IAEA- TCR- 11619
Original: English

IAEA

INTERNATIONAL ATOMIC ENERGY AGENCY

REPORT

EXTERNAL EVENTS SAFETY SECTION
SITE AND EXTERNAL EVENTS DESIGN (SEED) REVIEW SERVICE

Safety of the Belarusian NPP against Site Specific External Hazards

Minsk, Belarus
16–20 January 2017

SITE AND EXTERNAL EVENTS DESIGN REVIEW SERVICES
conducted under IAEA Technical Cooperation Project BYE2006/07/01

"Safety of the Belarusian NPP against Site Specific External Hazards"

DEPARTMENT OF TECHNICAL COOPERATION
Division for Europe

DEPARTMENT OF NUCLEAR SAFETY AND SECURITY
Division of Nuclear Installation Safety

REPORT

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SITE AND EXTERNAL EVENTS DESIGN (SEED)
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Safety of the Belarusian NPP against Site Specific External Hazards

Mission date:	16–20 January 2017	
Location:	Minsk, Belarus	
Facility:	Belarusian Ministry of Energy	
Organized by:	IAEA Technical Cooperation Project BYE2006/07/01	
IAEA Review Team:	RZENTKOWSKI, Greg	IAEA, Director of NSNI
	COMAN, Ovidiu	IAEA, Senior Engineering Safety Officer
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	DONOVAN, Jeffrey	IAEA, Press and Public Information Officer
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	KATONA, Tamas	External Expert (Hungary)

"*Findings, conclusions and recommendations resulting from the IAEA Programme are intended only to assist national decision makers who have the sole responsibility for the regulation and the safe operation of their nuclear power plants. Moreover, they do not replace a comprehensive safety assessment which needs to be performed in the framework of the national licensing process".*

IAEA-2017
Issue date: 27-04-2017
Rev.: 0

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EXECUTIVE SUMMARY

At the request of Belarusian Government, the IAEA conducted a Site and External Events Design (SEED) mission for the Belarusian Nuclear Power Plant (NPP) situated at the Ostrovets site. The IAEA and Belarusian Ministry of Energy (hereinafter "the Counterpart") agreed on the objectives, scope and the Terms of Reference for the SEED mission during a preparatory meeting held in Minsk, Belarus, from 25 to 27 July 2016.

The Belarusian SEED mission key objective was to review the relevant NPP design parameters against site-specific hazards to determine whether all necessary safety aspects were adequately considered, as outlined in IAEA Safety Standards.

The scope of the review covered aspects related to site-specific hazard characteristics and design parameters, as outlined in Chapter 2 and Chapter 3 of the Preliminary Safety Analysis Report. Specifically, it comprised the following safety elements:

- screening of site hazards;
- site characterization and design parameters;
- site hazards and conditions monitoring; and
- specific challenges related to external events in light of lessons from the Fukushima Daiichi accident.

The SEED review mission was conducted by a team of four IAEA staff members and two international experts from 16 to 20 January 2017. The counterpart, the Belarusian Ministry of Energy, was represented by the Vice Minister, directors, managers and technical staff from the Belarusian Nuclear Power Plant, and other involved institutions participated in the review.

The Review Team assessed information provided by the Belarusian counterpart and concluded, based on a comparison between site characteristics and design parameters, that appropriate steps were followed to adequately addresses all necessary aspects of site safety and site-specific design parameters for the Belarusian NPP for relevant external hazards. Furthermore, the Review Team concluded that appropriate measures have been taken to address challenges related to external events in light of lessons from the Fukushima Daiichi accident and that consideration should be given to future developments of relevant safety improvements.

1. INTRODUCTION

1.1. BACKGROUND

The IAEA's statute tasks the Agency with developing Safety Standards and supporting Member States in the application of those standards. Member States can request safety review services to determine how well they are applying the Safety Standards. In the areas of site selection, site evaluation and design of facilities against external events, the IAEA offers the Site and External Events Design (SEED) review services.

SEED Review Services offer several optional modules, such as reviews focused on the Member State's regulation, on the selection of the site, on the site environment or on the design safety against external hazards. Member States choose modules depending on their needs. The Review Team leader, in consultation with the host, sets the schedule, objectives and the scope of SEED Review Services during a preparatory meeting with the Counterpart. This enables the IAEA Secretariat to prepare for the main review mission and to select international experts depending on the subject and expertise to be covered.

