergency protection action[7] beyond 800 m from the reactor upon releases from the containment
- No delayed action[8] at any time beyond 3 km from the reactor
- Non-application of long-term action[9] beyond 800 m from the reactor

The existing 2 km PAZ may be modified, being expanded by some 300 m eastward in case the NNU is implemented on site 1 or 2. The new boundaries can be defined after selection of a specific reactor model and after a detailed analysis. The UPAZ is not expected to be modified in connection with the construction of a NNU. In all cases, after selection of a specific reactor model, an analysis to this end will be conducted.

---

[7] Actions involving public evacuation, based on projected doses up to seven days, which may be implemented during the emergency phase of an accident, e.g. during the period in which significant releases may occur. This period is usually shorter than 7 days. The sum total of soil and aerial releases during the whole period of releases must be checked against the reference values for each isotope: 131I - 4000 TBq; 137Cs - 30 TBq; 90Sr - 400 TBq

[8] Actions involving temporary public relocation based on projected doses up to 30 days, caused by ground shine and aerosol re-suspension, which may be implemented after the practical end of the release phase of an accident.

[9] Actions involving public resettlement, based on projected doses up to 50 years caused by ground shine and aerosol re-suspension. Doses due to ingestion are not considered in this definition.

In the EIA-REPORT (2013, CHAP. 6.1.3.7 and 11.3.3) it is concluded that the radiological results of the analyzed accidents, as evident from the conducted analyses, attest to the acceptability of the environmental risks. The results are summarized as follows:

The results of the assessment of design basis accidents show that, for a random hypothetical design accident, human exposure does not require the undertaking of any urgent protective actions, even within the closest inhabited zone around the NNU (EIA-REPORT 2013, CHAP. 11.3.3).

Chapter 6.1.3.6 describes and illustrates the results for severe accidents. Accordingly, urgent protective actions can be expected in case of a severe accident: The maximum size of the potential evacuation zone is 1 km. The maximum size of the potential shelter zone is 8 km.

The modeling of the radiological effects of severe accidents does not show any exceeding of the threshold values for the initiation of emergency protective measures outside existing emergency planning zones of Kozloduy NPP. As far as subsequent protective measures are concerned, even within the closest populated zone around the NNU no permanent resettlement is expected. It is highlighted that the threshold value of the 1 mSv dose would not be exceeded. The values of the effective doses of external exposure are presented in figures 6.1-7 and 6.1-10 of the EIA-REPORT (2013).

According to estimates, the contribution of ingestion to the total dose is approximately 71% at the boundary of the emergency planning zone at a distance of 12 to 14 km and up to 52% at a distance of 45 to 50 km. The shares of the separate exposure pathways in the lifetime dose are presented by the charts in Figures 6.1-8 and 6.1-9 (EIA-REPORT 2013, CHAP. 6.1.3.6).

It is summarized that, because more than half of the total exposure would happen along the pathway of ingestion, the introduction of a short-term restriction to the consumption of locally grown products would have a substantial impact on reducing the accumulated dose (EIA-REPORT 2013, CHAP. 11.3.3).

Transboundary impacts on the Austrian territory

In the EIA-REPORT (2013, CHAP. 11.4) the following requirement of the Austrian Ministry of Agriculture, Forestry, Environment and Water Management mentioned in the letter ref. no. 541402 of 26.06.2013 is discussed: "As regards the scope of the EIA, Austria expects the EIA-Report to provide complete analysis of major accidents with long-range impact."

Thus, Chap. 11.4.1 of the EIA-REPORT (2013) deals with the radiation risk for the Republic of Austria due to a major accident. As a start, it is emphasized that the distance to Austria is more than 750 km.

According to the EIA-REPORT (2013, CHAP. 11.4.1), "the estimates of the radiological consequences of major accidents are based on the system ESTE EU Kozloduy, which is adapted to reactors 5 and 6 of Kozloduy NPP and its purpose is to evaluate in parallel an emergency situation of the two reactors. ESTE EU Kozloduy contains a database of sources of releases calculated and prepared specifically for emergency response at units 5 and 6 of Kozloduy NPP. The database contains source terms related to spent fuel pools and accidents at different levels of damage to the containment (leaks in the containment)."

The EIA-REPORT (2013, CHAP. 11.4.1.1) presents the data inputs of the model. The source terms are as follows:

Table 7-2: Source terms for a severe accident

Radionuclide	TBq
Xe-133	770,000
I-131	1,000 (90% elementary, 5% aerosol, 5% organic)
Cs-137	30

The release time is assumed to be six hours. Two release heights (45 m and 100 m) are used for the dispersion calculations; a thermal super-elevation of the radioactive particle is not assumed. These parameters are the same as used for the calculation of the transboundary effects on Romanian territory, but the weather scenarios are different.

It is stated that typical weather conditions were used. Three different weather scenarios with the following parameters are given (EIA-REPORT 2013, CHAP. 14.1.1):

Table 7-3: Weather scenarios for the calculation of the transboundary impacts on Austrian territory

Weather scenario	1	2	3
Wind speed [m/s]	1	5	2
Atmosphere stability class	A	D	F
Rainfall [mm/h]	0	0	0

It is mentioned that the ESTE Kozloduy software was used to calculate prognoses and doses for each hour until the 168^{th} hour (7 days). Tabular data of radiation parameters is provided only for the points that are in the trace of the cloud up to 48 hours.

The forecast for 24 hours of the effective dose and effective thyroid dose for both adults and children are presented. Results are provided for four different distances: Kozloduy NPP site, PAZ (2 km), UPAZ (30 km) and the maximum distance for 48 hours, which is about 200 km.

The results are listed for each weather scenario in two tables divided for release height at 45 m and at 100 m.

According to the EIA-REPORT (2013, CHAP. 11.4.1.2), the analysis demonstrates that in any hypothetical design basic accident human exposure does not cause the need for adoption of any urgent protective measures.

Considering the radiological effects of major accidents, it is stated that the thresholds for urgent precautionary measures beyond the existing emergency planning zones of Kozloduy NPP were not exceeded within the calculations. However, the estimates demonstrated that protective measures must be applied as follows:

- On-site: Urgent protective measures – sheltering, evacuation, iodine prophylaxis, radiation control and use of personal protective equipment,

- in the 2 km precautionary protective action planning zone (PAZ) – sheltering, evacuation and iodine prophylaxis for children and adults,
- in the 30 km urgent protective action planning zone (UPAZ) – iodine prophylaxis for children and pregnant women;

At the distance of 200 km no protective measures are required. It is emphasized that the predicted values at the distance of 200 km are about 100 times lower than the criteria for the application of protective measures.

It is stated that in respect to Vienna (781 km by straight line from the Kozloduy site), the obtained estimates are lower than $1*10^{-9}$ Sv/h – a value multiple times lower than the natural background radiation and effective doses above the negligible dose of $1*10^{-5}$ Sv (10 µSv) are not expected (EIA-REPORT 2013, CHAP. 11.4.1.2).

The EIA-REPORT (2013, CHAP. 11.4.1.2) concludes: "The presented results, as can be concluded from the underlying analysis, confirm the absence of radiological risk to the Republic of Austria."

The reply to the above-mentioned requirement of the Austrian Ministry of Agriculture, Forestry, Environment and Water Management in letter ref. no. 541402 of 26.06.2013 says the same: "The presented results from modelling and analytical work demonstrate the absence of radiological risk to Austria" (EIA-REPORT 2013, CHAP. 11.4.1.2).

7.2 Discussion

As concluded in chapter 6 of the expert statement at hand, the information provided in the EIA-REPORT (2013) is not sufficient for an assessment of potential radiological consequences in Austria due to severe accidents. Basic information is missing. The source term for severe accidents provided in the EIA-REPORT (2013) can only be accepted as upper limit in case severe accident scenarios with higher releases could be judged as practically eliminated.

In general, information on the methods and results of probabilistic safety studies, accident analyses of the reactor types under consideration, and also concerning the safety requirements with regard to the concept of practical elimination, are missing (see chapters 4 and 6 of the expert statement at hand).

Only results of detailed safety assessments for the considered reactor type of the proposed NNU would permit to exclude a larger source term – in case it can be proven beyond doubt that such a larger source term cannot occur (practical elimination). Such results, however, are not yet available. Therefore, a source term for e.g. an early containment failure or containment bypass scenario should be analyzed as part of the EIA – in particular because of its relevance for long-range transport.

