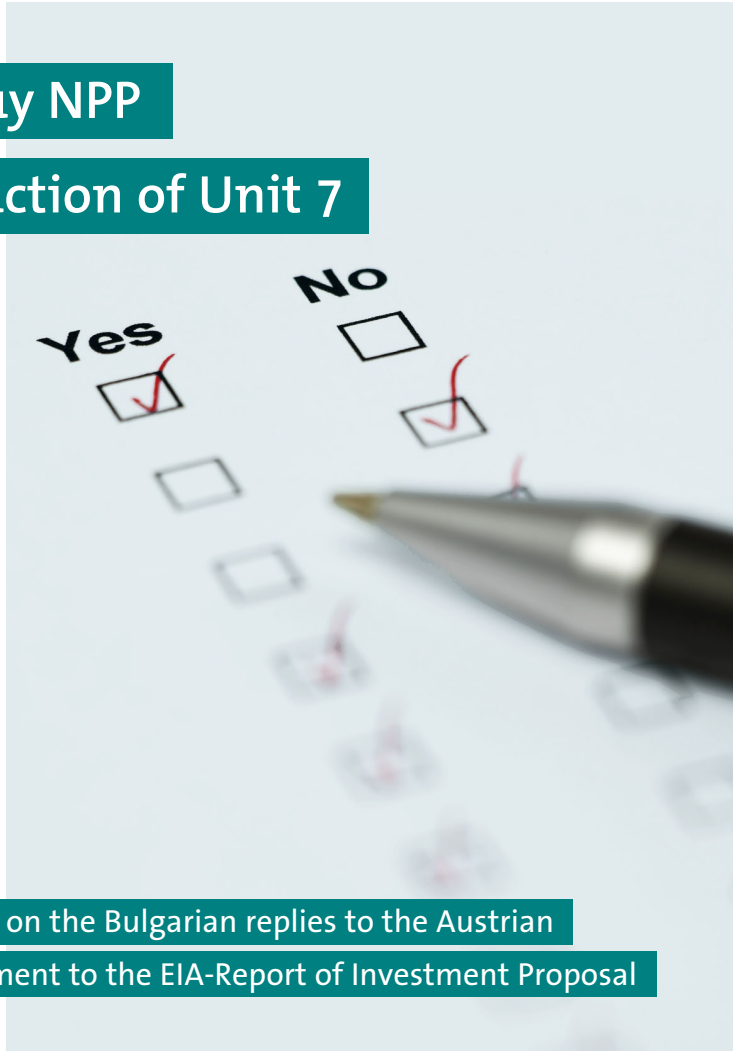
PERSPEKTIVEN FÜR UMWELT & GESELLSCHAFT umweltbundesamt

Kozloduy NPP

Construction of Unit 7



MINISTERIUM FÜR EIN LEBENSWERTES ÖSTERREICH

ÖSTERREICHISCHES ÖKOLOGIE INSTITUT

Report based on the Bulgarian replies to the Austrian Expert Statement to the EIA-Report of Investment Proposal

ENVIRONMENT AGENCY AUSTRIA umweltbundesamt

KOZLODUY NPP – CONSTRUCTION OF UNIT 7

Report based on the Bulgarian replies to the Austrian Expert Statement to the EIA-Report of Investment Proposal

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

ÖSTERREICHISCHES ÖKOLOGIE INSTITUT

REPORT
REP-0478

Vienna 2014

Project lead

Franz Meister, Umweltbundesamt

Authors in alphabetical order

Dipl.-Phys. Oda Becker
Dipl.-Math. Mathias Brettner
Dr. Helmut Hirsch, cervus nuclear consulting
Adhipati Y. Indradiningrat, cervus nuclear consulting
Mag. Andrea Wallner, Austrian Institute of Ecology

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 978-3-99004-284-7

CONTENT

SUMMARY

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. 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.

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").

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 EIA as the possibility of significant transboundary impacts of the projects on Austria cannot be ruled out.

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 was made 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 assigned the Consortium "Dicon – Acciona Ing." with the development of the EIA-Report.

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 an **expert statement on the EIA-Report** (UMWELTBUNDESAMT 2013). 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 the expert statement and assist in organizational matters.

This expert statement (UMWELTBUNDESAMT 2013) **contained recommendations and a list of questions**. **The Bulgarian side sent replies to these questions prepared by the applicant in March 2014** (REPLIES 2014).

The **goal of the expert statement at hand** is for the expert team to assess if these replies answer the questions of UMWELTBUNDESAMT (2013) sufficiently. The focus lies on providing a basis for making reliable conclusions about the potential impact of transboundary emissions.

The assessment of the REPLIES (2014) comes to the following **general conclusion**:

- Some of the questions were fully answered.
- Other questions were answered in as much detail as possible considering the information already available at the time of the EIA process.
  - Background: As the EIA procedure has to be completed before the choice of the reactor type, many details on safety-relevant questions are not available yet.
  - A list of open topics which can only be answered after the EIA procedure is given within the expert statement at hand. It would be appreciated if information on these topics could be provided at a later stage.

The implementation of the following **general recommendations** is important to reduce the risk of severe accidents and therefore the potential impact of transboundary emissions:

- It is recommended that the **concept of practical elimination** is applied consistently in the safety requirements for the NNU. Practical elimination of accident sequences has to be demonstrated with state-of-the-art probabilistic and deterministic methods, fully taking into account the corresponding publications of WENRA.
- It is recommended that the **seismic hazard** at the Kozloduy site should be **re-assessed** before the concrete design process for the NNU starts. The re-assessment should be based on the latest state-of-the-art methods in seismic hazard assessment for nuclear facilities (e.g. regarding model parameters, response spectra, consideration of uncertainties and assessment of local site effects) and take into account most current data about seismicity and tectonics.
- Concerning the **protection** of the nuclear facility **against aircraft crash** it is recommended that the NNU should be designed in a way that vital safety functions can be fulfilled despite of the thermal and mechanical impacts corresponding to the assumed crash of passenger aircrafts of the largest class (Airbus A-380) and fast military jets.
- Concerning the annual **probability of exceedance for the different meteorological impacts** accounted for in the design of the NNU, it is recommended that a value of at least 10^{-4} is used. In case some external hazards cannot be reliably determined for such a probability of exceedance, conservatively determined bounding values should be chosen.
- Because the justification of the used source term is not available yet, it is recommended to calculate the consequences of a **severe accident with a large release** – in addition to the limited release scenario presented in the EIA-Report – since the effects of severe accidents can be wide-spread and long-lasting and even countries not directly bordering Bulgaria, like Austria, can be affected.

BACKGROUND OF THE REPORT AT HAND

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 shutdown 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").

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 was made 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 assigned the Consortium "Dicon – Acciona Ing." with the development of the EIA-Report.

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 an expert statement on the EIA-Report (UMWELTBUNDESAMT 2013). 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 the expert statement and assist in organizational matters.

This expert statement contained recommendations and a list of questions. The Bulgarian side sent replies to these questions prepared by the applicant in March 2014 (REPLIES 2014).

The **goal of the expert statement at hand** is for the expert team to assess if these replies answer the questions sufficiently. The focus lies on providing a basis for making reliable conclusions about the potential impact of transboundary emissions. In this context, open topics are listed and recommendations are given.

As the EIA procedure has to be completed before the choice of the reactor type, many details on safety-relevant questions are not available yet. Therefore, the expert statement at hand assess if the REPLIES (2014) are either able to fully answer the questions of UMWELTBUNDESAMT (2013) or if additional information is necessary which can only be given after the EIA procedure.

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?

Answer by the Bulgarian side

The involvement of the public is a mandatory and important part of the Bulgarian EIA procedure. The set normative requirements allow the public to express their opinion of the implemented environmental impact assessment results and play an active role in the decision-making process of this assessment. According to the main Bulgarian by-law regulations in the field of the preservation of the environment – the Environment Preservation Act (EPA) and the Regulation for the conditions and procedure for environmental impact assessment implementation, the Principal of IP notifies in writing the competent body, the Ministry of Environment and Waters, about their investment proposal at the earliest stage. In parallel with notification of the competent body, the Principal of IP notifies in writing the mayor of the respective municipality, and the concerned population – via the mass media and/or other appropriate way. The Principal of IP consults with the decision-making authorities, other specialized institutions, and the affected public about the scope and content of the EIA Report. According to the Environmental Protection Act, upon a positive assessment of the EIA Report quality, the Principal of IP organizes public hearings of the EIA Report and its attachments jointly with the affected public as identified by the competent body. For investment proposals for construction, activities and technologies on the territory of Republic of Bulgaria (country of origin) which are supposed to have considerable transboundary effect on the territory of another country or countries, the Minister of Environment and Waters notifies the affected countries at the earliest possible stage of the investment proposal, and in case of agreement for participation in the procedure, submits information about the investment proposal nature and its eventual transboundary effect on the environment, as well as the possible direct participation of the affected country in the public hearings. In case of agreement for participation in the EIA procedure, the country of origin's national legislation is observed, provided no other provisions are made in the international treaty. The competent body considers the consultations held, the ex-pressed comments, and statements of the stakeholders during the EIA procedure in transboundary context on EIA decision-making. This decision is published and affected countries and their public are notified. The EIA procedure is a part of the licensing process for construction of a new nuclear unit which is stipulated in the Safe Use of Nuclear Energy Act (SUNEA). According to the SUNEA, a nuclear power plant is constructed by the decision of the Council of Ministers. The minister of economy and energy organizes public hearings of the proposal for nuclear power plant construction which is attended by state authorities and local self-government bodies, representatives of public organizations and interested physical and juridical bodies. During licensing, according to the requirements of the Territorial Development Act (TDA), a Detailed Territorial Plan (DTP) needs to be developed. The drafts of the general town and country plans are posted on the Internet web sites of the respective municipalities and are subject to public hearings prior to their submittal to the territorial planning commissions of experts. The design contracting authority organizes

and concludes the public hearing, and the notice is posted on the Principal and Municipality Internet web sites, in a national daily newspaper and in a local newspaper. The municipality notifies the stakeholders about the draft of the detailed territorial plan by publishing a notice, promulgated in the State Gazette. According to the EURATOM Contract (ar.41-44), the project is to be reported to the Commission at least three months before concluding the first contracts with suppliers. Upon discussions, the commissions shall report their statement to the interested member-state. Given the official consent of the interested member-state, the commission may publish all investment proposals that have been reported to it.

Comment of the expert team

The question was fully answered.

2 COMPLETENESS OF DOCUMENTATION

no questions/answers

3 DESCRIPTION OF THE PROJECT

1.2. 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?

Answer by the Bulgarian side

The design shall be developed according to the requirements of the Bulgarian legislation related to the safe use of nuclear energy and IAEA, EUR, and WENRA documents.

Comment of the expert team

The question was fully answered.

The specific WENRA documents listed in section 3.2 of the Austrian Expert Statement are not explicitly referred to in the answer. However, we assume that the answer is to be understood as referring to all relevant documents.

1.3. 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?

Answer by the Bulgarian side

Lessons learned from Fukushima accident shall be thoroughly considered in terms of requirements for the NNU design and safety assessment analysis. The designers of the considered reactor types declare that they have considered them in their designs. Detailed information about the implementation stage shall be provided at the stage of submitting the technical design of the selected model for review and approval.

Comment of the expert team

The question was answered in as much detail as possible considering the information already available at the time of the EIA process.

However, it would be appreciated if information on the requirements and analyses concerning the following topics could be provided at a later stage:

- long-term loss of power and/or ultimate heat sink,
- multi-unit accidents,
- accidents in spent fuel pools,
- use of mobile equipment,
- consideration of extreme natural hazards,

- robustness and scope of severe accident management,
- other Fukushima-related aspects relevant for the project.

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

Answer by the Bulgarian side:

The designers of the considered reactor types declare that they have considered them to a great extent in their reference designs. Detailed information about the considered lessons learned from Fukushima accident shall be provided at the stage of submitting the technical design of the selected reactor model for review and approval.