This statement is further underlined by a recently published report. In 2012, the Norwegian Radiation Protection Authority (NRPA) published a report concerning the potential consequences in Norway after a hypothetical accident at the new nuclear power plant Leningrad II. The plant under construction is of type AES-2006, which is one of the reactor types under consideration for the NNU. It is stated that the calculation was based on a catastrophic release of this NPP, i.e. the most severe radiological consequences that could occur as a result of a 'credible' accident scenario in a nuclear power plant of the latest design. The severe accident scenario was selected by Enconet based on a Level 2 PSA for a WWER-1000 reactor (V-320 model) (NRPA 2012).

The accident scenario (containment bypass) is initiated by a large break in the steam generator (40 mm). The emergency core cooling systems and the auxiliary feed water systems are assumed to be operable, the operator is successfully preventing steam generator (SG) overfilling, and the SG relief valve is operating normally. However, the fast cool-down and stabilization of the unit fails, leading to core melt. This is an accident sequence with bypass of the containment that involves early and late releases directly to the environment. Nevertheless, the source term is limited due to the retention in the primary system caused by a high flow in intact legs and intensive heat exchange and condensation in the SG. The authors noted that for the plants of the new designs the frequencies of accident scenarios that contribute to this release category are expected to be significantly reduced (below the frequency threshold of 1E-7/yr).

The radionuclide inventory of the core was based on Russian data derived for the original Soviet fuel. The source term of this scenario was calculated to 2,800 TBq (0.85% of core inventory) for Cs-137 and 26,700 TBq (0.85% of core inventory) for I-131 (NRPA 2012).

These source terms are considerably higher compared to those used in the EIA-REPORT (2013). However, as explained in chapter 4 of the expert statement at hand, the results of probabilistic studies are only of limited significance. Therefore, it would be problematic to exclude this accident scenario from consideration unless there are further arguments to demonstrate that it can be practically eliminated.

In the EIA-REPORT (2013) it is mentioned that the ESTE EU Kozloduy database contains source terms related to spent fuel pools and accidents at different levels of damage to the containment (leaks in the containment). From the Austrian experts´ point of view these source terms are of utmost interest.

It is not possible to exclude the fact that a large (early) release during a severe accident at the Kozloduy NPP site can affect the Austrian territory, despite the distance of about 700 km. Several studies as well as accidents have confirmed the long-term transportation of radioactive material. According to SEIBERT (ET AL. 2012), for example, substantial consequences of a severe accident are possible for distances of up to 500 to 1000 km.

After the Fukushima accident, several studies were performed in order to estimate the consequence of severe accident at nuclear power plants all over the world. Major reactor accidents of nuclear power plants are rare, yet the consequences are catastrophic. In a recently published study the cumulative global risk of exposure to radioactivity due to atmospheric dispersion of gases and particles following severe nuclear accidents (the most severe ones on the International Nuclear Event Scale, which are categorized to INES 7) is calculated, using particulate Cs-137 and gaseous I-131 as proxies for the fallout. A deposition of more than 40 kBq/m² is defined as "contaminated", following the definition by the IAEA. At this level, the human dose during the first year after the major accident is about 1 mSv and is considered to be radiologically important (LELIEVELD ET AL. 2012).

The results indicate that the occurrence of INES 7 major accidents and the risks of radioactive contamination have been underestimated in the past. The authors concluded: in the event of a major reactor accident of any nuclear power plant in the world, more than 90% of the emitted Cs-137 would be transported beyond 50 km and about 50% beyond 1000 km distance before being deposited. The results of this study corroborate that such accidents have large-scale and transboundary impacts (LELIEVELD ET AL. 2012).

Dispersion calculation

The EIA-Report states that "ESTE EU Kozloduy" is used for the dispersion and dose calculations. However, no references or further information for this program are provided in the EIA-Report.

Some information can be found in the internet: ESTE (Emergency Source Term Evaluation) is a name given to the group of programs which serve as instruments for source term evaluation and calculation of radiological impacts in case of a nuclear accident.[10] ESTE EU is an information system and software for radiological impacts assessment to the territory of the country in case of any radiation accident outside or inside the country. The system is implemented at the Czech State Office for Nuclear Safety. The database[11] of ESTE EU calculated and prepared by ABmerit (Trnava, Slovakia) contains source terms for emergency response purposes in case of severe accidents for every European power reactor. ESTE EU applies a Lagrangian puff or particle model. It can read meteorological fields as produced by meteorological models. It tracks releases for a maximum of 48 hours. There are specific ESTE versions to serve specific NPP installations (SMEJKALOVÁ ET AL. 2013).

According to the EIA-REPORT (2013), a version for ESTE EU Kozloduy was employed. However, information about this version is not available. It has to be pointed out that a description of the methods applied has to be included in any EIA-Report.

In principle, a Lagrangian puff model, and especially a Lagrangian particle model, should be able to correctly simulate long-range transport, diffusion and deposition. However, as detailed information of the model used by ESTE EU Kozloduy is not provided, it cannot be judged whether there are relevant limitations or simplifications. Furthermore, and this is confusing, the EIA-REPORT (2013) presents results from dispersion calculations with three weather scenarios. The parameters of these scenarios are given by stability class and wind speed as well as precipitation. However, a long-range dispersion model cannot be operated by this type of input parameters which is typical for Gaussian plume or simple Gaussian puff models. It can be supposed that the program

---

[10] ESTE EDU (Dukovany NPP) and ESTE ETE (Temelin NPP), for example, are implemented at the Czech State Office for Nuclear Safety and serve as basic instruments for the emergency staff in case of a nuclear incident/ accident. Modified versions of codes ESTE EDU v. Austria and ESTE ETE v. Austria are implemented at the Crisis Centre of Austrian Federal Ministry of the Environment (BMLFUW) in Vienna.

[11] The database is created in general format "xls" appropriate e.g. for the code ESTE, in the format "ST1" appropriate for PC Cosyma and in the format "F6" appropriate for the code RODOS v.6. All descriptions of the database are available in digital form.

ESTE EU Kozloduy has an option to use such a simple dispersion model and that this model was used. However, this would not be suitable to calculate consequences at distances of several hundred kilometers.[12]

In the EIA-REPORT (2013) it is mentioned that for the calculations of the transboundary impacts on the Austrian territory "typical" weather conditions were used. However, it would be more appropriate to use a worst case weather scenario. In the framework of the EIA procedure for Fennovoima´s new nuclear power plant the possible transboundary effects were evaluated. A source term of 100 TBq Cs-137 was used, which is also not justified from the point of Austrian experts´ view. However, the calculated Cs-137 deposition at a distance of 1,000 km for "unfavorable" weather conditions is about 1.3 kBq/m², which is more than four times higher compared to the results for "typical" weather conditions (0.28 kBq/m²) (UMWELTBUNDESAMT 2010).

Additionally, the use of only three weather scenarios is insufficient even in the case of a simple model to find the worst condition at a given location. All three weather scenarios selected are dry cases. Dry cases may deliver the highest dose under the assumptions that only short time doses are considered. Dry cases may also deliver higher doses compared to those wet cases in which precipitation would occur from the beginning of the release (and, thus, nearly all radionuclides are washed out before the plume will reach the Austrian territory.) However, different scenarios with precipitation are possible which would causes higher contamination in Austria compared to the scenarios used in the EIA-REPORT (2013).

Furthermore, only the calculated data for the distance of 200 km and only for an integration time of 24 hours are provided in the EIA-REPORT (2013). These results are not sufficient to judge the long-term consequences at larger distances.

It must be concluded that the documentation in the EIA-REPORT (2013) is not sufficient, neither for the applied dispersion model nor for the results. Thus, the presented consequences for Austria are not comprehensible. One additional remark: the presented distances to Austria and to Vienna are also not comprehensible. The distances to the border of Austria are about 700 km and to Vienna about 750 km.

The EIA-REPORT (2013, CHAP. 6.17) states that the designs of a reactor model for the NNU must also be assessed against the requirements of the EUR. The EIA-REPORT (2013) presents three criteria of the EUR requirements in table 6.1.7 (see above). However, the EUR (2012) include the following four "Criteria for Limited Impact":

1. for no emergency action beyond 800 m,
2. for no delayed action beyond 3 km,
3. for no long term actions beyond 800 m,
4. for economic impact.

[12] The authors thank Univ.-Prof. Dr. Petra Seibert (Institut für. Meteorologie u. Geophysik, Universität Wien) for her helpful advice concerning this issue.

Furthermore, it is explained in the EUR (2012) that each of the targets (1) to (3) shall be verified independently according to the following methodology:

- the releases from the plant to the atmosphere are broken down into the 9 reference isotope groups (which are listed in tables B1 to B3),
- these releases are combined and compared with one criterion according to a specific formula.

For the fourth target, only three reference isotopes are given. In the EIA-REPORT (2013, CHAP. 6.1.7) these three reference isotopes are mentioned for the requirement of target 1. All in all, it is not comprehensible why the methodology including the 9 reference isotope groups for each of the criteria is not mentioned as intended by the EUR (2012).

The results of the dispersion calculation for the 30 km zone (including Romanian territory) are not discussed in the expert statement at hand that deals with the possible transboundary impact on Austrian territory. However, according to the EIA-REPORT (2013, CHAP. 6.1.3.4) more area-specific factors are determined in calculating the individual doses in the area of location of the Kozloduy NPP; information on the location of the individuals and on the points at which food products for human consumption are produced. In the framework of the EIA procedure of Temelin 3/4 it was explained that the program (HAVAR RP) used specific information and data of the NPP Temelin site. Nevertheless, the results presented in the EIA-REPORT (2013) are the same – only the presented share of exposure pathways in a dose at a distance of 45-50 km and 12-14 km are interchanged.

Austrian analyses of transboundary impacts

For Austria, the safety and risk analysis of the new NPP is the most important issue of the transboundary EIA procedure. Accidents with a large release of radioactive substances into the atmosphere could affect the Austrian territory. Whether Austria could be significantly affected by a severe accident depends on the amount of radioactive substances released. The maximal source term is reactor specific, therefore the EIA-Report should present the maximal release in case of a severe accident and detailed information on the design and safety features of the NPP. This issue is discussed in chapters 4, 5 and 6 of the expert statement at hand.

Whether Austria could be significantly affected by a nuclear accident also depends on the weather conditions at the time of the accident. A study on behalf of the Austrian Federal Ministry of Agriculture and Forestry, Environment and Water Management analyzed the probability of weather conditions under which releases of severe accidents could affect Austrian territory to an extent that would require radiation protection measures for risk groups (children and pregnant woman (level 2)) and for the normal population (level 3), respectively (SEIBERT ET AL. 2004).

Transport, diffusion and deposition of the released substances were calculated using the Lagrangian particle dispersion model FLEXPART – a model suitable for mesoscale to global-scale calculations. The calculations were made for 88 different dates in the year 1995. This year has proved to be climatologically representative at least for the Alpine region. The source term for Cs-137, as a characteristic nuclide, was considered in the dispersion model. A source term of

67,500 TBq Cs-137 was used, which was assumed to be a large release due to a severe accident at a 1,000 MW_e pressurized water reactor. A simple conversion factor to derive dose estimates from the total Cs-137 depositions was applied. The calculated conditional probability of a release from the Kozloduy NPP site, which causes a significant impact to Austria, is in the range of 6.7 (level 3) to 10.1 percent (level 2). The levels applied in the study correspond to an effective dose during the first year after the accident of 2.5 mSv and 25 mSv, respectively (SEIBERT ET AL. 2004).

The probability of weather situations of this kind is relatively small, and it would be even smaller with lower source terms. However, this proves that an impact on Austrian territory due to a severe accident at the Kozloduy NPP site cannot be excluded.

As pointed out above, severe accidents with large early releases at the NNU cannot be excluded, although their calculated probability is below 1E-7/a. There is no convincing reason why such accidents should not be addressed in the EIA-Report; quite to the contrary, it would appear rather evident that they should be included in the assessment since their effects can be widespread and long-lasting, and Austria can be affected.

The calculations of the recently published flexRISK project can be used for the estimation of possible impacts of a severe accident at the proposed NNU at the Kozloduy NPP site (FLEXRISK 2013). The flexRISK project modeled the geographical distribution of severe accident risks arising from nuclear facilities, in particular nuclear power plants in Europe. Using source terms and accident frequencies as input, the large-scale dispersion of radionuclides in the atmosphere was simulated for different meteorological situations.

For each reactor, an accident scenario with a large release of nuclear material – usually rather unlikely to occur – was selected. The accident scenarios are core melt accidents with containment bypass or containment failure. To determine the possible radioactive release for the chosen accident scenarios, the specific known characteristics of each NPP were taken into consideration.[13]

Using the Lagrangian particle dispersion model FLEXPART, both radionuclide concentrations in the air and their deposition on the ground were calculated and visualized in graphs. The total cesium-137 deposition per square-meter (Cs-137 Bq/m²) is used as the contamination indicator.

For a severe accident at the Kozloduy unit 5 or 6, a Cs-137 source term of 54,460 TBq is evaluated. This source term corresponds to 20% of the core inventory (FLEXRISK 2013).

In the framework of the flexRisk project, the same source term is applied in case of a severe accident[14] at one of the reactor types under consideration for the NNU (AES-2006).

[13] Data was collected from plant-specific probabilistic safety analyses (PSA), the report of the International Atomic Energy Agency (IAEA), publications in journals, etc.

[14] STGR=steam generator tube rupture and obviously combined with more failures of safety systems than assumed by Enconet

The Cs-137 source term used in the flexRisk project is relatively high; however, even higher source terms cannot be excluded for example, in case of an airplane crash. As stated in chapter 5 of the expert statement at hand, it does not become clear from the presentation in the EIA-REPORT (2013) to which extent the NNU will be designed to withstand a crash of a large passenger or military aircraft.

In this context, it has to be pointed out that – in compliance with the preliminary assessment of the design of the AES-2006 carried out by the Finnish nuclear radiation protection authority STUK – the structural protection against airplane crashes is of special concern (STUK 2009). As already mentioned in chapters 4 and 5 of the expert statement at hand, the structural protection against a collision by a large commercial airplane focuses on the outer containment and on the fresh fuel storage. The safety buildings, however, are not designed to withstand the impact of a large airplane.

In the following, the results provided by the FlexRISK project are discussed. The results are also converted to the above-mentioned source term provided by the Norwegian Radiation Protection Authority for Cs-137 of 2,800 TBq (0.85% of core inventory) (NRPA 2012). From the point of the Austrian experts´ view, these source terms represent the range of source terms that should be used to calculate the transboundary impacts on the Austrian territory.

The results obtained by using the flexRISK source term show: For about 10% of the evaluated 88 real weather situations in 1995, the resulting Cs-137 depositions in Austria are above 20 kBq/m². The highest values are about 800 kBq/m². Note: Values above a deposition of 300 kBq/m², corresponding to an effective dose of 0.1 mSv during the first 7 days, mean a risk situation of level 1 in Austria ("Gefährdungslage 1") (SKKM 2010).

The results obtained by using the NRPA source term show: For about 10% of the evaluated 88 real weather situations in 1995, the resulting Cs-137 depositions in Austria are above 1 kBq/m². These values are higher than the threshold that triggered agricultural intervention measures (see below), i.e. Austria would be affected. The maximum value of the Cs-137 depositions is about 40 kBq/m². Note: According to the IAEA, as mentioned above, this value corresponds to a dose of 1 mSv in the first year and, thus, these areas are classified as "contaminated".

The scenarios with the most negative consequences for the Austrian territory are illustrated in Figure 7-1 and Figure 7-2.

Figure 7-1 presents the cesium-137 deposition in case of a severe accident at the Kozloduy unit 5 or the NNU under weather conditions similar to those on June 12, 1995. A large area shows Cs-137 depositions of about 100 kBq/m². Values up to 600 kBq/m² occur. Even for the NRPA source term, which is by a factor of about 20 smaller, Austria would be highly affected. Values up to 30 kBq/m³ are calculated, and a large area in the middle of the country shows values of about 5 kBq/m².