Comment of the expert team

The question was answered in as much detail as possible considering the information already available at the time of the EIA process.

However, it would be appreciated if information on the design covering the aspects listed above (question 3.2) could be provided at a later stage.

1.5. 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?

Answer by the Bulgarian side:

The specialized studies of the four alternative sites are carried out during the licensing process. These studies cover the following:

1. Local and regional meteorological characteristics. Clarification of the atmospheric dispersal characteristics.

1.1. Regional meteorology and climatology;

1.2. Assessment of extreme meteorological phenomena and their adverse combinations.

1.3. Local meteorology and micro climate; Comment of the Austrian expert team

1.4. Spreading of radioactive materials in the atmosphere of the supervised area.

2. Update of the hydrological studies of the Danube River.

2.1. Analysis and assessment of water surface elevation at the selected Hydrometric Station for an important period.

2.2. Updating of the information about the ice phenomena in the Bulgarian section of the Danube, in the region of Kozloduy NPP.

2.3. Updating of data about the physical and chemical characteristics of the Danube in the region of the operating NPP.

3. Contemporary movements of the lithosphere in Bulgaria, Central, and South Romania.

3.1. Brief tectonic characteristics of the South Mediterranean region and Bulgarian location;

3.2. The contemporary movements of the lithosphere in the Southern Mediterranean. South-Balkan extensional region

3.3. Processing and analysis of Bulgarian and Balkan Peninsular permanent GPS stations for monitoring of the contemporary lithospheric movements;

3.4. Analysis of received velocities and temporary rows for permanent SPS stations on the territory of Bulgaria.

3.5. Analysis of contemporary movements of the lithosphere in Bulgaria, Central, and South Romania.

3.6. Vertical motion of the lithosphere.

4. Demography and man-induced effects;

4.1. Stationary sources;

4.2 Leaks of hazardous fluids and gases

4.3. Explosions

4.4. Fire

5. Modelling of radionuclide migration in the subterranean area of the sites;

6. Seismic hazard for the studied sites.

The seismic hazard analysis for the proposed sites is structured in the following parts:

- **Chapter 1** Tectonic and neotectonic conditions
- **Chapter 2** Seismic Hazard Assessment
- **Chapter 3** Geodynamic models of the studied sites
- **Chapter 4** Impact of local geological conditions

7. Engineering and geological studies of the sites.

8. Evaluation of Kozloduy site protection against harmful meteorological, hydrological, and geological phenomena.

8.1. Review and assessment of the protective dykes in the area of the site;

8.2. Review and assessment of the bank protection facilities;

8.3. Review and assessment of the roads;

8.4. Evaluation of Kozloduy site protection against harmful meteorological, hydrological and geological phenomena;

8. Evaluation of Kozloduy site protection against harmful meteorological, hydrological, and geological phenomena.

8.1. Review and assessment of the protective dykes in the area of the site;

8.2. Review and assessment of the bank protection facilities;

8.3. Review and assessment of the roads;

8.4. Evaluation of Kozloduy site protection against harmful meteorological, hydrological and geological phenomena;

Comment of the expert team

The expert statement (UMWELTBUNDESAMT 2013), section 3.2, refers to differences regarding the connection of the four sites to outdoor switchgear. For sites 1 and 3, this connection is much more difficult according to the EIA-Report.

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.

There were no discussions in the EIA-Report on this aspect, and there also were no references to assessments or analyses which deal with this topic.

This issue is not addressed in the answer. We assume that it will be addressed, along with the issues listed above, in specialized studies performed during the licensing process. It would be appreciated if information could be provided at a later stage.

Regarding the other aspects, the question was answered in as much detail as possible considering the information already available at the time of the EIA process. However, it would be appreciated if information on the results of the specialized studies on the topics listed above could be provided at a later stage.

4 REACTOR TYPE

1.6. 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?

Answer by the Bulgarian side:

The information about the safety systems of the considered types of reactors is provided in Chapter2, section 2.3 – Alternatives of the options for the construction of a new nuclear unit.

Detailed information about the safety systems and corium retention measures will be provided after the submittal of the technical design. At this stage we can state that the design should comply with both the requirements of the Bulgarian regulations and requirements described in the documents of EUR, IAEA and WENRA in order to implement the project.

Comment of the expert team

The question was answered in as much detail as possible considering the information already available at the time of the EIA process.

However, it would be appreciated if information on the safety systems, in particular the passive cooling systems and the systems to control the molten core, of the selected reactor type could be provided at a later stage.

1.7. 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?

Answer by the Bulgarian side:

All manufacturers of the considered reactor models declared that a deterministic safety assessment was in place and PSA, Levels 1 and 2 were developed.

More detailed information about the scope of probabilistic analyses and the changeable factors in these analyses will be provided upon the submittal of the technical design. At this stage we can declare that the design should comply with both the requirements of the Bulgarian regulations and the require-ments described in the documents of EUR, IAEA and WENRA in order to implement the project.

Comment of the expert team

The question was answered in as much detail as possible considering the information already available at the time of the EIA process.

However, it would be appreciated if information on the probabilistic analyses (in particular, plant states and event categories included; treatment of uncertainties) could be provided at a later stage.

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

Answer by the Bulgarian side:

The report makes references to the nuclear power units of AES-2006 model which are being constructed in the Russian Federation. Should this type be selected, and the technical design submitted by the Manufacturer, we will have more information. The requirements for the design are specified in the response to Question 4.1.

Comment of the expert team

The question was answered in as much detail as possible considering the information already available at the time of the EIA process.

However, it would be appreciated if information on the differences between the two types of AES-2006 (with VVER-1200/392M and with VVER-1200/V491) could be provided at a later stage, should one of these two reactor types be selected.

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

Answer by the Bulgarian side:

All manufacturers of the considered reactor models declared that a deterministic safety assessment was in place and PSA, Levels 1 and 2 were developed.

The design shall consider the safety requirements of the Bulgarian legislation related to the safe use of nuclear energy and the ones of the IAEA, EUR, and WENRA documents.

Comment of the expert team

The answer does not explicitly refer to the concept of practical elimination. However, this concept is an important element of the safety requirements and safety objectives of IAEA and WENRA which are referred to in the answer. Thus, the question can be considered to be answered in as much detail as possible considering the information already available at the time of the EIA process.

It is recommended that the concept of practical elimination is applied consistently in the safety requirements for the NNU. Practical elimination of accident sequences has to be demonstrated with state-of-the-art probabilistic and deterministic methods, fully taking into account the corresponding publications of WENRA.

It would be appreciated if more explicit information on the application of the concept of practical elimination in the safety requirements for the NNU could be provided at a later stage.

1.10. 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?

Answer by the Bulgarian side:

The results of the detailed safety assessments of the specific reactor type will be available after the submittal of the technical design.

Comment of the expert team

The question was answered in as much detail as possible considering the information already available at the time of the EIA process (see also question 4.4).

However, it would be appreciated if specific information on the criteria for practical elimination of conditions or accident sequences could be provided at a later stage.

1.11. 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?

Answer by the Bulgarian side:

*The safety systems of the different reactor models are considered in **Chapter 2**, section 2.3.*

All manufacturers of the considered reactor models declared that a deterministic safety assessment was in place and PSA, Levels 1 and 2 were developed. More detailed information about these issues will be available after the submittal of the technical design.

Comment of the expert team

The question was answered in as much detail as possible considering the information already available at the time of the EIA process.

However, it would be appreciated if information on assessments and analyses of the reliability and effectiveness of the safety systems of the reactor type selected could be provided at a later stage.

5 SITE EVALUATION INCL. EXTERNAL EVENTS

SEISMIC HAZARD ASSESSMENT

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

Answer by the Bulgarian side

According to the activities recommended by the IAEA, the programme Study and Activities for Improving the Security of the sites of Kozloduy NPP and Belene NPP project - 1991-1992 was developed. Several annexes were concluded to the programme, and the activities under its implementation continued until the end of 1995, the effect of local earthquakes and some other specific local parameters were additionally analysed. The seismic characteristics of the Kozloduy NPP site used as a basis for the environmental impact assessment were defined in that time period (1991 – 1995) by using a series of task reports on the joint project with IEAE (above-mentioned – BUL 9/012 "Site and Seismic Safety of Kozloduy and Belene NPPs. One of the many reports on the project is: Geomorphology, Neotectonics, Seismicity and Seismotectonics of Kozloduy NPP. Final report, Geoph. Inst. BAS, Sofia, 1992. The earthquake characteristics (seismic levels, design envelope response spectrum of free field, and respective three-component accelerograms) were repeatedly reviewed and verified (updated) by the IAEA experts (within the period from 1992 to 2008).

Comment of the expert team

Additional information was given and two reports have been cited. However, the question was not fully answered.

It would be appreciated if information on the following topics could be provided at a later stage:

- More detailed information about the conducted analyses concerning the evaluation of the seismicity of the site and the reports where the results have been documented.

Note: If recommendation 5.8 that the seismic hazard at the Kozloduy site should be re-assessed before the concrete design process for the NNU starts is implemented, the question number 5.1 ceases to apply.

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

Answer by the Bulgarian side

Having in mind the neogene-quaternion activity of the known Mesozoic (Trias) fault structures and the genetic and dynamic characteristics of the Kozloduy pretortone fossilization valley, additional surveys of the terrain, and cameral geological and geomorphological studies were conducted.

These are more precisely expressed in:

- *additional data evaluation of the velocity characteristics of the upper geological cross-sections (neogene, quarternion), and their correlations with the reflecting surfaces of the lower levels of the same profiles (upper Cretaceous Period, old Tertiary);*
- *precise revisions of surfaces discovered in the neogenic structural tier;*
- *geomorphological and neotectonic detailing of the local field of the considered structures (the Ogosta platform, and the Southern Moesian platform).*

(Refer to the response of Question 5.1 as well.)

Comment of the expert team

Additional information was given, which is however quite general. Therefore, the question was not fully answered.

It would be appreciated if information on the following topics could be provided at a later stage:

- More detailed information about the field studies and the methods applied to identify main geological structures and to evaluate Neogene-Quarternary activities.

1.14. 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?

Answer by the Bulgarian side

The real normalized response spectra from the Vrancha inter-mediate-focus earthquake records were used for the analyses and some were modelled for local or other shallow earthquake sources. The received hazard curves for spectral accelerations are specified and the unified (uniform) hazard response spectra of the respective 5 types of sources (Vrancha intermediate-focus earthquakes, Vrancha shallow, Bulgarian, Others, Local Earthquakes) for an annual probability of exceedance of 10-2, 10-3 and 10-4.

Yes, the normalized standard spectra, scaled (normalized) up to 0.2 g, are widely used for response spectra probabilistic analysis.

Comment of the expert team

Substantial additional information was given, but the horizontal response spectrum for annual exceedance probability of 10^{-4} has not been provided. Therefore, the question was not fully answered.

It would be appreciated if information on the following topics could be provided at a later stage:

- The derived horizontal response spectra for the 5 types of sources for an annual exceedance probability of 10^{-4}.

Note: If recommendation 5.8 that the seismic hazard at the Kozloduy site should be re-assessed before the concrete design process for the NNU starts is implemented, the question number 5.3 ceases to apply.

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

Answer by the Bulgarian side

The response to this question is in the clarification given in the previous question response: – Different spectral shapes are used for the 5 different sources - Vrancha intermediate-focus earth-quakes, Vrancha shallow earthquakes, Bulgarian earthquakes, Others, Local earthquakes, i.e. different shapes are used for long and short distances.

Comment of the expert team

The question was fully answered.

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

Answer by the Bulgarian side

According to the outcomes from Project BUL 9/012 "Site and Seismic Safety of Kozloduy and Belene NPPs", the vertical acceleration is 50% of the horizontal one. Three-component accelerograms are accepted for this design. From the vertical component of these accelerograms, the velocity curve of the vertical velocities is received, and from it – the vertical motion seismogram.

Comment of the expert team/open questions

The question was fully answered.

1.17. 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)?

Answer by the Bulgarian side

The seismic hazard assessment methods have evolved to a certain extent since 1992, but its main principles and rules remain comparatively the same. After 1992, the specification of site seismic characteristics has been a subject of amendment, review and assessment:

1. *In 1995: – following the recommendation of the IAEA, Local Earthquake Effects have been additionally studied. The free-field response spectra concerning local earthquakes and relevant three-component accelerograms (with duration of 20 s) have been determined.*
2. *In 1995: – Probabilistic assessment of the seismic effect for the needs of PSA, Level 1 for Kozloduy NPP was performed in addition. The contribution of the different seismogenic zones at defining the acceleration attenuation factors de-pending on the magnitude and distance is assessed in the study.*

They arrived at the conclusion that the intermediate-focus earthquakes at the epicentre of Vrancha have the most significant effect. Graphically, the effect on the seismic hazards depending on the spectral acceleration (in %) of the seismogenic zones, split into three groups: local area, areas generating shallow (crust) earthquakes and Vrancha area (intermediate-focus earthquake). The seismic hazard is calculated separately for each of the areas, for each of the three groups, and for all sources as a whole.

3. *In 2008: – Periodic Safety Review (PSR) was conducted at Kozloduy NPP. The compliance of safety with the national regulations was assessed. In the area of Site Characteristics and seismic requirements in particular, non-compliances have not been identified.*
4. *In 2011: – "Stress tests at Kozloduy NPP" were conducted. The applicability analysis of the conducted seismic characteristics reassessment was carried out. It was concluded that the seismic characteristics reassessed in 1992: (Project BUL 9/012 "Site and Seismic Safety of Kozloduy and Belene NPPs") seismic characteristics of Kozloduy NPP site and the additional studies from 1995 (studies for local earthquakes and probabilistic assessment of the seismic effect for the purposes of the seismic PSA) do not contradict the require-ments of the current regulations.*

Comment of the expert team

Additional information was given. However, on the basis of the answer it doesn't really become clear whether substantial new analyses have been performed after 1995. Therefore, the question was not fully answered.

It would be appreciated if information on the following topics could be provided at a later stage:

- More detailed information about the analyses conducted after 1995 to make sure that the seismic hazard assessment 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).

Note: If recommendation 5.8 that the seismic hazard at the Kozloduy site should be re-assessed before the concrete design process for the NNU starts is implemented, the question number 5.6 ceases to apply.

1.18. 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?

Answer by the Bulgarian side

The evaluations in the framework of the Probabilistic Safety Assessment (PSA) and Periodic Safety Review (PSR), part Seismic, have been performed and they are in compliance and take into account the following information:

- *Current Regulatory requirements which are valid for the time, when the study is performed;*
- *Plant Specific Data;*

- *Generic Data;*
- *Current, up-to-date methods for evaluation of the seismic hazard.*
- *Probabilistic Seismic Hazard Analysis (PSHA)*

The first step of seismic PSA consists in the development of a probabilistic seismic hazard analysis (PSHA). A very detailed analysis is performed to validate the results of the probabilistic seismic hazard analysis used for the seismic PSA. The main concerns of the reviewer were related to:

- *Adequate treatment of epistemic uncertainty and aleatory variability in the PSHA model;*
- *Adequate consideration of local/background seismicity that in many international studies drives the hazard results;*
- *Adequate treatment of site amplification effects (soil site);*
- *Adequate selection of the spectral shape of the uniform hazard spectrum used as an input for the subsequent fragility analysis;*

Additionally the actual probabilistic seismic hazard maps of Bulgaria and actual neo-deterministic calculations for the Kozloduy site are performed and analysed. The new IAEA guide SSG-9, requests to perform such a comparison between probabilistic and deterministic seismic hazard analysis methods for plausibility is used. Detailed information about the seismic characteristic of the Kozloduy NPP site is used. It confirmed the lack of any relevant seismic sources in the vicinity of the Kozloduy site. Earlier mi-nor seismic events observed in the time period from 1976-1990 most likely represent induced seismic events resulting from mining activities.

Seismic Fragility Assessment

The task of fragility assessment for a PSA consists in the assessment of the seismic capacity of safety important structures, systems and components (SSCs). The Kozloduy seismic PSA is developed on the basis of a de-tailed analysis of potential impacts of seismic events on SSCs. A very detailed safe shutdown list (SSL) is developed. For all elements of the safe shutdown list fragility functions are provided. As an input to the calculation probabilistic in-structure floor response spectra is developed for the reactor building while traditional deterministic response spectra are used for other buildings. The fragility functions are developed mainly on the basis of component qualification data from the vendor, generic data and a limited set of engineering calculations. Failure probabilities are calculated to obtain the frequency of initiating events caused by earthquakes and for components required to mitigate the consequences of these events. A simplified statistical moment propagation method is used for the computation of the failure probabilities.

Comment of the expert team

Additional information was given. However, on the basis of the answer the scope of the mentioned analyses doesn't really become clear. Also, it is not comprehensible whether separate analyses independent from those mentioned in the answer to question 5.1 have been performed. Therefore, the question was not fully answered.

Appreciated additional information is covered by the foregoing comments.

1.19. 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?

Answer by the Bulgarian side

Refer to the response of Question 2.4.

Comment of the expert team

Question 2.4 doesn't exist and the answer to question 5.4 doesn't fit (in case of a type error). Therefore, the question was not answered. It is recommended that the **seismic hazard** at the Kozloduy site should be **re-assessed** before the concrete design process for the NNU starts. The re-assessment should be based on the latest state-of-the-art methods in seismic hazard assessment for nuclear facilities (e.g. regarding model parameters, response spectra, consideration of uncertainties and assessment of local site effects) and take into account most current data about seismicity and tectonics.

1.20. 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?

Answer by the Bulgarian side

Yes, it is confirmed. The IAEA guidelines and documentation how to perform a PSHA for exsting plants have been recently updated [IAEA, "Seismic Hazards in Site Evaluation for Nuclear Installations, SSG-9," 2010]. The actual IAEA guide on seismic hazard analysis requests that in case of difficulties of the interpretation of results of probabilistic seismic hazard analysis a deterministic seismic hazard analysis should be performed for comparison. Such an analysis is performed by using simulation techniques (neodeterministic method) considering the Vrancea source as the dominating contributor to the Kozloduy seismic hazard. Considering possible site amplification effects the results of deterministic analysis are in reasonable good compliance with the hazard curves developed in the PSHA.

Comment of the expert team

The question was not fully answered.

It would be appreciated if information on the following topics could be provided at a later stage:

- Availability of new data about seismicity and tectonics obtained after the finalization of the seismic hazard study mentioned in the answer to question 5.1.
- Evaluation of possible consequences for the validity of the seismic hazard study in case new data are available.

Note: If recommendation 5.8 that the seismic hazard at the Kozloduy site should be re-assessed before the concrete design process for the NNU starts is implemented, the question number 5.9 ceases to apply.

1.21. 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)?

Answer by the Bulgarian side

The received hazard curve set (family) for Kozloduy NPP site, each of which has its respective probability, contains the whole information about the seismic hazard of a given site, the model inaccuracies, possible error sources, and the extent of the influence exerted by each of these sources. The median and the arithmetic mean of the hazard curves for the ground accelera-tion peak values are defined from the resulting set (family) of the hazard curves. The received accelerations are higher than 50% of the quantile value of the curve (i.e.they are close to the median).

Comment of the expert team

The answer is somewhat ambiguous as it is stated on the one hand that the received accelerations are higher than 50% of the quantile (= median) and on the other hand that they are close to the median. However, we conclude that the accelerations are above the median, therefore the question was sufficiently answered.

1.22. 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?

Answer by the Bulgarian side

Due to the specific characteristics of the Kozloduy NPP site ground layers, the local effects were studied when the enveloping response spectra was compiled by modifying registered accelerograms from Vrancha intermediate-focus earthquakes with the help of the SHAKE software. Because of missing original accelerograms recorded on the site, the accelerograms registered for similar to Kozloduy site geological conditions were selected. Detailed deconvolution and convolution analyses were conducted at Kozloduy, and, on one side, the geological condi-tions of the respective registration places were considered in details, and the specificity of the geological layer, on the other side. The accelerogram modification procedure starts with drawing up the mathematical models of geological layers. The depth from the surface to the base rock of the soil models is studied for different variations. The effect of G module has been studied by varying the soil characteristics. The characteristics of the soil layers (lithological description, thickness, density, velocities of P- and S-waves, etc.) were taken from drills and cameral tests in situ. The velocities of the cross waves varied with +/- 30%, and respective cut modules were also calculated. Non-linear variation of the module was experimentally determined depending on relative deformations. The local effects, due to the peculiarities of the soil layers, were also studied by calculating the model synthetic accelerograms of local earthquakes (there were no original real records due to the exceptionally low seismic activity in the nearby regional zone). The well-known Trifunac M.D. software was used. "Generation of

Sinthetic Accelerograms", allowing to vary both geo-logical characteristics during spreading of seismic waves from the source to the site base rock, and to the soil layers (medium, soft, hard) under the site itself.

Comment of the expert team

Information about the shear wave velocity profiles at the site was not provided. However substantial additional information was provided, therefore our question was sufficiently answered.

1.23. 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?

Answer by the Bulgarian side

The three-component independent normalized accelerograms of 61 seconds duration are synthetic time-histories, generated by the identified response spectra with the help of the SIMQKE software. The duration of the accelerogram, the enveloping curves of the accelerogram amplitude, the ratio between the maximum horizontal and vertical acceleration was received by analysing records of really registered accelerograms. Therefore, such three-component accelerograms for a free field are used as seismic input for dynamic analyses of civil struc-tures. The result of these analyses determines the seismic load of equipment which is located in these structures. Therefore, the seismic qualification of all components, systems and structures is in compliance with the requirements for the respective installation place.

Comment of the expert team

The question was fully answered.

EXTERNAL HUMAN INDUCED EVENTS – AIRCRAFT CRASH

1.24. 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?

Answer by the Bulgarian side

Aircraft crash Type 2

According to NS-G-3.1, the hazard of aircraft crash during landing approach or taking off needs to be considered in the cases when: 1) airways or airport approaches for taking off/landing pass within the 4 km zone around the site; 2) there are airports within the 10 km zone; 3) there are big airports within the 16 km zone with a total of operations (taking off/landing) exceeds 500.d2, where d is the distance to the airport in km; 4) there are big airports at a greater distance than 16 km, they need to be considered in case the total number of operations

(taking off/landing) is larger than 1000.d2; 5) the air-space within the 30-km zone around the plant is used for military training flights. There are no big civil airports within the 30-km zone around the Kozloduy NPP. The closest airport to the plant site is in the town of Krayova, which is 68 km away from the plant. In order to consider it, it should have 4 624 000 operations per year, which exceeds the real traffic of many orders (3394 operations for year 2010). The largest airport to the considered sites is the one in Sofia with 44171 operations in 2012. Due to the large distance from the the plant, the latter cannot generate the Aircraft crash hazard:

Type 2 for the considered sites.

The only similar facilities are the four flying fields of the agricul-tural aviation in the town of Byala Slatina, in the villages of Glojhene, Harlets, and Selanovtsi. Two of these facilities, the flying fields in the vilages of Glojhene and Harlets are within the 10 km zone of the four possible sites, while for sites 1 and 2, the taking off/landing approaches pass within the 4 km zone around the sites. According to the requirements, the hazard of aircraft crash Type 2 due to the traffic of the flying fields in the villages of Glojhene and Harlets needs to be considered. As of the moment of the current study, there is no available reliable information about the status of these flying fields and the number of the annual operations (taking off and landing). Because of that reason, the task was solved in the reverse order - the minimum number of annual operations was calculated and the probability of aircraft crash at taking off or landing would be equal to 1.10-6. Using the detailed methodology (DOE-STD-3014-2006) for calculating the probability of aircraft crash during airfield operations - taking off and landing (aircraft crash: Type 2), to receive the probability of aircraft crash on the territory of the new nuclear unit site, equal to 1.10-6 initiated at landing at the flying field in the village of Glojhene, we should have a minimum of 214 landings per year. As of the moment of the current study, there was no available information about the actual status of the flying fields in terms of numbers of flights performed during the last years. Having in mind the specificity and the size of the flying field in the village of Glojhene, it can be used only by the light aviation (flight weight under 5670 kg), therefore, the load which would be generated in result of a hypothetical crash would be considerably lower than the Type 3 effect.