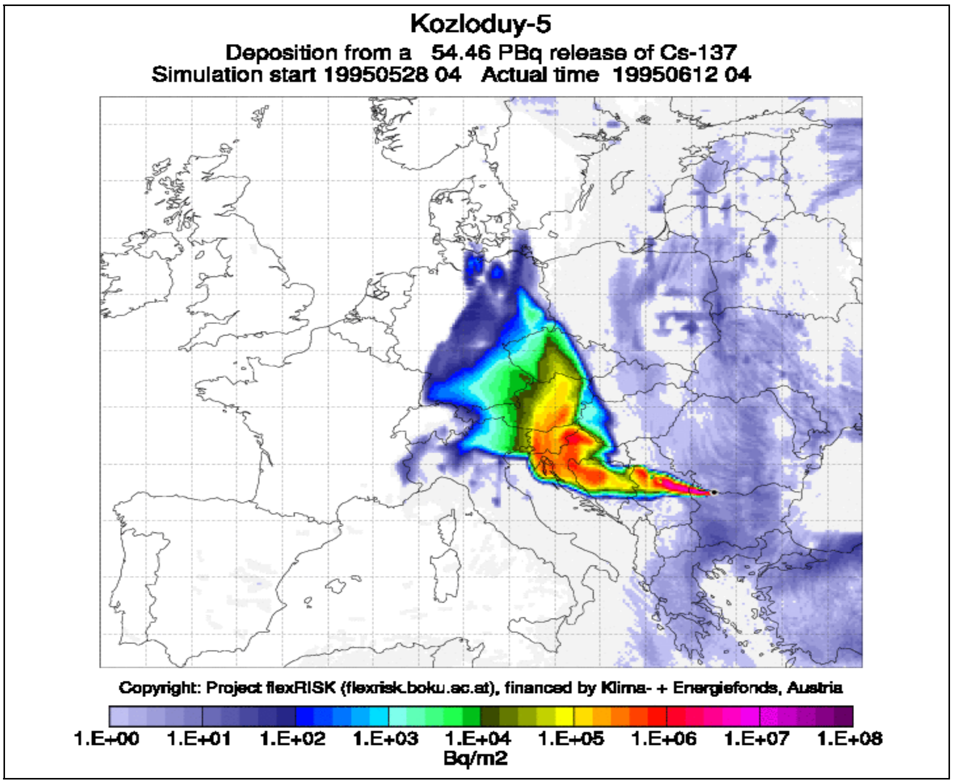


Figure 7-1: Cs-137 deposition in case of a severe accident at the Kozloduy NPP site (Example 1)

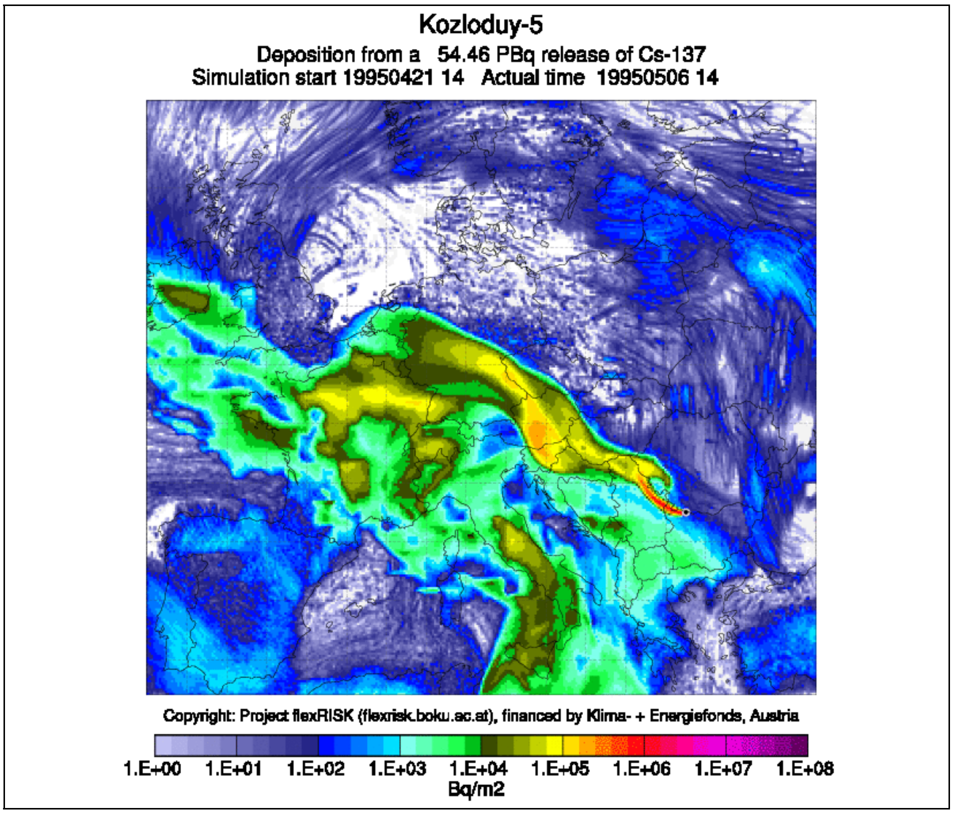


Figure 7-2: Cs-137 deposition in case of a severe accident at the Kozloduy NPP site (Example 2)

Figure 7-2 illustrates that many countries including Austria could be affected by a severe accident at the Kozloduy NPP site. For a potential Cs-137 release of 54,460 TBq under weather conditions comparable with those on April 21, 1995, a considerable contamination of the Austrian territory would result. Most parts of Austria show depositions of more than 10 kBq/m². The central part of the country would be contaminated with 100 to 200 kBq/m². The results show that, even if the source term is smaller by a factor of 20 – as used in the calculation of the Norwegian Radiation Protection Authority – the calculated Cs-137 depositions are above 1 kBq/m² and, thus, above the threshold that triggers agricultural intervention measures in Austria.

These measures include earlier harvesting, closing of greenhouses and covering of plants, putting livestock in stables etc. For these measures, Austrian and German authorities defined a threshold for Cesium-137 ground deposition of 650 Bq/m² (FLEXRISK 2013; SKKM 2010; SSK 2008). These agricultural measures are quite complex and take some time. Reactions are especially difficult if there is only very little time between the onset of an accident and the arrival of the first radioactive clouds (FLEXRISK 2013).

7.3 Conclusions/Recommendations

Severe accidents with releases considerably higher than 30 TBq Cs-137 cannot be excluded for the reactor types under consideration, even if their probability is below 1E-7/a. Although PSA results are of considerable value for the orientation of designers and regulators, such analyses are beset with considerable uncertainties. Additionally, some risk factors are difficult to include.

Only results of detailed safety assessments for the considered reactor type of the proposed NNU would permit to exclude a larger source term than 30 TBq – in case it can be proven beyond doubt that such a larger source term cannot occur (practical elimination). Such results, however, are not yet available. Therefore, a source term for e.g. an early containment failure or containment bypass scenario should be analyzed as part of the EIA – in particular because of its relevance for long-range transport.

Calculations of a severe accident at the Kozloduy NPP site with source terms used in the flexRISK project or in a study by the Norwegian Radiation Protection Authority (NRPA) show possible consequences for Austria, while with the release of 30 TBq Cs-137 such consequences would not be expected.

From the Austrian experts' point of view, it is recommended to provide the results of a severe accident with a large release, in addition to the limited release scenario presented in the EIA-REPORT (2013), since the effects can be widespread and long-lasting and even countries not directly bordering Bulgaria, like Austria, can be affected. Furthermore, it is recommended to provide information concerning the used programs. The justification for this program (ESTE EU Kozloduy) and for its input parameters should also be provided.

The information contained in the EIA-REPORT (2013) does not permit a meaningful assessment of the effects that conceivable accidents at the Kozloduy NPP site could have on Austrian territory. The analysis of a worst case scenario would close this gap and allow for a discussion of the possible impact on Austria. This should be taken into consideration in the further course of the procedures.

7.4 Questions

- *The EIA-Report (2013) mentions that the ESTE EU Kozloduy database contains source terms related to spent fuel pools and accidents at different levels of damage to the containment (leaks in the containment). From the Austrian experts´ point of view these source terms are of utmost interest. Would it be possible to provide those source terms?*
- *Would it be possible to provide source terms for accident scenarios in addition to those used in ESTE EU Kozloduy, which would include accidents in the spent fuel pools for the reactor type under consideration for the NNU with calculated large release frequencies (LRF) below 1*10E-7?*
- *Can information about the used program ESTE EU Kozloduy be provided? Why is the program ESTE EU Kozloduy and the used input parameters (including weather scenarios) considered to be appropriate for the calculation of the long-term effects for Austria?*
- *Can more information about the results of the dispersion calculation be provided? Why, for example, are only results for the distance of 200 km presented, whereas the distance for transport of the radioactive substances after 48 hours with wind velocities of 2 m/s or 5 m/s is about 346 km or 864 km, respectively?*
- *Is it envisaged to apply all four Criteria for Limited Impact of EUR as intended in EUR? Why are the specific Criteria for Limited Impact of EUR not quoted for the three cases considered in Table 6.1-7 of the EIA-Report (2013), but only the criteria for economic impact?*
- *Why are the calculated doses in case of the severe accident at the NPP Temelin 3&4 the same as those presented in the EIA-Report (2013) for the NNU?*

8 RADIOACTIVE WASTE MANAGEMENT

8.1 Treatment in the EIA-Report

The State Enterprise for Radioactive Waste (SE-RAW) is responsible for Radioactive Waste Management in Bulgaria.