Comment of the expert team

The answer provides substantial additional information. However, it doesn't contain any explicit statement about air space usage within 30 km of the plant for military training flights. Therefore, the question was not fully answered.

It would be appreciated if information on the following topics could be provided at a later stage:

- Information about air space usage within 30 km of the plant for military training flights.
- Information about the potential hazard of aircraft crash Type 2 due to the traffic of the flying fields in the villages of Glojhene and Harlets.

1.25. 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 5.66x10-7 (on an area of 0.5 km²) and of 1.13x10-6 (on an area of 1 km²) based on traffic data within 30 km of the site?

Answer by the Bulgarian side

Technical error while assessing aircraft crash of type 3 was found in the document. The annual probability of aircraft crash of one of the sites under consideration (area of 0.5 km2) is p(y) [30 km]=5.66E-07 using the traffic data within the 30 km zone and p(y) [100 km] 2.93E-07 using the traffic data in the 100 km zone. It should be noted that in compliance with NS-G-3.1 in some member states all nuclear facilities are designed for an impact of an aircraft crash in case the probability of such an event calculated for an area of0.01-0.04 km2 is equal to or greater than 10-6. Using this criterion, the output values of the annual frequency for aircraft crash shall vary in the range p(y) [30 km]=1.13–4.52E-08 (on an area of 0.01 and 0.04 km2 respectively) using the traffic data in 30 km zone and p(y) [100 km]=5.86E-09÷2.34E-08 using the traffic data in 100 km zone (on an area of 0,01 and 0.04 km2 respectively). It should be noted that the recommendations considered in the IAEA documents are aimed at reaching target values from 0.01 to 0.04 km2 and respectively criteria regarding the frequency of occurrence of an event - aircraft crash of type 3 relate mainly to values received upon considering these areas but not the whole area of the nuclear facility. Considering the analysis output data, the conclusion drawn in the EIAR that aircraft crashes of type 3 can be excluded can be confirmed. Nevertheless, the design basis shall be included in the requirements of the BNRA, IAEA, EUR and WENRA for protection of the nuclear facility in the event of a large passenger aircraft. Detailed information confirming the design basis shall be provided at the stage of providing technical design of the selected model for review and approval.

Comment of the expert team

The question was fully answered.

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

Answer by the Bulgarian side

The design basis shall be included in the requirements of the BNRA, IAEA, EUR and WENRA for protection of the nuclear facility in the event of a large passenger aircraft. This indicates that the safety-related structures, systems and components (Safety systems) required for placing and maintaining the plant

in a safe condition following such a crash shall be designed and protected adequately. In particular, the implementation of the following fundamental safety functions shall be ensured:

- *Reactivity control including reactor trip;*
- *Residual heat removal (including long-term removal) from the core and spent fuel pool to prevent fuel meltdown in the core or SF in the pool;*
- *Keeping the radioactive substances within the set values.*

Detailed information confirming the design basis shall be pro-vided at the stage of providing technical design of the selected model for review and approval.

Comment of the expert team

The question was answered in as much detail as possible considering the information already available at the time of the EIA process.

Concerning the protection of the nuclear facility against aircraft crash it is recommended that the NNU should be designed in a way that vital safety functions can be fulfilled despite of the thermal and mechanical impacts corresponding to the assumed crash of passenger aircrafts of the largest class (Airbus A-380) and fast military jets.

In addition, it would be appreciated if information on the following topics could be provided at a later stage:

Information about the basic approach concerning the design of the NNU against a supposed crash of large passenger or military aircraft including information about

- Protection by adequate design of buildings or physical separation.
- Characterization of the assumed mechanical and thermal impacts.

1.27. 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?

Answer by the Bulgarian side

The design basis shall be included in the requirements of the BNRA, IAEA, EUR and WENRA for protection of the nuclear facility in the event of a large passenger aircraft. The direct and indirect impacts of the aircraft shall be considered and especially:

Consequent primary and secondary impact on the mechanical resistance of the safety structures and systems required for placing and maintaining the plant in a safe condition following an aircraft crash;

- *Effects of vibrations on the safety structures and systems required for placing and maintaining the plant in a safe condition following an aircraft crash;*
- *Effects of combustion and/or explosion of aircraft fuel on the integrity of the structures and systems required for placing and maintaining the plant in a safe condition following an aircraft crash.*

The assessment of plant damages resulting from the impact of a large commercial aircraft is a task which completion requests a complex analysis related to the structural impact, crash-induced vibrations and fire effects and the analysis scope and scenarios considered shall comply with the regulatory requirements. All regulatory requirements shall be considered while deter-mining the scope of the buildings, structures, systems and components to be designed and adequately protected to minimize the damages to the plant resulting from the impact of a large commercial aircraft maintaining the possibility to perform the fundamental safety functions. All safety-related structures, systems and components (safety systems) required for placing and maintaining the plant in a safe condition are protected through the adequate design of the buildings they are located in (physical barriers) in combination with the use of passive fire protection, train physical separation. At the stage of issuance of the site approval order by the BNRA chairman, the compliance of all specified characteristics with the regulatory requirements and their correctness shall be verified. These characteristics shall be defined as requirements to the technical design. At the stage of issuance of the technical design approval order by the BNRA chairman, detailed information on ensuring the protection of the systems required for the implementation of the fundamental safety functions shall be submitted and the compliance with these requirements shall be verified.

Comment of the expert team

The question was answered in as much detail as possible considering the information already available at the time of the EIA process.

Concerning appreciated additional information see the comment to question 5.15.

External Human Induced Events – Leaks of hazardous fluids and gases

1.28. 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?

Answer by the Bulgarian side

The site pre-surveys in the 10 km zone of the potential sites for the new nuclear unit identified the main potential sources of hazardous gases as follows:

Nabucco Gas Pipeline (planned)

- *South Stream Gas Pipeline (planned)*
- *UGS Chiren–Kozloduy–Oryahovo Gas Pipeline (planned)*
- *Thermal power plant at the Kozloduy NPP site including gas pipeline (planned)*

The completed analysis of the impact assessment of the following planned gas pipelines and facilities at the Kozloduy NPP site are used as follows:

1. *Risk assessment of the Nabucco gas pipeline in the area of Kozloduy NPP, document REL-1007-DD-001, October 2012.*

The report includes analysis of the following components:

T.6 – Description of the gas release process and specification of the parameters of the formed air-gas mixture. The Chapter describes the physical and thermodynamic processes resulting from the raising of the gaseous mixture and defining the parameters of gas condition and the formed air-gas mixture - concentration, density, state of matter, etc. Gas is lighter than air and it rises to a height at which the cloud will form a directed to its axis Z fan.

T.7 – Physical explosion (disruption) of the gas pipeline – defines the seismic impact. This part analyses the impacts of the physical explosion (disruption) of the gas pipeline. The seismic impact parameters are defined through an accelero-gram and velocity-time graph presenting the acceleration change respectively the free surface speed in the time function. The analysis results show that there is no impact on the plant because the intensity in 500 m from the disruption is zero.

T.8 – Missiles (debris) formation resulting from the physical explosion (disruption) of the gas pipeline. Two processes are considered in the debris risk assessment:

- *Fragmentation;*
- *Define the ballistic parameters - speed, trajectory and interaction with the target.*

The debris is primary and secondary in origin. There is not impact of the debris on the plant site - the gas pipeline is located at a considerable distance away.

T.9 – Formation of an air-gas cloud spreading towards the plant. As defined in section 6, the air-gas cloud is raised at a height because it is lighter than the air. There is no possibility for the cloud reaching the ground surface and staying on it.

T. 10 – Detonation combustion of air-gaseous cloud formed. The air-gas mixture is inclined to detonation only if the gas con-centration in the mixture is between the upper and lower detonation threshold of ignition. Therefore, this part defines the concentration and detonation thresholds of ignition. The possible ignition sources are defined and analysed. Whether there is an ignition source during the gas release or not and when it occurs, the results in the form of the burning - as a fireball, detonation or deflagration. The main task considered in this part is to define the overpressure during the detonation of the air-gas mixture. The analysis results of the most severe possibility for detonation burning show no risk for the plant site due to its far location.

T.11 – Burning of the air-gas cloud in the form of a fireball. The BIS software is used to predict this type of burning. The analysis results show no risk for the plant site due to the low values of the thermal flow.

T.12 – Fire in the vicinity of the accident and fire spreading over the verdure towards the plant site. The analysis results show that there is sufficiently enough period of time for the fire brigades to react and bring the fire under control.

T.13 – Gas release resulting from local depressurization. Such a scenario could initiate steady burning in the form of a torch. The heat generated during the torch burning does not carry risk for the plant site.

T.14 – Analysis of the capabilities of the response teams in the event of human induced hazards. An analysis is performed and the relevant recommendations are made.

2. *Simulation through mathematical modelling of emergencies along the South Stream gas pipeline route in the area of Kozloduy NPP", document 03-06/01-SSB-MODEL/KzNPP, October 2012. The report includes analysis as follows:*

T.2 – Characteristics of the analysed subject. This part pro-vides information on the parameters of the transported gas and its characteristics. The minimum distance to the south institutional road of the plant is 6.7 km. Information about the meteorological conditions typical for this section of the gas pipeline has been provided.

T.3 – Protected sites in the area of the gas pipeline. This part provides general information on the settlements ans sites that could be affected in the event of an accident.

T.4 – Risk assessment methodology. The individual and collective risks have been determined. The probability of fatal result is defined as a fatal consequence of the event. Information about the limit values for overpressure, thermal radiation and gas concentration has been provided. The algorithms of the analysis and specialized software used have been given.

T.5 – Risk event scenarios. Gas releases resulting from three types of damages are considered (rupture of the entire pipeline, aperture – up to 1/10 from the pipeline diameter and fault – up to 1/100 from the pipeline diameter). The scenario tree is presented.

T.6 – Probability of occurrence of events. This part addresses the probability of gas release and ignition. Qualitative characteristic of the initiators of gas release is made. The potential gas ignition sources are considered.

T.7 – Consequence analysis of uncontrolled release. On what the jet gas release mainly depends on and the gas dispersion are defined. The impact of the debris and the seismic impact resulting from gas explosion as well as the generation of the shock wave in the atmosphere have been assessed. There are no con-sequences following the shock wave, debris and seismic impact for the plant site in view of the most severe scenario. The impact resulting from the occurrence of torch burning and torch explosion has also been assessed. No impact on the plant site has been registered. An alternative scenario related to failure of the cutoff valves to close is also considered. Hazardous gas concentrations are not registered at the plant site.

T.8 – Risk assessment. The probability data of the different scenarios have been summarized. The risk to the population in the vicinity of the considered area of the gas pipeline and the buildings and facilities nearby has been assessed. The possibil-ity of setting the verdure nearby on fire.

T.8.5 – Distance from the hazardous area to Kozloduy NPP. This section summarizes and provides graphic visualization of the hazardous area.

3. *UGS Chiren – Kozloduy – Oryahovo Gas Pipeline*

There is no information available as of the date of the study about such detailed analysis of the possible emergency events on the gas pipeline route between Kozloduy and Oryahovo within the plant zone. The possible emergency scenarios and relative impact parameters of the area of the gas pipeline located at the Kozloduy NPP site are addressed in document "Preliminary analysis and impact assessment of possible industrial accidents occurred at the thermal power plant and their impact on the Kozloduy NPP buildings and facilities nearby". Consider-ing the lower diameter of the pipeline in this area and the greater remoteness to the sites, a logical conclusion can be de-rived that significantly lower parameters of possible emergency impacts can be expected. Therefore, the emergencies considered for the gas pipeline "at the site" are reliable.