The concrete plans on Radioactive Waste management are described in the Bulgarian "Strategy for Managing the spent nuclear fuel and radioactive Waste until 2030"- therefore, the content of the EIA-Report on RAW is not evaluated in detail – also only general questions are asked in the expert statement at hand.

Quantity of spent fuel

The total quantity of SNF generated during the operation of units 1-6 for the period 1974-2009 was about 1,880 tons of heavy metal. Units 5 and 6 currently produce about 38.7 tons heavy metal/year. (EIA-REPORT 2013, CHAP. 1.1.1.4.4)

For the NNU, estimated numbers of casks required for dry storage of SNF over the service lifetime of 60 years are given for the different reactor types. The numbers vary from 63 to 216 dry storage casks. (EIA-REPORT 2013, CHAP. 2.3.3 Table 2.3-5) The casks vary in capacity, the produced spent fuel elements will amount to approximately 2330 and approximately 4,100.

Interim/final storage of spent fuel

On the Kozloduy NPP site, a spent nuclear fuel storage facility (SNFSF) and a dry spent nuclear fuel storage facility (DSNFSF) have already been built. (EIA-REPORT 2013, CHAP. 1.1.1.2.1).

The **spent nuclear fuel pond** of the **SNFSF** is located south-west of units 3 and 4 and provides long-time temporary storage under water (EIA-REPORT 2013, CHAP. 1.1.1.2.1.4). (After being removed from the core, the spent fuel is left to cool in spent fuel ponds (SFP) at the reactors before being transferred to the SNFP.) The design capacity of the SNFSF is 5,040 fuel casks of WWER-440 - also casks of WWER-1000 can be stored (the term "cask" as used in the EIAR in this context seems to refer to fuel assemblies) (EIA-REPORT 2013, CHAP. 1.1.1.4.1).

Currently, a part of the spent nuclear fuel is transported to Russia (country of origin of the fuel) for **reprocessing**. If the fuel is transferred to Russia, it remains in the spent fuel ponds at the reactors for 5 instead of 3 years (EIA-REPORT 2013, CHAP. 1.1.1.4.1). Vitrified HLW capsuled in 170-liters canisters is returned to Bulgaria. For the SNF shipped 1998-2009 about 128 tons of HLW will be returned to Bulgaria after 2020 (EIA-REPORT 2013, CHAP. 1.1.1.4.4). In future, an **open fuel cycle** (no reprocessing) is envisaged. At the same time, SNF is considered "a usable resource, which may be processed to benefit the country", therefore the storage should keep the possibility of a future use open. (EIA-REPORT 2013, CHAP. 2.3.3).

The **dry spent nuclear fuel storage facility** (DSNFSF, permit for commissioning: 2011) site is located north-northwest of the SNFSF building. It uses casks for air cooled storage on the principle of natural convection (CONSTOR 440/84 type with a capacity of 84 fuel assemblies from WWER-440). It is an extension of temporary spent nuclear fuel storage in SNFSF. (EIA-REPORT 2013, CHAP. 1.1.1.2.1). Its purpose is to provide the necessary capacity for interim storage for the spent fuel from the decommissioned reactors and the operating reactors if needed. The storage period is no shorter than 50 years. (EIA-REPORT 2013, CHAP. 1.1.1.4.3) Stage 1 and 1a were designed to hold respectively 2,800 and 2,456 casks (probably meaning fuel assemblies, see above) from reactors WWER-440. (EIA-REPORT 2013, CHAP. 1.1.1.4.4)

For the **NNU**, different reactor types are considered – they all have spent fuel ponds with capacities sufficient for SNF storage over 10 years – this period of time is "considered sufficient for deciding the next steps to be taken in respect of SNF management". (EIA-REPORT 2013, CHAP. 2.3.3). The EIA-Report states that the "availability of a dry spent fuel storage facility for the proposed models is important, especially until a national decision for the future use of SNF is taken." Differences in the reactor types concerning dry storage solution are given. (EIA-REPORT 2013, CHAP. 2.3.3)

Final storage: The building of near-surface long-term repository with a period of administrative control not shorter than 100 years for HLW and medium active RAW category 2b is planned. However, "possible alternative solutions to the management of HLW and RW" are not to be refuted. (EIA-REPORT 2013, CHAP. 1.1.1.4.5) In Bulgaria, spent nuclear fuel is considered "a useable resource". (EIA-REPORT 2013, CHAP. 2.3.3)

Quantity of low and intermediate level waste (LILW)

The EIA-REPORT (2013, CHAP. 2.2) states that according to EUR requirements, the solid radioactive waste generated during operation, including conditioned liquid RAW, must not exceed 50 m³ per 1,000 MW of installed capacity on annual basis. The generated solid RAW will belong mainly to Category 1[15] and 2a[16]. No details on the expected LILW quantities of different reactor types are given.

Depending on the selected alternative for new nuclear capacity that would mean, according to the EIA-Report, conditioned RAW between 180 m³ and 250 m³ per year. The EIA-Report also states that compared to the flow of RAW produced by decommissioning units 1-4 the RAW produced by the NNU will be negligible over the next 16 years. (EIA-REPORT 2013, CHAP. 5.8.2)

Used classification system for LILW

The used classification system is described in EIA-REPORT (2013, CHAP. 11.3.7.2).

---

[15] transient RAW which can be released from control after appropriate treatment and/or temporary storage of no more than 5 years

[16] short-lived low and intermediate level waste, containing mostly short-lived radionuclides (with half-life shorter or equal to the half-life of Cs-137), and long-lived alpha-activity radionuclides with specific activity smaller than or equal to 4.10^6 Bq/kg for each individual package and smaller than or equal to 4.10^5 Bq/kg within the whole volume of RAW

Interim/final storage of LILW

Units 1 and 2 of Kozloduy NPP were decommissioned in 2002 and declared as radioactive waste management facilities in 2008. In 2010, NRA issued licences to the Radioactive Waste State Enterprise for the operation of those facilities. Units 3 and 4 were decommissioned in 2006, in 2013 NRA issued the operation licence as radioactive waste management facilities. In all four units, no spent nuclear fuel is stored. (EIA-REPORT 2013, CHAP. 1.1.1.2.1) Currently, untreated solid RAW and solidified liquid RAW concentrate are stored in units 1-4 (EIA-REPORT 2013, CHAP. 3.7.2). EIA-REPORT (2013, TABLE 3.7-7) gives a summary on current quantities of LILW stored in and capacities of LILW storage facilities.

A national long-term repository for RAW (NRRAW) for low and intermediate level short lived radioactive waste from NPP operation, decommissioning and other sources with a capacity of 138,200 m³ is planned, which is the expected amount for the “final disposal of conditioned low and intermediate level RAW generated during the operation, decommissioning of Kozloduy NPP and Belene NPP operation”. The first stage has to be completed by 2015. The near-surface facility could operate for a period of 60 years and is to provide the capacity for final disposal of all RAW expected to be generated till 2075. (EIA-REPORT 2013, CHAP. 3.7.2).

Existing/planned facilities for radioactive waste treatment

The RAW management activities cover preliminary treatment, treatment and storage of primary liquid and solid RAW. A detailed description of current LILW RAW treatment is given in EIA-REPORT (2013, CHAP. 3.7.2, CHAP. 11.3.8).

8.2 Discussion

According to Directive 2011/92/EU Annex IV a, description of the project, including an estimate, by type and quantity, of expected residues and emissions resulting from the operation of the proposed project is a compulsive requirement of an EIA-Report. Also, a description of the likely significant effects of the proposed project on the environment resulting from the emission of pollutants and the elimination of waste is necessary. Concerning RAW, thus, the following information has to be given in the EIA-Report:

a. Quantity of the spent fuel which arises per reactor year/within the operational lifetime of the NNU
b. Quantity of the LILW which arises per reactor year/ within the lifetime of the NNU including decommissioning – broken down according to their level of activity including the information on the used classification system used for RAW
c. Information on the amount and storage time of spent fuel in spent fuel pools

Ad. a) The EIA-Report gives information on estimated **SNF quantities**, but as the quantity of the SNF is highly dependent on the not yet selected reactor type no final numbers can be given at the moment. The SNF quantities vary between 63 to 216 dry storage casks.