4. *Thermal power plant planned at the Kozloduy NPP site including gas pipeline at the site*

A construction of a thermal power plant operating with a natural gas is planned at the existing site of Kozloduy NPP. The doc-ument „Preliminary analysis and impact assessment of possible industrial accidents occurred at the thermal power plant and their impact on the Kozloduy NPP buildings and facilities nearby studies the possible causes for industrial accidents and specifies the parameters of these impacts. In view of the initial stage of the project and exact location of the thermal power plant that is not determined yet, three possibilities are considered where the length of the gas pipeline at the site (stop valve of the gas control station/in the immediate vicinity of the NPP fence/ and stop valve at the thermal power plant site) varies from 500 to 2000 m. The probability of depressurization varies from 16E-6 to 64E-6 depending on the considered length of the gas pipeline at the site. The probabilities indicated are higher than the common admissible value for occurrence of an emergency at the NPP site equal to 1.10-6 which requires considering the impacts resulting from damages of the gas pipeline when assessing the safety of the nuclear facilities nearby. The released gas quantities in case of total depressurization of the gas pipeline at the site are expected to be between 677 and 744 kg depending on the location of the depressurization but the time for gas release is comparable to the response time of the instrumentation to close the stop devices. The maximum gas quality that could be released inside the thermal power plant in the event of a rupture of one of the pipelines with a natural gas is 76.1 kg.

5. *Existing facilities at the Kozloduy NPP site*

The analysis of probabilities and causes for occurrence of indus-trial accidents with hazardous substances at the Kozloduy NPP site is performed in a separate document "Probabilistic analysis of industrial accidents occurring outside the units' buildings on the Kozloduy NPP site". A system analysis is used as a main approach in the analysis of the possible progression of the most severe accident scenarios and the process itself includes several consecutive stages:

1. *The information required on the type, quantities and stor-age system of hazardous materials on the plant site is col-lected.*
2. *The hazardous materials properties are analysed and de-scribed. Safety data sheets for the most hazardous ones are developed.*

3. *The hazardous materials are classified in compliance with the international regulations.*
4. *Scenarios for occurrence and progression of accidents with the most hazardous materials are developed.*
5. *An assessment of the response capabilities and potential consequences of accidents is performed.*
6. *The technical decisions and proposals to reduce the risk of occurrence of accidents with hazardous materials.*

Referring to the release of hazardous liquids and gases, the fol-lowing emergency situations are identified:

- *Gassing resulting from depressurization of a 16 m3 tank with 60% nitric acid;*
- *Gassing resulting from an accident related to falling of a 200 l barrel, unsealing of the barrel and leakage of the entire quantity of hydrazine hydrate on the asphalt.*
- *Gassing of the adjacent area with toxic substances re-sulting from the interaction of these substances - in case of an accident with a truck full of sulphuric acid, spilling the acid and falling into the sewage system;*
- *Leakage of hazardous liquids at the plant site.*

Considerable quantities of flammable liquids are stored at the plant site and under certain conditions these liquids could flow out of the tanks, ignite and result in complex fire. Such fires could occur in the oil storage station at Units 5 and 6 where considerable quantities of diesel fuel and oil are stored. The analysis addresses the probability of the most significant and expected fire at the plant site, in particular, fire of diesel fuel leaked from a 2000 m3 tank in the oil storage station. The analy-sis is performed considering the most severe and expected emergency, mainly:

- *Depressurization of one of the tanks and leakage of the entire quantity of diesel oil in the containment;*
- *Ignition of the diesel oil and spreading of fire over the entire surface of the leakage.*

The results obtained on the heat flow rate for the adjacent sites are as follows:

- *On the pump station walls – 36.9 kW/m2;*
- *On the RAW treatment station walls – 1.11 kW/m2;*
- *On the RAW Department walls – 0.36 kW/m2;*
- *On the control panel walls – 0.36 kW/m2;*
- *On the Diesel Generation Station walls – 0.24 kW/m2;*
- *On the receiver walls – 0.21kW/m2;*

On the grounds of the results obtained, the following prediction of the impact of the diesel fuel fire in the oil storage station over the adjacent sites is made and the following conclusions can be drawn:

- *The fire carries risk for the oil storage station. Most probably the heat flow shall cause meltdown and ignition of the damp proofing of the station roof and dam-age of the walls' external surface.*

The fire does not carry risk for the other adjacent sites. The density of the heat flow could not cause any damages on these sites.

Comment of the expert team

Substantial additional information was provided. E.g. the thermal power plant planned at the Kozloduy NPP site including gas pipeline at the site was not even mentioned in the EIA-Report.

However, some information which would be valuable was not given, e.g. the closest possible distance between the planned Nabucco gas pipeline and the NNU.

It would be appreciated if information on the following topics could be provided at a later stage:

- Closest possible distance between the planned Nabucco gas pipeline and the NNU.
- Information about hazard evaluations for the thermal power plant planned at the Kozloduy NPP site including gas pipeline and the UGS Chiren - Kozloduy – Oryahovo gas pipeline.

1.29. 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)?

Answer by the Bulgarian side

The fire load caused by the materials stored including the quantities and types of the chemical substances stored in the considered warehouses (sites) and the passive fire protection provisions - physical separation (using fire protection barriers) and isolation (using cameras and storage containers) of the materials stored comply with the requirements of the Bulgarian legislation. The regulatory requirements (fire protection and ensuring safety during storage of hazardous chemical substances) are very conservative and set in a way that in case of an event of such kind in these sites or occurrence of secondary events initiated from the first event (combination of events), the impact remains within the site's boundary or in the worst case within the restricted area around it. The results of the analysis per-formed including analysis of combination of events confirm the local characteristics of their impact and the implementation of the objectives set in the regulations. In addition, the sites are situated on the existing site in a way that eliminates in practice the impact of the events considered over the other sites of the existing units and the sites of the new nuclear unit considering the distance from the source and the calculated impact distances.

Comment of the expert team

Taking into account also the answer to question 5.17, the question was sufficiently answered.

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

Answer by the Bulgarian side

Probabilistic analysis of industrial accidents occurring outside the units' buildings on the Kozloduy NPP site is prepared at Kozloduy NPP. The report includes analysis of the probabilities and causes for occurrence of industrial accidents with hazardous substances /warehouse No.106/, response capabilities and possible consequences. The analysis addresses the following initiated emergency situations resulting from violation of the administrative rules for fire safety in storage facility No.106.

- *Violation of the compatibility of the chemical materials during storage;*
- *Unsealing of flammable liquids resulting from non-compliance with the procedures used during handling activities;*
- *Malfunction of the ventilation system, gassing of the ware-house building;*
- *Using electrical equipment not complying with the relevant room class under fire safety and explosion safety;*
- *No using the required protection means, smoking.*

The analysis shows that in the event of fire of flammable materials in warehouse No.106, the impact shall be local, within the warehouse site.

Comment of the expert team

The question was fully answered.

1.31. 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?

Answer by the Bulgarian side

The required analysis of the impact of the explosives transported in the immediate vicinity of the site (e.g. using trucks or ships along the Danube) are performed in the licensing process of the new nuclear unit. Deterministic approach is used and the maximum quantities of the explosive material set are as follows:

- *road transport - 23 t trinitrotoluene equivalent (TNT);*
- *water transport - 4500 t TNT.*

The values of the dynamic pressure within the explosive wave for a range of distances of 100÷4500 m for road transport and, respectively, from 2100÷7000 m in sections of 100 m are determined. The analysis results show that no impacts are expected for the water transport and, for the road transport, the harmful effects shall be minimal at a distance of 230 m from the site and shall be considered in the design basis of the nuclear facility. However, satisfying the requirements of the Regulation for the provision of physical protection of nuclear facilities, nuclear material and radioactive substances, a number of administrative and technical measures shall be implemented minimizing additionally the

effects of the considered impacts - removing the threat source from the nuclear facility through specifying the adequate size of the perimeter defence and using state-of-the-art technical means of monitoring, alarm and control of hazardous materials.

Comment of the expert team

The question was fully answered.

1.32. 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)?

Answer by the Bulgarian side

Such analysis is performed as described in Chapter 6, section 6.2.4. We provide you additional information in reply to your request: A mathematical modelling of the possible emergencies on the South Stream gas pipeline route in the 10 km zone around the plant is made. Three possible events of "uncontrolled release" are considered: Rupture (d=138cm), Aperture (d=44cm) and Fault (d=14cm), in three section points located at 8.7 km, 6.7 km and 8.6 km respectively from the perimeter fence of the NNU. The results of two atmospheric stability classes and wind speed respectively are presented as follows: Class F (stable stratification) and wind speed of 1.5m/s, and Class D (neutral stratification) and wind speed of 5m/s. Certified computer codes are used for data processing. The analysis results of the considered situations show the maximum impact threshold - natural gas dispersion in the event of a RUP-TURE of 1.2 km from the source at Stability Class D and wind speed of 5m/s. There is no risk to the NNU sites based on the results from the analysis performed of the pressure parameters of the pressure shock wave resulting from the detonation burning of the air-gas cloud in view of the most severe scenario with a gas pipeline rupture, type "Rupture". The analysis performed of the missiles (debris) formation resulting from the gas pipeline explosion show that the effects are limited to 800 m from the source.

Comment of the expert team

Substantial additional information was provided. However, it remains unclear whether an analysis comparable to the one described for the South Stream gas pipeline was also performed for the Nabucco pipeline (as a value for the distance of the Nabucco pipeline from the site was not provided the comparability of possible release scenarios cannot be judged).

It would be appreciated if information on the following topics could be provided at a later stage:

- Information about analyses on the formation of pressure shock waves due to gas release from the Nabucco pipeline including information on the meteorological boundary conditions of the analyses.

1.33. 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?

Answer by the Bulgarian side

The project robustness parameters shall be defined on the grounds of the analyses and studies performed regarding the pressure shock waves as a part of the design basis. The requirements for the design robustness to pressure shock waves shall comply with the requirements of the BNRA, IAEA, EUR and WENRA and shall be imposed on the NNU design. Detailed information shall be provided at the stage of providing technical design of the selected model for review and approval.

Comment of the expert team

The question was answered in as much detail as possible considering the information already available at the time of the EIA process. However, it would be appreciated if information on the following topics could be provided at a later stage:

- Information about the load time curve assumed for the design against the impact of pressure shock waves and information about the respective protection of the different safety relevant buildings.

EXTERNAL HUMAN INDUCED EVENTS – FIRE

1.34. 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?

Answer by the Bulgarian side

Refer to the answer of question 3.17. Fire analysis is ad-dressed in the documents specified.

Comment of the expert team

Obviously the answer refers to question 5.17. The question was fully answered.

OTHER EXTERNAL EVENTS – OFF-SITE FLOODING

1.35. 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?

Answer by the Bulgarian side

This point will for certain be addressed in the next design phase, following the selection of the most suitable site and the respective technology. The hydrological assessment made with regard to the possibilities of flooding and the elevation that could be reached under the worst case flooding scenario, the Stress

Tests for the site in operation, and the possibility of water ingress via the sewerage system, are part of the decision associates with development of the General Layout Plan for the NNU site, determining of its elevation 0.00, the site landshaft, etc. The 0.00 elevation envisaged for the future site will be at 36.00m, and all the facilities of the belowground sewerage network for bathroom sewers, service water and rainwater liquid discharges will conform to the requirement to prevent water flowing back through them and flooding the work premises via this network.

Comment of the expert team

The question was fully answered.

OTHER EXTERNAL EVENTS – EXTREME WINDS AND TORNADOES

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

Answer by the Bulgarian side

On the basis of analyses performed for the design basis, the characteristics of these impacts will be determined and they will be considered at the subsequent design stage. The containment design will consider loads both from extreme winds and tornado, and from shock waves resulting from external explosion.

Comment of the expert team

The question was answered in as much detail as possible considering the information already available at the time of the EIA process. However, it would be appreciated if information on the following topics could be provided at a later stage:

- Information about the assumed wind and tornado loads and the respective protection of the different safety relevant buildings.

1.37. 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?

Answer by the Bulgarian side

Article 13 of the Regulation on Ensuring the Safety at Nuclear Power Plants identifies the external events and hazards, characteristic of the site, shall be considered by the design. These include:

- *Extreme climatic conditions;*
- *Earthquakes;*
- *Off-site flooding;*
- *Aircraft crash;*
- *Industrial and transport activities in the vicinity of the site;*

- *Acts of sabotage and diversion;*
- *Electromagnetic fields.*

Pursuant to the provisions of article 15, para. 4, section 1 of the ASUNE; article 26, para. 2 of the ASUNE and article 33 of the ASUNE, Kozloduy NPP – New Build has awarded a contract for the development of a project entitled "Study and Assessment of the Site Selected for the Construction of a New Nuclear Unit at the Current Site of Kozloduy NPP". The performance of this project in under way and as a result of its implementation, the design features of the preferred site to which the design of the new nuclear unit will comply will be defined. All components of the meteorological impact of the stress tests of ENSREG are within the scope of the study and will be included in the design features. For example, in addition, probabilistic analyses and studies of extreme meteorological phenomena and combinations thereof will be made. Once the design characteristics have been determined, information will be available for the probability of exceedance.

Comment of the expert team

The question was answered in as much detail as possible considering the information already available at the time of the EIA process.

Concerning the annual probability of exceedance for the different meteorological impacts accounted for in the design of the NNU, it is recommended that a value of at least 10^{-4} is used. In case some external hazards cannot be reliably determined for such a probability of exceedance, conservatively determined bounding values should be chosen.

It would be appreciated if information on the following topics could be provided at a later stage:

- Respective probabilities of exceedance for the different meteorological impacts accounted for in the design of the NNU.

6 ACCIDENT ANALYSIS

1.38. 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?

Answer by the Bulgarian side

According to EUR, the design basis accidents are divided in two sub categories. The first one covers events with a probability of occurrence in the range of 10-2÷10-4 per year. The second one covers events with a probability of occurrence in the range of 10-4÷10-6 per year. Similar categorisation exists in the Bulgarian Regulatory documents (article 12 of the Regulation on Ensuring the Safety at Nuclear Power Plants). In accordance with EUR, the effective dose for the public in case of design basis accidents with probability of occurrence in the range of 10-2÷10-4 shall be less than 1mSv/event. In accordance with EUR, the effective dose for the public in design basis accidents with probability of occurrence in the range of 10-4÷10-6 shall be less than 5mSv/event. The design basis accident nuclide vector considered in terms of this applies to events with probability of occurrence in the range of 10-4÷10-6 per year. The text used in EIAR, Chapter 6, section 6.1.3.3 "According to EUR, this concerns an accident with a probability of occurrence approximating 10-6 /year." implies that the accident considered has a probability of occurrence close to the upper limit of 10-6 , in other words, of the lowest probability and with the most severe consequences.

Comment of the expert team

The EUR deliberately do not provide dose criteria but release targets (see volume 2, chapter 1, appendix B). Therefore, the dose limits mentioned in the answer cannot be derived from the EUR.

Among the two EUR release targets for DBA conditions of category 3 (10-2/a÷10-4/a) and 4 (10-4/a÷10-6/a) only the target for economic impact is referred to in table 6.1-3 of the EIA-Report. The EUR release target for economic impact is identical for DBA category 3 (10-2/a÷10-4/a) and 4 (10-4/a÷10-6/a) conditions. Therefore, the nuclide vector of the source term stated in table 6.1-3 of the EIA-Report refers to DBA conditions with frequencies from 10-2/a÷10-6/a and not solely to DBAs of the lowest probability and with the most severe consequences.

Summarized, the reference to the EUR is still not comprehensible and the question wasn't sufficiently answered.

It would be appreciated if information on the following topics could be provided at a later stage:

- Unambiguous information about the applied release targets for DBA that have to be fulfilled by the NNU.

1.39. 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?

Answer by the Bulgarian side

The main assumption of the EIA is that the suppliers are obliged to follow the EUR requirements about limiting the consequences of beyond design basis accident (BDBA) (as well as of the design basis accident (DBA), but we do not consider DBA in this response). The source term of release, and, therefore, the potential draining of radioactive substances in the environment are shown in EUR, volume 1, Chapter 1, attachments A and B. For the purpose of EIA, the only pints of significance are the total amount of the source in the environment and its parameters (temperature, height of release, duration of release), and not the manner or the causes for release of that source term to the environment. In the continuing licensing process, the Suppliers should justify that the real source term for a given beyond de-sign accident is below the one in the EUR or that the event /scenario with the largest release can be "practically eliminated" pursuant to the documents of the Association of the West European Nuclear Regulatory Association (WENRA) for new nuclear reactors. The EUR document contains a number of criteria for limiting of releases to the environment in case of a DBA. But the following two criteria pose the greatest restraints: ´

- *Exclusion of evacuation of the public for up to 7 days following the accident, beyond 800 m distance from the reactor.*
- *Exclusion of economical consequences from the accident such that may affect the free trade with food of food consumption in the region over a long-term period. This does not mean that any measures should be excluded regarding agricultural production in the area of emergency planning.*

Using these two criteria, the following EUR requirements in respect of the beyond DBA source terms are set:

- *The releases of isotope Cs-137 may not exceed 30 TBq (limiting of the long-term consequences of the accident);*
- *For the linear combination of activity released to the environment in the first 24 hours following the accident, the following inequality (characterising the short-term radiological consequences – of importance for the planning of emergency actions) has to be fulfilled (for the characteristic isotopes):*

$$\sum_{i=1}^{9} R_{ig} C_{ig} + \sum_{i=1}^{9} R_{ie} C_{ie} < 5 \times 10^{-2}$$

where R_{ig} and R_{ie} (expressed in TBq) stand for the accumulated releases to the ground and in height of representative isotopes up to 24 hours following the beyond design basis accident, while the coefficients C_{ig} and C_{ie} are identified in the following table:

Xe-133	6.5E-8	1.1E-8
I-131	5.0E-5	3.1E-6

Cs-137	1.2E-4	5.4E-6
Te-131m	1.6E-4	7.6E-6
Sr-90	2.7E-4	1.2E-5
Ru-E3	1.8E-4	8.1E-6
La-140	8.1E-4	3.7E-5
Ce-141	1.2E-3	5.6E-5
Ba-140	6.2E-6	3.1E-7

Pursuant to EUR, the ground releases and the respective coefficients are assumed to have a height of up to 100m. The releases in height are those above 100m and are typical for the ventilation stacks. Regarding the term source, the first criterion for the purpose of EIA was derived from EUR (Cs-137 releases shall not exceed 30 TBq) and has been applied unchanged, while the second criterion has been increased conservatively about 2.4 times. A detailed description is provided in the response to the next query. If the manufacturers of a given reactor can prove that they satisfy the EUR for beyond design accident, they can automatically perform the allowable values of the source term for beyond design accident which are applied in the EIA Report. The EIAR does not address specific initiating events of the beyond DBA (neither of the design basis accident). The EIAR refers to the national normative documents and to those of IAEA, WENRA and EUR, in connection with the list of events that need to be considered in the licensing process. The EIA does not specify the routes in which the source term leaves the reactor and moves in the environment. EIA shows that the requirements to the barriers have to be fulfilled pursuant to the national normative documents and those of IAEA, WENRA and EUR. The EIA Report assumes that that reactor pressure vessel integrity can be damaged during a severe accident scenario, but the integrity of the containment can be preserved, which are the requirements for the reactors of generation III. During the beyond design basis accident, the containment is isolated so that the releases through the ventilation stack (releases in height) can be excluded. The entire amount of the source term comes from the releases as a result of the containment integrity damage. It is assumed that the release rate complies with the EUR requirements but in all cases leads to releases to the environment (source term) in less amounts than those accepted in the EIA Report.

Comment of the expert team

The question was answered in as much detail as possible considering the information already available at the time of the EIA process. However, it would be appreciated if information on the following topics could be provided at a later stage:

- Initiating events that shall be considered in the determination of possible core damage states.
- Consideration of core damage states originating from events with containment-bypass.
- Design extension conditions (e.g. external events beyond the design basis) that shall be considered.

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

Answer by the Bulgarian side

According to the Bulgarian regulation framework– REGULATION for ensuring safety of nuclear power plants core damage frequency in case of severe accidents defined on the basis of probabilistic safety analysis should be lower than 10-5 events in NPP per year. The results of the pre-feasibility study have shown that the core damage frequency of the reactors discussed in the EIA Report is lower than 10-5events in NPP per year. The issue is related to analyses which are subject to probabilistic safety analysis (PSA) and Safety Analysis Report (SAR). At this stage of project progress (pre-feasibility study) the data are not available due to the lack of technical design.

Comment of the expert team

The question was answered in as much detail as possible considering the information already available at the time of the EIA process. However, it would be appreciated if information on the following topics could be provided at a later stage:

- Frequencies of the considered core damage states and the statistical confidence level of these frequencies.

1.41. 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?

Answer by the Bulgarian side

US NRC NUREG-1465 is applied to determination of the release rates of radionuclides different from Xe-133 and I-131. For ground level release the term source of Xe 133 is defined according to the EUR formula.

$$\sum_{i=1}^{9} R_{ig} C_{ig} + \sum_{i=1}^{9} R_{ie} C_{ie} < 5 \times 10^{-2}$$

The result for Xe-133 is 770 000 TBq. This is a conservative approach to the source term of Xe-133 as well as for all other source terms. When determining the source term of I-131, the same approach as for Xe-133 is used (assuming that the above formula is applied only to I-131). The result for Xe-133 is 1 000 TBq.

For the other radionuclides the following approach is applied:

The initial activity of the main radionuclides in the reactor core is determined in accordance with the data for the irradiated fuel, which are provided by the Suppliers. The concentration of radionuclides in the air of the confinement is calculated using the transfer coefficient of radionuclides from the reactor core to the air of the confinement on the basis of NUREG-1465 as follows:

Xe-133 = 1; I-131 = 0.75; Cs-137 = 0.75; Sr-90 = 0.12; Te-131m = 0.305; Ru-103 = 0.005, La-140 = 0.0052; Ce-141 = 0.0055, Ba- 140 = 0.12 – this means that 100% of Xe-133 available in the reactor core enter in the air of the confinement during severe accident with reactor core melt which is 75% of the available I 131, 12 % of Sr-90, etc. Thus the source term in the confinement of each of the dis-cussed reactor is determined (for example AP-1000). For releases to the environment of radionuclides different from I -131 and Xe-133 (refer above) it is assumed that the same are transferred through the damaged integrity of the containment with the same release rate as for Cs-137. If the release of Cs-137 is 30 TBq, than the release rate of a given radionuclides is according its concentration in the containment. Following this approach, releases of all separate source terms for each of the reactors are calculated, and then the EIA Report is applied to the framework (maximum values) obtained for the corresponding nuclides. Note: the same applies to Sr-90, Te-131, Ru-103, La-140, Ce-141, Ba-140. For Cs-137, Xe-133, I-131 the amount of source term in the environment is determined according to the above described manner. In terms of NUREG-1465 the conclusion can be made that this document has only supportive role. The term sources in the reactor core are based on the data from the Suppliers rather than the assumptions according to NUREG-1465. Only the transfer coefficient of Sr-90, Te-131, Ru-103, La-140, Ce-141, Ba-140 from the reactor core to the air of the containment is based on NUREG-1465.

Comment of the expert team

The usage of the results of the report US NRC NUREG-1465 was comprehensively explained. No answer was given to the question concerning the applicability of the source terms derived in US NRC NUREG-1465 to fuel irradiated to high burn-up levels (in excess of about 40 GWD/MTU). However, it is also stated that results of the report US NRC NUREG-1465 have only a supportive role and the term sources in the reactor core should be based on the data from the suppliers rather than on the results according to NUREG-1465. Altogether, the question was sufficiently answered.