Ad. b) Concerning **LILW quantities**, the same applies – conditioned LILW from 180 m³ to 250 m³ per year will be produced. It is not explained how this corresponds to the EUR which require generation of not more than 50 m^3 of LILW per 1000 MW per year. Furthermore, no information is given on which reactor types produces which quantity of LILW or on levels of activity.

Ad. c) Information of the amount and storage time of spent fuels that is stored in the spent fuel pool is necessary to evaluate consequences of possible beyond design basis accidents in the spent fuel pools.

The following additional information is useful to be able to evaluate the topic "Radioactive waste" adequately:

- Information about facilities for radioactive waste treatment (existing and planned) and their location on the site
- Information on the interim storage of spent fuel including the capacity of the storage facility and the planned storage period
- Information on the back end strategy for HLW (open or closed fuel cycle)
- Information on the current status of the search for/construction of a final depository for HLW

The EIA-Report gives mainly information on the existing facilities – a lot less detailed information is given on the NNU – the actual topic of the EIA:

- The question of SNF storage for the NNU is left open to decide later – although an open fuel cycle is envisaged, a closed fuel cycle has not been ruled out yet. Therefore, also the questions of interim and final storage are left open.

8.3 Conclusions/Recommendations

From the Austrian expert's point of view, more information on the expected quantities of RAW should be given – open questions concerning spent fuel should be either answered or a time schedule when these questions can be answered should be given.

8.4 Questions

- *When will the decision whether an open or closed fuel cycle will be implemented in future be taken?*
- *Interim storage of SNF in case of an open fuel cycle: Will the existing dry spent nuclear fuel storage facility (DSNFSF) be enlarged to accommodate the SNF from the NNU or will separate facilities be used? Will/can also the existing wet interim storage (spent nuclear fuel pond of the SNFSF) be used for the NNU?*
- *Long Term storage of HLW: What is the current status concerning the planned construction of a long-term repository with a period of administrative control not shorter than 100 years for HLW and medium active RAW category 2b mentioned in the EIA-Report (2013, Chap. 2.3.3)?*

- *Are the capacities of the current LILW interim waste storage facilities sufficient to accommodate the LILW from the NNU as well?*
- *What quantities of conditioned LILW will be produced by the different reactor types/which levels of activity?*

9 COMPILATION OF QUESTIONS

1. Introduction

1.1. *Could Information on participation rights for the public in Bulgaria and abroad in individual steps of the licensing process be given?*

2. Completeness of Documentation

no questions

3. Description of the Project

3.1. *Are WENRA documents for new reactors and the WENRA safety reference levels also to be taken into consideration with regard to the safety requirements for the NNU?*

3.2. *To which extent are the lessons learned from the Fukushima accident to be taken into account in the safety requirements and safety analyses for the NNU?*

3.3. *To which extent are the lessons learned from Fukushima already covered by the design of the candidate reactor types?*

3.4. *Is it possible to provide more information on analysis and assessments which have been or are planned to be performed to compare the four alter-native sites presented in the EIA-Report, especially those related to the safety of the NNU?*

4. Reactor Type

4.1. *Would it be possible to provide more detailed information on the safety systems of the reactor types under consideration, especially concerning passive core cooling system, passive containment cooling system, in-vessel retention measures for AP-1000 as well as the core catchers of the AES-92 and the AES-2006?*

4.2. *Would it be possible to provide information on the scope of the probabilistic analyses (in particular, plant states and event categories included) and the treatment of uncertainties in these analyses?*

4.3. *Would it be possible to provide more details regarding the differences between the two types of AES-2006 under consideration?*

4.4. *Is the concept of practical elimination applied in the safety requirements for the NNU?*

4.5. *Assuming that the concept of practical elimination is applied in the safety requirements for the NNU, which exact criteria are used to define that a condition or accident sequence is practically eliminated?*

4.6. *Would it be possible to provide information on assessments or analysis concerning the reliability and effectiveness of the safety systems of the reactor types under consideration?*

5. Site Evaluation incl. External Events Accident Analysis

Seismic Hazard Assessment

5.1. *Which seismic hazard study (reference) was used as a basis of the environmental impact assessment?*

5.2. Which field studies were undertaken and which methods were applied in detail to identify main geological structures and to evaluate Neogene-Quarternary activities?

5.3. What is the horizontal response spectrum for annual exceedance probability of 10-4 and which spectral shape has been applied? Have normalized standard spectra, scaled to 0.2 g, been used?

5.4. Was one spectral shape used for all seismic sources or different ones for close and far distances?

5.5. Would it be possible to provide us with the values of the vertical seismic motion considered for the site?

5.6. Was an evaluation conducted to make sure that the seismic hazard assessment from 1991-1992 still fulfills the actual state-of-the-art in seismic hazard assessment for nuclear facilities (e.g. regarding model parameters, response spectra, consideration of uncertainties and assessment of local site effects)?

5.7. Which evaluations have been performed in the course of the periodic updates of the seismic PSA and in the PSR, on the basis of the information available and verified, concerning the need of a reassessment of the seismic hazard on the site?

5.8. Are there current plans for re-assessment of seismic hazards at the Kozloduy site – either within the scopes of the periodic safety review for the existing units, or specifically for the new unit?

5.9. Was it made sure, that new data about seismicity and tectonics (obtained in the last 20 years) could have not have a considerable influence on the seismic hazard results?

5.10. The seismic hazard is given in peak ground accelerations for an annual exceedance probability of 10-2 and 10-4. The resulting accelerations are 0.1 g and 0.2 g. To which fractile values of the hazard curve do these accelerations correspond (e.g. mean, 50% fractile)?

5.11. How are local site effects taken into account (considering amplification due to soil resonance) and what are the shear wave velocity profiles at the sites?

5.12. The EIA-Report states that "Three-component accelerograms (continuation 61 s), measuring the geological conditions on the site" are given in addition. How are these accelerograms used and are these accelerograms real earthquake registrations or synthetic time-histories? How are they obtained?

External Human Induced Events – Aircraft crash

5.13. Are there relevant risk contributions due to airways or airport approaches passing within 4 km of the site or air space usage within 30 km of the plant for military training flights?

5.14. Is it justifiable, to conclude that aircraft crashes of type 3 ("crash at the site owing to air traffic in the main traffic corridors of regular Civil Aviation and traffic in the military flight zones") can be excluded when considering

- *Art. 30. (1) of the Bulgarian Regulation BNRA (2008) according to which it is not allowed to neglect sources of human induced hazards with a frequency of occurrence greater than or equal to 10^{-6} events per year,*
- *the tentative value of 10^{-7}/a for a Screening Probability Level stated in IAEA (2002) and*
- *the derived annual frequency for aircraft crashes of 5.66×10^{-7} (on an area of 0.5 km²) and of 1.13×10^{-6} (on an area of 1 km²) based on traffic data within 30 km of the site?*

5.15. To which extent will the NNU be designed to withstand a supposed crash of large passenger or military aircraft?

5.16. Which loads shall be covered by the design (e.g. mechanical impacts in form of load-time curves, thermal impact as a consequence of burning fuel)? Which systems necessary for providing the basic safety functions shall be protected by adequate design strength of the respective buildings and which by redundancy in combination with physical separation of the respective buildings?

External Human Induced Events – Leaks of hazardous fluids and gases

5.17. Would it be possible to provide information on the conducted analyses and their basic approach with respect to facilities at the Kozloduy NPP site and the planned gas pipelines?

5.18. Would it be possible to provide information whether only single events were considered (e.g. a single failure of a storage facility) or also combinations of events like an interconnected cascade of destructions and subsequent explosions (e.g. a release of explosive gases because of foregoing fires or local explosions) with respect to the events listed in the EIA-Report (2013, Chap. 6.2.3)?

5.19. Would it be possible to provide information on the probabilistic assessment for the violation of administrative fire protection rules in storage facility No. 106?

5.20. Were analyses conducted to find out whether relevant impacts from to explosives transported next to the site are possible (e.g. ships on the Danube or trucks) and need to be taken into account?

5.21. Have analyses on the formation of pressure shock waves and their possible impact on buildings of the NNU due to explosions outside the perimeter of the NPP been conducted (e.g. due to pipelines or transportation of explosives)?

5.22. Will the basic design of the NNU be required to withstand pressure shock waves? If this is the case: Would it be possible to specify the design values?

External Human Induced Events – Fire

5.23. Would it be possible to provide more information on the analyses conducted and their basic approach with respect to facilities at the Kozloduy NPP site and the planned gas pipelines?