1.42. 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?

Answer by the Bulgarian side

The considered types of reactors are of Generation III+ complying with or designed to comply with the requirements of EUR. The requirement is to meet the regulatory requirements (Regulation for ensuring safety of nuclear power plants and EUR) for impact on the public and the environment for design basis and severe accident. Containment (containments) and corresponding process systems should provide such level of protection so that the radionuclide release to the environment in the amounts exceeding those established in the EUR, Chapter 2.1, Appendix B- PROCESS OF VERIFICATION OF THE OBJECTIVES OF EUR REGARDING TO THE ENVIRONMENTAL IMPACT More detailed analyses will be made at the design stage of the specific reactor model.

Comment of the expert team

The question was fully answered.

1.43. 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)?

Answer by the Bulgarian side

The safety systems are described in Chapter 2, section 2.3 – Alternative options for construction of new nuclear unit. The considered types of reactors are of Generation III+ complying with or designed to comply with the requirements of EUR. The designers have developed deterministic safety analyses and PSA, Level 1 and 2, as well as provided measures for prevention and mitigation of the severe accident consequences in case of design extension conditions. The detailed information in terms of robustness of the design, provided in the developed analyses shall be provided at the stage of submitting a technical design of the selected model for review and approval.

Comment of the expert team

The question was answered in as much detail as possible considering the information already available at the time of the EIA process. However, it would be appreciated if information on the following topics could be provided at a later stage:

- Information about effectiveness and robustness of 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).

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

Answer by the Bulgarian side

Any specific scenarios for design basis accidents and beyond design accidents are not analysed. This is not objective of the EIA Report. The maximum allowable consequences for the environment of potential design basis and beyond design accidents are analysed. The consequences are determined for maximum release of term source in the environment. For both de-sign basis and beyond design accidents, the level of source term in the EIA Report is higher (more conservative) than the one according to the requirements, criteria and objectives of the EUR in terms of maximum environmental impact of design basis and beyond design basis accident. The term sources are defined for all scenarios for design basis and beyond design accidents indicated in the documents of WENRA, EUR and IAEA. The design basis accident can be indicated as representative (loss of primary coolant, including double sided guillotine rupture of pipeline with the largest diameters or SG tube rupture with preceding iodine spike) and be-yond design accident (core melt outside the reactor pressure vessel and core melt inside the reactor pressure vessel for AP-1000 reactor where the core melt outside the reactor pressure vessel is in fact excluded).

Comment of the expert team

The question was answered in as much detail as possible considering the information already available at the time of the EIA process. However, it would be appreciated if information on the following topics could be provided at a later stage:

- Information about the considered spectrum of design basis and beyond design basis accident scenarios.

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

Answer by the Bulgarian side

According to the Bulgarian regulation framework–REGULATION for ensuring safety of nuclear power plants large early release rate to the environment requiring the urgent protective measures for the population should be higher than 10-6 events per NPP per year. The results of the pre-feasibility study have shown that the core damage frequency of the reactors discussed in the EIA Report is significantly lower than 10-6events per NPP per year. (Refer to Chapter 2 of EIA Report). The issue is related to analyses which are subject to probabilistic safety analysis (PSA) and Safety Analysis Report (SAR). At this stage of project progress (pre-feasibility study) the data are not available due to the lack of technical design. According to the WERNRA requirements to the new reactors, scenarios with significant early releases should be in fact eliminated (definition and examples for practical elimination are given in the WENRA documents for new reactors).

Comment of the expert team

The question was answered in as much detail as possible considering the information already available at the time of the EIA process. However, it would be appreciated if information on the following topics could be provided at a later stage:

- Information about the frequencies of scenarios with large early releases respectively the provisions for their practical elimination.

1.46. 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?

Answer by the Bulgarian side

Specific values for the assumption of the retention of radioactive nuclides in the containment are not applied in the EIA Re-port. The term sources are defined on the basis of the requirement that the EUR criteria for limited environmental impact of design basis and beyond design accidents should be met. The term sources in the EUA Report are defined in the answer 6.1 and 6.4 according to the described manner and are more conservative compared to those according to EUR. The Contractor for Unit 7 in Kozloduy should meet the EUR in terms of source terms for all conditions including beyond design accidents. If the Contractor fulfils the EUR, than it also fulfils the assumptions of the EIA Report. In

addition, the Contractor should fulfil the EUR requirements for leaktightness of the containment (regulation for leaktightness 0.5 % per day of the primary containment, and for the secondary containment - maximum 10% of the regulation for primary containment leaktightness). These values are confirmed by the referent reactors of the Suppliers (0.1 -0.3% of the regulations for leak tightness of the primary containment).

Comment of the expert team

The question was answered in as much detail as possible considering the information already available at the time of the EIA process. However, it would be appreciated if information on the following topics could be provided at a later stage:

- Values concerning the efficiency of the retention of radioactive nuclides inside the plant and the technical justification for these values.

1.47. 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)?

Answer by the Bulgarian side

It is taken from EUR (answer 6.2), where it is justified to be so. In the Bulgarian Regulation for ensuring safety of nuclear power plants there is a requirement saying "During severe accidents the release rate of Cs-137 to the environment, which does not require long-term restrictions for the usage of soil and water in the monitored area is 30 TBq. The combined release of other radionuclides different from the isotopes of caesium should not be caused on a long-term basis with the beginning of 3 months after the accident higher than the risk identified for the caesium releases within the stated limit".

Comment of the expert team

The question was fully answered.

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

Answer by the Bulgarian side

At design stage the WENRA requirements concerning "practical elimination" will be set as obligatory for the Designer, who should secure design provisions where possible strengthened by operational ones. The scenarios accident sequences which will be set for considering for "practical elimination" by the Designer will include but won't be restricted to the following: reduction of potential radioactive releases to the environment from accidents with core melt as a result of unacceptable initiating faults and consequential faults, as well fuel melt sequences, during all operational conditions which are challenging the confinement. The WENRA methodology shall be mandatory. Deterministic and probabilistic analysis will be requested, as well submission of adequate supported calculations and experimental results.

Comment of the expert team

The question was answered in as much detail as possible considering the information already available at the time of the EIA process. However, it would be appreciated if information on the following topics could be provided at a later stage:

- Accident scenarios and plant respectively containment states that shall be practically eliminated and information about the respective provisions to achieve this goal.

1.49. 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?

Answer by the Bulgarian side

Refer to answer 6.11.

Comment of the expert team

See comment to question 6.11.

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

Answer by the Bulgarian side

The EIA Report procedure is a main preventive tool which guarantees that the impact of the investment proposal on the environment is established and assessed at the earliest possible stage. It is a part of the licensing process for construction of a new nuclear unit which is established in Act on Safe Use of Nu-clear Energy (ASUNE). According to the licensing process, studies to define the updated design features for construction of a new nuclear unit are performed on the basis of Bulgarian regulations and the IEAE and WENRA requirements taking into consideration the lessons learned from the Fukushima accident. After the definition of the design features of the new nuclear unit, these should be satisfied by the technical design of the new nuclear unit.

Comment of the expert team

The question was answered in as much detail as possible considering the information already available at the time of the EIA process. Concerning appreciated additional information, see the comment to question 3.2.

7 TRANSBOUNDARY IMPACTS

1.51. 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?

Answer by the Bulgarian side

The required data are not subject to the EIA Report. Kozloduy NPP -New Build EAD as a Contracting Authority of the investment proposal is not the owner of these data and cannot provide them.

Comment of the expert team

The question was fully answered.

1.52. 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?

Answer by the Bulgarian side

The allowable discharges to the environment are established in the regulations The EIA Report does not consider the specific initiating events which have caused these discharges. When selecting a specific reactor model, the Technical Design should cover their limits.

Comment of the expert team

The question was answered in as much detail as possible considering the information already available at the time of the EIA process. However, it would be appreciated if information on the following topic could be provided at a later stage:

- Source terms for specific accident scenarios including accidents in the spent fuel pools for the selected reactor type for the NNU and the related large release frequencies (LRF) even if the value is below 1*10E-7.

1.53. 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?

Answer by the Bulgarian side

The ESTE EU is an information system and software for radio-logical impact assessment at the territory of the European countries in case of radiological accident in and outside the country. The system was implemented by the State

Nuclear Safety Service of Prague, Nuclear Regulatory Agency of Sofia and Crisis Centre of the Federal Environmental Ministry of Austria (BMLFUW) in Vienna

According to the set source term, the Republic of Austria is not affected and there are no long-term effects of the impact on the public and population observed.

In order to model conservatively the possible impact on Austria, such characteristics of meteorological data are used so that the maximum effect on your territory to be considered - neutral stratification (stability class D) when the pollution cloud may reach longer distances from the source term and stable stratification (class F) where there is no or there is a very weak turbulence, which prevent the dispersion of pollutants in vertical direction and transports them in horizontal one. During the analysis with real meteorological data, even lower values are obtained due to the specifics of the meteorological situation in this region.

Comment of the expert team

The question was answered in as much detail as possible considering the information already available at the time of the EIA process. However, the results don´t show any consequences for the Austria territory in case of severe accident at the new NNU only because of the postulated limited source term. Thus, it would be appreciated if information on the justification of the postulated source term on basis of specific safety analysis of the new NNU could be provided at a later stage.

Because the justification of the used source term is not available yet, it is recommended to calculate the consequences of a **severe accident with a large release** – in addition to the limited release scenario presented in the EIA-Report – since the effects of severe accidents can be wide-spread and long-lasting and even countries not directly bordering Bulgaria, like Austria, can be affected.

1.54. 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?

Answer by the Bulgarian side

Impact assessment using the program ESTE EU-Kozloduy is made using the Gaussian plume model, which is based on the Lagrange – statistical approach to describe the processes of turbulent diffusion.

The selected adverse meteorological conditions where higher ground level concentrations can be obtained are a combination of a dry conditions and two atmospheric stability classes:

Class D – neutral stratification (adiabatic temperature conditions in height) and strong wind - velocity of 5m/s when lower ground level concentrations at a longer distance from the source term are observed because the time for which the cloud reaches the ground layer is higher and the atmospheric diffusion dilutes the concentration in the plume

Class F – strong stability conditions (temperature is increased in height - inversion) and light winds with velocity of 2m/s. In stable conditions of the atmosphere the lacking or very weak turbulence prevents from dispersion of pollutants in vertical direction and transports them in horizontal direction. Thus the plume is spread very far away from the source term.

With the ESTE EU programme a 168 hour forecast is made and the obtained results for the effective dose in the selected quadrant (5 per 5 m) for Vienna is below 1E-09 Sv and dose rate is 1E-11Sv/h.

These results are below the minimal significant values established in EUR and IAEA.

The ESTE EU programme of Kozloduy computes the required protective measured up to 200 km from Kozloduy NPP, and in ESTE EU mode provides a 7 day assessment of selected point on the European territory for set meteorological parameters.

Since intervention levels for application of short term and long terms protective measures outside the emergency planning zones are not reached, detailed calculations for distances longer than 200 km are not required. The obtained results for distances longer than 200 km are below the minimal significant values for contamination of the environment (40 kBq/m2 for reference radionuclides Cs-137 and I-131, which is defined as radioactively contaminated according to the IAEA definition).

Comment of the expert team

The questions were fully answered. (But see comment to answer 7.3)

1.55. 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?

Answer by the Bulgarian side

Yes. All EUR criteria shall be considered. The design of the new nuclear unit should satisfy these criteria. In Chapter 6, section 6.1.4.2. the emergency planning zones are considered, i.e. the focus is on the distance of 800m and 3km

Comment of the expert team

The questions were fully answered.

1.56. 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?

Answer by the Bulgarian side

A similar approach is applied. The type of reactor has not been chosen yet, which is why there is Technical Design. Criteria set out in EUR, and no specific data for a certain reactor type, are used. In this case, it is logical for the results obtained to be similar. Thus the calculated doses should be verified during the Technical Design phase.

Comment of the expert team

The question was answered in as much detail as possible considering the information already available at the time of the EIA process. However, it would be appreciated if the verified doses could be provided at a later stage.

8 RADIOACTIVE WASTE MANAGEMENT

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

Answer by the Bulgarian side

According to the updated national strategy for spent nuclear fuel and radioactive waste management considering the fact that Bulgaria has no possibility to apply the closed fuel cycle, it is recommended to use an open cycle with priority to the use of dry spent fuel storage method. This provides possibility to avoid at this stage errors in terms of disposal of radioactive waste. Technologies are expected to develop in the near future.

Comment of the expert team

The answer clarifies that an open fuel cycle will be used, but a closed fuel cycle will not be completely ruled out due to possible future technological developments in this area. The question was answered in as much detail as possible considering the information already available at the time of the EIA process.

1.58. 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?

Answer by the Bulgarian side

For the new nuclear unit a new spent fuel storage facility will be constructed depending on the type of fuel to be used and the storage technology. The existing spent nuclear fuel storage facility with underwater storage is not provided for the new nuclear unit.

Comment of the expert team

The question was fully answered.

1.59. 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)?

Answer by the Bulgarian side

By the end of 2021 in compliance with the National Strategy for Management of Spent Nuclear Fuel and Radioactive Waste 2030 a long -term repository with a period of administrative control not shorter than 100 years for high active radioactive waste and 2b category medium radioactive waste should be constructed and commissioned.

Comment of the expert team

The question was fully answered.

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

Answer by the Bulgarian side

The interim waste storage facilities for conditioned and unconditioned RAW at the site of Kozloduy NPP are fully sufficient for RAW management for both the existing nuclear installations and new nuclear unit. The capacity of the planned for construction National Repository for Low and Medium Active Radioactive Waste (NRRAW) according to preliminary evaluation is 138 200 m3 or 345 500 tons. When defining the capacity, the RAW streams from operation and maintenance activities at Kozloduy NPP were considered. The amount of historic RAW, which are stored in temporary storage facilities are considered. RAW which will be gen-erated as a result of the performance of the decommissioning activities at Kozloduy NPP have been considered. When defining the capacity of the National Repository for RAW, the RAW streams from IRT-2000 research reactor, RAW from operation of the future nuclear unit as well as nuclear applications in the Republic of Bulgaria (industry, agriculture, science, medicine, etc.) have been considered. The capacity of the NRRAW has considered the current technologies for RAW management where the volume reduction factor for disposal ranges from 3 to 7. With commissioning of the facility for RAW conditioning with a high reduction factor (Plasma Melting Facility for RAW), which is expected to be commissioned by 2015, the disposal volumes in NRRAW will be reduced significantly. In this connection it can be said that the capacity of the NRRAW is also fully sufficient to accept RAW from the new nuclear unit.

Comment of the expert team

The question was fully answered.

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

Answer by the Bulgarian side

The data are provided in the EIA Report, Chapter 4.7. The EUR requirements which are the total amount of the final solid radioactive waste (wet solidified, dry compressed or un-compressed) generated by a single plant shall not exceed 50m3 per 1 000MW annually during normal operation with dose rate limit of the package surface (typical value of 10 mSv/h), without considering the equipment, contaminated during service and maintenance will be considered in the the future project. As of the performance of the pre-feasibility study, the manufacturers of the discussed reactor models state that this has been performed.

Comment of the expert team

The question was answered in as much detail as possible considering the information already available at the time of the EIA process. However, it would be appreciated if information on the following topic could be provided at a later stage:

- What quantities of conditioned LILW will be produced by the chosen reactor type?

9 OPEN TOPICS

As the EIA procedure has to be completed before the choice of the reactor type, many details on safety-relevant questions are not available yet. In the following, a list of open topics is given. It would be appreciated if information on these topics could be provided at a later stage.

3. Description of the project

3.2/3.3

It would be appreciated if information on the requirements and analyses concerning the following topics could be provided at a later stage:

- long-term loss of power and/or ultimate heat sink,
- multi-unit accidents,
- accidents in spent fuel pools,
- use of mobile equipment,
- consideration of extreme natural hazards,
- robustness and scope of severe accident management,
- other Fukushima-related aspects relevant for the project.

3.4

The expert statement at hand, section 3.2, refers to differences regarding the connection of the four sites to outdoor switchgear. For sites 1 and 3, this connection is much more difficult according to the EIA-Report. 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. This issue is not addressed in the answer. We assume that it will be addressed, along with the issues listed above, in specialized studies. It would be appreciated if information on the results of the specialized studies on the topics listed above could be provided at a later stage.

4. Reactor Type

It would be appreciated if information on the following topics could be provided at a later stage:

- 4.1 information on the safety systems, in particular the passive cooling systems and the systems to control the molten core, of the selected reactor type
- 4.2 information on the probabilistic analyses (in particular, plant states and event categories included; treatment of uncertainties)
- 4.3 information on the differences between the two types of AES-2006 (with VVER-1200/392M and with VVER-1200/V491), should one of these two reactor types be selected
- 4.4 more explicit information on the application of the concept of practical elimination in the safety requirements for the NNU

- 4.5 criteria for practical elimination of conditions or accident sequences
- 4.6 information on assessments and analyses of the reliability and effectiveness of the safety systems of the reactor type selected

5. Site evaluation incl. external events

It would be appreciated if information on the following topics could be provided at a later stage:

Seismic hazard assessment

- 5.1 More detailed information about the conducted analyses concerning the evaluation of the seismicity of the site and the reports where the results have been documented.
- 5.2 More detailed information about the field studies and the methods applied to identify main geological structures and to evaluate Neogene-Quarternary activities
- 5.3 The derived horizontal response spectra for the 5 types of sources for an annual exceedance probability of 10^{-4}.
- 5.6 More detailed information about the analyses conducted after 1995 to make sure that the seismic hazard assessment 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).
- 5.9
  - Availability of new data about seismicity and tectonics obtained after the finalization of the seismic hazard study mentioned in the answer to question 5.1.
  - Evaluation of possible consequences for the validity of the seismic hazard study in case new data are available.

    Note: If recommendation 5.8 that the **seismic hazard** at the Kozloduy site should be **re-assessed** before the concrete design process for the NNU starts is implemented, the questions number 5.1, 5.3, 5.6 and 5.9 cease to apply.

External human induced events – aircraft crash

- 5.13
  - Information about air space usage within 30 km of the plant for military training flights.
  - Information about the potential hazard of aircraft crash Type 2 due to the traffic of the flying fields in the villages of Glojhene and Harlets.
- 5.15 Information about the basic approach concerning the design of the NNU against a supposed crash of large passenger or military aircraft including information about
  - Protection by adequate design of buildings or physical separation.
  - Characterization of the assumed mechanical and thermal impacts.

External Human Induced Events – Leaks of hazardous fluids and gases

- 5.17
  - Closest possible distance between the planned Nabucco gas pipeline and the NNU.

  - Information about hazard evaluations for the thermal power plant planned at the Kozloduy NPP site including gas pipeline and the UGS Chiren – Kozloduy - Oryahovo gas pipeline.
- 5.21 Information about analyses on the formation of pressure shock waves due to gas release from the Nabucco pipeline including information on the meteorological boundary conditions of the analyses.
- 5.22 Information about the load time curve assumed for the design against the impact of pressure shock waves and information about the respective protection of the different safety relevant buildings.

Other External Events – Extreme winds and tornadoes

- 5.25 Information about the assumed wind and tornado loads and the respective protection of the different safety relevant buildings.
- 5.26 Respective probabilities of exceedance for the different meteorological impacts accounted for in the design of the NNU.

6. Accident Analysis

It would be appreciated if information on the following topics could be provided at a later stage:

- 6.1 Unambiguous information about the applied release targets for DBA that have to be fulfilled by the NNU.
- 6.2
  - Initiating events that shall be considered in the determination of possible core damage states.
  - Consideration of core damage states originating from events with containment-bypass.
  - Design extension conditions (e.g. external events beyond the design basis) that shall be considered.
- 6.3 Frequencies of the considered core damage states and the statistical confidence level of these frequencies.
- 6.6 Information about effectiveness and robustness of safety systems as well as measures for prevention and mitigation of severe accidents in case of different design extension conditions (e.g. external events be-yond the design basis).
- 6.7 Information about the considered spectrum of design basis and beyond design basis accident scenarios
- 6.8 Information about the frequencies of scenarios with large early releases respectively the provisions for their practical elimination.
- 6.9 Values concerning the efficiency of the retention of radioactive nuclides inside the plant and the technical justification for these values.
- 6.11 Accident scenarios and plant respectively containment states that shall be practically eliminated and information about the respective provisions to achieve this goal.

7. Transboundary Impacts

It would be appreciated if information on the following topics could be provided at a later stage:

- 7.2 Source terms for specific accident scenarios including accidents in the spent fuel pools for the selected reactor type for the NNU and the related large release frequencies (LRF) even if the value is below 1*10E-7.
- 7.3 Information on the justification of the postulated source term on basis of specific safety analysis of the new NNU
- 7.6 Verified doses in case of the severe accident

8. Radioactive Waste Management

- 8.5 What quantities of conditioned LILW will be produced by the chosen reactor type?

10 RECOMMENDATIONS

The implementation of the following general recommendations is important to reduce the risk of severe accidents and therefore the potential impact of transboundary emissions:

4. Reactor Type

- 4.4: It is recommended that the **concept of practical elimination** is applied consistently in the safety requirements for the NNU. Practical elimination of accident sequences has to be demonstrated with state-of-the-art probabilistic and deterministic methods, fully taking into account the corresponding publications of WENRA.

5. Site evaluation incl. external events

- 5.8 It is recommended that the **seismic hazard** at the Kozloduy site should be **re-assessed** before the concrete design process for the NNU starts. The re-assessment should be based on the latest state-of-the-art methods in seismic hazard assessment for nuclear facilities (e.g. regarding model parameters, response spectra, consideration of uncertainties and assessment of local site effects) and take into account most current data about seismicity and tectonics.
- 5.15 Concerning the **protection** of the nuclear facility **against aircraft crash** it is recommended that the NNU should be designed in a way that vital safety functions can be fulfilled despite of the thermal and mechanical impacts corresponding to the assumed crash of passenger aircrafts of the largest class (Airbus A-380) and fast military jets.
- 5.26 Concerning the annual probability of exceedance for the different meteorological impacts accounted for in the design of the NNU, it is recommended that a value of at least 10^{-4} is used. In case some external hazards cannot be reliably determined for such a probability of exceedance, conservatively determined bounding values should be chosen.

7. Transboundary Impacts

- 7.3 Because the justification of the used source term is not available yet, it is recommended to calculate the consequences of a **severe accident with a large release** – in addition to the limited release scenario presented in the EIA-Report – since the effects of severe accidents can be wide-spread and long-lasting and even countries not directly bordering Bulgaria, like Austria, can be affected.

11 REFERENCES

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.

REPLIES (2014)/CONSORTIUM DICON – ACCIONA ING (2014): Replies to Austrian Expert Statement to the EIA Report of Investment Proposal: „Building a New Nuclear Unit of the latest Generation at the Kozloduy Npp Site", Received during the EIA Procedure in a transboundary Context (Espoo Convention) by Umweltbundesamt (Environment Agency Austria), commissioned by the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management.

UMWELTBUNDESAMT (2013): Wallner, A.; Hirsch, H., Indradiningrat, A.Y., Becker, O. & Brettner, M.: Kozloduy NPP – Construction of unit 7 Expert Statement to the Environmental Impact Assessment Report. 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. Umweltbundesamt, Report REP-0449, Vienna.

PERSPEKTIVEN FÜR UMWELT & GESELLSCHAFT **umweltbundesamt**

Umweltbundesamt GmbH
Spittelauer Lände 5
1090 Wien/Österreich

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

office@umweltbundesamt.at
www.umweltbundesamt.at

EMAS
Geprüftes Umweltmanagement
REG.NO. AT- 000484

ISBN 978-3-99004-284-7