Other External Events – Off-site flooding

5.24. Does the planning require to exclude an ingress of water into safety relevant buildings of the NNU via rainwater or domestic sewers by taking adequate design provisions?

Other External Events – Extreme winds and tornadoes

5.25. Will loads due to tornadoes be covered, e.g. due to a design against other impacts (e.g. air pressure waves)?

5.26. Which design values will be assumed for the NNU concerning the full spectrum of meteorological impacts (i.e. the impacts treated within the ENSREG stress test)? What are the respective probabilities of exceedance?

6. Accident Analysis

6.1. What is the precise connection between the statement in the EIA-Report that the underlying accident has a probability of occurrence approximating the value of 10-6/year and the EUR?

6.2. Which initiating events have been considered in the determination of possible core damage states? Have core damage states originating from events with containment-bypass been considered? Which design extension conditions (e.g. external events beyond the design basis) have been considered?

6.3. What are the frequencies of the respective core damage states and the statistical confidence level of these frequencies?

6.4. How have the releases rates provided in NRC (1995) been applied for the derivation of the source term? How has the possibility that the source terms derived in NRC (1995) may not be applicable for fuel irradiated to high burn-up levels (in excess of about 40 GWD/MTU) been taken into account?

6.5. Which requirements have been applied to the potential suppliers of the nuclear facility with respect to the definition of the severe accident source term? In which way have these requirements been used for the determination of the fraction of nuclides released from the containment to the environment?

6.6. How effective and robust are safety systems as well as measures for prevention and mitigation of severe accidents in case of different design extension conditions (e.g. external events beyond the design basis)?

6.7. Which design basis and beyond design basis accident scenarios have been considered?

6.8. What are the frequencies of scenarios with large early releases?

6.9. Which values have been assumed concerning the efficiency of the retention of radioactive nuclides inside the plant? What is the technical justification for these values?

6.10. Has the assumed release of Cs-137 (30 TBq) been taken directly from the "Regulation on Ensuring the Safety of Nuclear Power Plants" BNRA (2008)?

6.11. *Which accident scenarios and which plant respectively containment states have been judged to be practically eliminated?*

6.12. *Which arguments guarantee the necessary high confidence for the scenarios or for the plant states respectively containment states which are judged to be practically eliminated?*

6.13. *In which manner have the lessons learned from Fukushima been taken into account?*

7. Transboundary Impacts

7.1. *The EIA-Report (2013) mentions that the ESTE EU Kozloduy database contains source terms related to spent fuel pools and accidents at different levels of damage to the containment (leaks in the containment). From the Austrian experts´ point of view these source terms are of utmost interest. Would it be possible to provide those source terms?*

7.2. *Would it be possible to provide source terms for accident scenarios in addition to those used in ESTE EU Kozloduy, which would include accidents in the spent fuel pools for the reactor type under consideration for the NNU with calculated large release frequencies (LRF) below 1*10E-7?*

7.3. *Can information about the used program ESTE EU Kozloduy be provided? Why is the program ESTE EU Kozloduy and the used input parameters (including weather scenarios) considered to be appropriate for the calculation of the long-term effects for Austria?*

7.4. *Can more information about the results of the dispersion calculation be provided? Why, for example, are only results for the distance of 200 km presented, whereas the distance for transport of the radioactive substances after 48 hours with wind velocities of 2 m/s or 5 m/s is about 346 km or 864 km, respectively?*

7.5. *Is it envisaged to apply all four Criteria for Limited Impact of EUR as intended in EUR? Why are the specific Criteria for Limited Impact of EUR not quoted for the three cases considered in Table 6.1-7 of the EIA-Report (2013), but only the criteria for economic impact?*

7.6. *Why are the calculated doses in case of the severe accident at the NPP Temelin 3&4 the same as those presented in the EIA-Report (2013) for the NNU?*

8. Radioactive Waste Management

8.1. *When will the decision whether an open or closed fuel cycle will be implemented in future be taken?*

8.2. *Interim storage of SNF in case of an open fuel cycle: Will the existing dry spent nuclear fuel storage facility (DSNFSF) be enlarged to accommodate the SNF from the NNU or will separate facilities be used? Will/can also the existing wet interim storage (spent nuclear fuel pond of the SNFSF) be used for the NNU?*

8.3. Long Term storage of HLW: What is the current status concerning the planned construction of a long-term repository with a period of administrative control not shorter than 100 years for HLW and medium active RAW category 2b mentioned in the EIA-Report (2013, Chap. 2.3.3)?

8.4. Are the capacities of the current LILW interim waste storage facilities sufficient to accommodate the LILW from the NNU as well?

8.5. What quantities of conditioned LILW will be produced by the different reactor types/which levels of activity?

10 REFERENCES

BG-NR (2011): EUROPEAN "STRESS TESTS" FOR NUCLEAR POWER PLANTS: National Report of Bulgaria, Nuclear Regulatory Agency, December 2011.

BMI (1976): Richtlinie für den Schutz von Kernkraftwerken gegen Druckwellen aus chemischen Reaktionen durch Auslegung der Kernkraftwerke hinsichtlich ihrer Festigkeit und induzierter Schwingungen sowie durch Sicherheitsabstände, Bek. des BMI v. 1.8.1976 - RS I 4 - 513 145/1-.

BMLFUW (2011): Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft: Gesamtstaatlicher Interventionsplan für radiologische Notstandssituationen; Zwischenfälle in kerntechnischen Anlagen; Dezember 2011.

BNRA (2008): REGULATION ON ENSURING THE SAFETY OF NUCLEAR POWER PLANTS, published SG, No. 66 of 30 July 2004, amended SG No. 46 of 12 June 2007, and amended SG No. 53 of 10, Nuclear Regulatory Agency, June 2008.

BNRA (2012): Bulgarian Nuclear Regulatory Authority, European Stress Tests: National Action Plan of Bulgaria, December 2012.

BONČEV et al. (1982): Bončev, E.K.; Bune, V.I.; Christoskov, L.; Karagjuleva, J.; Kostadinov, V.; Reisner, G.J.; Rizhikova, S.; Shebalin, N.V.; Sholpo, V.N.; Skerova, D. (1982): A method for compilation of seismic zoning prognostic maps for the territory of Bulgaria. – Geologia Balcanica, 12. 2, pp. 3-48, Sofia, Jun. 1982.

CEZ (2010): Umweltverträglichkeitserklärung (CEZ 2010): Neue Kernkraftanlage am Standort Temelín einschließlich der Ableitung der Generatorleistung in das Umspannwerk mit Schaltanlage Kocin - Dokumentation der Umweltverträglichkeit des Vorhabens; erstellt im Sinne von § 8 und Anlage Nr. 4 Gesetz Nr. 100/2001 Slg. über die Umweltverträglichkeitsprüfung in der geltenden Fassung, Mai 2010.

DABOVSKI et al. (2002): ‚C., Boianov, I.; Khrischev, Kh.; Nikolov, T.; Sapunov, I.; Yanev, Y. & I. Zagorchev (2002): Structure and Alpine evolution of Bulgaria. -- Geologica Balcanica, 32, 2-4, 9-15.

EIA-REPORT (2013)/CONSORTIUM DICON – ACCIONA ING (2013): Environmental Impact Assessment Report for Investment Proposal: BUILDING A NEW NUCLEAR UNIT OF THE LATEST GENERATION AT THE KOZLODUY NPP SITE. Consortium Dicon – Acciona Ing.

ENSREG (2012): Bulgaria peer review country report – Stress tests performed on European nuclear power plants, European Nuclear Safety Regulators Group Stress Test Peer Review Board, 2012.

ENSREG (2012): Compilation of Recommendations and Suggestions, peer review of stress tests performed on European nuclear power plants. European Nuclear Safety Regulators Group. February 2012.

ENSREG (2013): ENSREG National Action Plans Workshop, Summary Report. European Nuclear Safety Regulators Group. Juni 2013.

EUR (2012): European Utility Requirements for LWR Nuclear Power Plants; Volume 2; Generic nuclear island and requirments; chapter 1 Safety requiments, Revision D; October 2012.

FLEXRISK (2013): http://flexrisk.boku.ac.at/en/index.html

GPR (2000): Technical Guidelines for the Design and construction of the next generation of nuclear power plants with pressurized water reactorsv - Adopted during the French Groupe Permanent chargé des Réacteurs nucléaires (GPR) / German experts plenary meetings held on October 19th and 26th 2000; http://www.french-nuclear-safety.fr/index.php/content/view/full/32525 download 11/2013.

HIRSCH et al. (2012): Schwere Reaktorunfälle – wahrscheinlicher als bisher angenommen: Grenzen und Möglichkeiten von probabilistischen Risiko-Analysen (PRA). Neustadt a. Rbge., Februar 2012.

IAEA (2002): External Human Induced Events in Site Evaluation for Nuclear Power Plants, SAFETY GUIDE No. NS-G-3.1, International Atomic Energy Agency, 2002.

IAEA (2004): Design of Reactor Containment Systems for Nuclear Power Plants - Safety Standards Series No. NS-G-1.10. International Atomic Energy Agency. Vienna, 2004.

IAEA (2011): Status Report 108 – VVER-1200 (V-491). International Atomic Energy Agency, Advanced Reactors Information System (ARIS). August 2011. URL: http://www.iaea.org/NuclearPower/Downloadable/aris/2013/36.VVER-1200(V-491).pdf

IAEA (2012): Safety of Nuclear Power Plants: Design, IAEA Specific Safety Requirements No. SSR-2/1, International Atomic Energy Agency, 2012.

LELIEVELD et al. (2012): J. Lelieveld, D. Kunkel, and M. G. Lawrence: Global risk of radioactive fallout after major nuclear reactor accidents, Atmos. Chem. Phys., 12, p. 4245–4258, 2012.

LEYDECKER et al (2008): Leydecker, G., Busche, H., Bonjer, K.-P., Schmitt, T., Kaiser, D., Simeonova, S., Solakov, D., & L. Ardeleanu (2008): Probabilistic seismic hazard in terms of intensities for Bulgaria and Romania – updated hazard maps. -- Nat. Hazards Earth Syst. Sci., 8, 1431–1439, 2008 (www.nat-hazards-earth-syst-sci.net/8/1431/2008).

NRC (1995): Accident Source Terms for Light-Water Nuclear Power Plants, NUREG-1465, U.S. Nuclear Regulatory Commission, 1995.

NRPA (2012): Statens strålevern: Potential consequences in Norway after a hypothetical accident at Leningrad nuclear power plant; Potential release, fallout and predicted impacts on the environment; Norwegian Radiation Protection Authority; June 2012.

RHWG (2013): "Report – Safety of new NPP designs", Study by Reactor Harmonization Working Group, March 2013.

SEIBERT et al. (2004): Seibert, P.; Frank, A.; Formayer, H. (Universität für Bodenkultur Wien, Institut für Meteorologie), Wenisch, A. & G. Mraz, (Österreichisches Ökologie-Institut)Entwicklung von Entscheidungskriterien betreffend die Beteiligung an UVP-Verfahren entsprechend der Espoo-Konvention, im Auftrag des BMLFUW, Wien, 2004.

SEIBERT et al. (2012): Seibert, P.; Arnold, D.; Mraz, G.; Arnold, N.; Gufler, K., Kromp-Kolb, H., Kromp, W.; Sutter, P. & Wenisch, A. (2012): Severe accidents of nuclear power plants in Europe: possible consequences and mapping of risk. Extended Abstracts, 4th International Disaster and Risk Conference IDRC, Davos, 26-30 August 2012.

SKKM – Staatliches Krisen- und Katastrophenschutzmanagement (2010): Probenahmeplan. Organisation und Durchführung von Probenahmen bei großräumiger radioaktiver Kontamination; AG Proben des SKKM; Wien 5. Oktober 2010.

SMEJKALOVÁ ET AL. (2013): Eva Smejkalová, Peter Čarný, Dušan Suchoň, Miroslav Chylý: ESTE – Systems for Response to the Nuclear Accidents and Evaluation of Radiological Impacts, GIS Ostrava 2010; 24. - 27. 1. 2010, Ostrava; http://gis.vsb.cz/GIS_Ostrava/GIS_Ova_2010/sbornik/Lists/Papers/EN_1_22.pdf

SSK – Strahlenschutzkommission (2008): Übersicht über Maßnahmen zur Verringerung der Strahlenexposition nach Ereignissen mit nicht unerheblichen radiologischen Auswirkungen. Überarbeitung des Maßnahmenkatalogs Band 1 und 2. Empfehlung der Strahlenschutzkommission; Bonn 29. August 2008.

STUK – Finnish Radiation and Nuclear Safety Authority (2009): Preliminary Safety Assessment of the Loviisa 3 Nuclear Power Plant Project; Radiation and Nuclear Safety Authority; September 30, 2009.

UMWELTBUNDESAMT (2010): Wenisch, A.; Hirsch, H. & Wallner, A.: NPP Fennovoima, Bilateral Consultation, January 28th 2009, Helsinki. Reports, Bd. REP-0215, Umweltbundesamt; Vienna, 2010.

WENRA (2010): WENRA Statement on Safety Objectives for New Nuclear Power Plants. Western European Nuclear Regulator's Association. November 2010.

WENRA (2013): WENRA Safety Reference Levels for Existing Reactors, update in relation to lessons learned from TEPCO Fukushima Dai-ichi Accident. Western European Nuclear Regulators' Association. November 2013.

WENRA-RHWG (2008): WENRA Reactor Safety Reference Levels. Western European Nuclear Regulators' Association – Reactor Harmonization Working Group. January 2008.

WENRA-RHWG (2009): Safety Objectives for New Power Reactors. Western European Nuclear Regulators' Association – Reactor Harmonization Working Group. December 2009.

WENRA-RHWG (2012): Safety of New NPP Designs - Draft 9. October 2012.

WENRA-RHWG (2013): Report in Safety of New NPP Designs. Western European Nuclear Regulator's Association – Reactor Harmonization Working Group. March 2013.

11 GLOSSARY

AC ....Alternating Current

ASUNE ....Act on Safe Use of Nuclear Energy

BDBA..................Beyond Design Basis Accident

BNRA ....Bulgarian Nuclear Regulatory Authority

Bq ....Becquerel

Chap. ....Chapter

CDF ....Core Damage Frequency

Cs ....Cesium

DBA ....Design Basic Accident

DBE ....Design Base Earthquake

DC ....Direct Current

DG ....Diesel Generator

DSNFSF ....Dry Spent Nuclear Fuel Storage Facility

EIA......................Environmental Impact Assessment

EPR ....European Pressurized Reactor

ESTE ....Emergency Source Term Evaluation

EUR....................European Utility Requirements

g ....Acceleration of free fall

HLW ....High Level Waste

I ....Iodine

I&C ....Instrumentation and Control

IAEA ....International Atomic Energy Agency

IEC ....International Electrotechnical Commission

IP ....Investment Proposal

km/h....................Kilometers per hour

kN/m² ....kiloNewton per square meter

LERF ....Large Early Release Frequency

LILW ....Low and Intermediate Level Waste

LRF.....................Large Release Frequency

LWR ....Light Water Reactor

ms.......................milliseconds

MSK scale ....Medwedew-Sponheuer-Karnik scale

MW ....Megawatt

MWL ....Maximum Water Level

NF .... Nuclear Fuel

NNU .... New Nuclear Unit

NPP.................... Nuclear Power Plant

NRA .... Nuclear Regulatory Agency of Bulgaria

NRPA .... Norwegian Radiation Protection Authority

OPL .... Overhead Power Lines

PAZ .... Precautionary Action Planning Zone

PGA .... Peak Ground Acceleration

PSA .... Probabilistic Safety Analysis

PSA .... Probabilistic Safety Assessment

PWR................... Pressurized Water Reactor

RAW................... Radioactive Waste

RHWG................ Reactor Harmonization Working Group

RPV.................... Reactor Pressure Vessel

RWM .... Radioactive Waste Management

SDV.................... Screening Distance Value

SE .... State Enterprise

SF .... Spent Fuel

SFP .... Spent Fuel Pool

SG .... Steam Generator

SL....................... Seismic Level

SNF .... Spent Nuclear Fuel

SNFSF .... Spent Nuclear Fuel Storage Facility

SPL .... Screening Probability Value

SRL .... Safety Reference Levels

SSE .... Save Shutdown Earthquake

STGR .... Steam Generator Tube Rupture

STUK .... Finnish Nuclear Regulatory Authority

TBq .... Tera-Becquerel

UPAZ .... Urgent Precautionary Action Planning Zone

UPS.................... Uninterruptible Power Supply

WENRA.............. Western European Nuclear Regulators Association

WWER .... Water-Water-Power-Reactor, Pressurized Reactor originally developed by the Soviet Union

WWTP................ Waste Water Treatment Plant

Xe....................... Xenon

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
Umweltmanagement
REG.NO. AT- 000484

ISBN 978-3-99004-254-0