Belarus began site selection activities in the early 1980s. Initially, 74 locations were identified, with the number reduced to three after considering safety risks and economics. At the end of the site selection process, the site located in Ostrovets was selected as the most suitable site for the Belarusian Nuclear Power Plant (NPP). The Belarusian NPP received a construction license in September 2013 for the first unit and in February 2014 for the second unit. Construction was underway for both units at the time of review service.

In 2008, the IAEA conducted two Site Safety Review missions at Belarusian authorities' request. The Agency's first involvement in site-related activities in Belarus started with these missions aimed to evaluate and, if possible, resolve outstanding safety related issues of geotechnical aspects concerning three potential sites.

In September 2014, the Belarusian Ministry of Foreign Affairs requested the IAEA to conduct a SEED mission. After a series of consultations, three IAEA staff members and one international expert conducted a preparatory meeting in July 2016 to establish the objectives, scope and Terms of Reference for the SEED mission.

This report summarizes findings and conclusions from the SEED review service for the Belarusian NPP conducted in January 2017.

1.2. OBJECTIVES

The Belarusian SEED mission key objective was to review the relevant NPP design parameters against site-specific hazards to determine whether appropriate steps were followed to adequately address all necessary safety aspects, as outlined in IAEA Safety Standards.

The Terms of Reference documents the SEED mission's specific objectives as follows:

- determine whether the screening process adequately evaluates hazards selection based on clear defined criteria and uses appropriate data to obtain reasonable conclusions;
- determine whether the selected site contains or adequately addresses all necessary aspects of site safety for the nuclear installation;

- determine whether the site-specific design parameters for selected hazards have been derived appropriately based on the results of hazard analyses;
- advise on the implementation of site monitoring; and
- evaluate the resolution of specific concerns revealed by the Fukushima Daiichi accident.

1.3. SCOPE

The scope of the review covered aspects related to site specific hazard characteristics and design parameters, as outlined in Chapter 2 and Chapter 3 of the Preliminary Safety Analysis Report, [1]. Specifically, the mission scope comprised the following safety elements:

- Screening of the site hazards
  - Review the process of selecting screening hazards to consider
  - Basis for screening and screening results
- Site characterization results includes:
  - Human-induced hazards
    - ✓ Aircraft crash
    - ✓ Offsite Explosion
    - ✓ External fire
    - ✓ Accidental discharge of explosives or toxic clouds
    - ✓ Electromagnetic interference
    - ✓ Damage of water retaining structures such as dams
    - ✓ Accidental discharge of corrosive/chemical aggressive liquid into surface and ground water
  - Natural external hazards
    - ✓ Flood
    - ✓ Tornado
    - ✓ Strong winds (hurricane)
    - ✓ Seismic hazard
    - ✓ Geotechnical
    - ✓ Meteorological (precipitation, temperature and wind)
- Site related design parameters
- Site Monitoring
- Specific challenges related lessons learned from the Fukushima Daiichi Accident, including hazard assessment methods, use of uncertainties, adequacy of the design basis against external hazards, margins, combination of hazards, PSR, cliff-edge effect of hazards impact.

2. CONDUCT OF THE MISSION

The review was prepared with the development of Terms of Reference, including objectives and scope. Preparations also included identifying documents needed for the review. The Review Team's preliminary activities comprised reviewing documents provided by the Counterpart, and requesting clarification where needed. In advance to the mission, the Review Team also developed preliminary comments and recommendations aimed to support the Counterpart in its work to align with IAEA Safety Standards. The main review was conducted in plenary sessions and parallel working groups with results discussed and agreed by the IAEA Review Team as a whole. Final review findings and conclusions were discussed and delivered to the Counterpart at the exit meeting.

2.1. PREPARATORY WORK

The Terms of Reference including the objectives and scope of the SEED mission were discussed and agreed during the preparatory meeting held in Minsk, Belarus, from 25 to 27 July 2016. Documentation containing the required information for the review, including the relevant chapters of the PSAR, was made available to IAEA Review Team prior to the SEED mission. To facilitate the review process, the IAEA Review Team, as part of preparatory work, developed a set of review tables including the preliminary findings and relevant site characteristics and associated design parameters.

2.2. REFFERENCE FOR REVIEW

The main references for review include: (i) Chapter 2 and Chapter 3 of the Belarusian NPP PSAR [1], and (ii) relevant IAEA Safety Standards summarized below:

Code	Title	Edition
SF-1	Fundamental Safety Principles	2006
NS-R-3 (Rev.1)	Site Evaluation for Nuclear Installations	2016
SSG-35	Site Survey and Site Selection for Nuclear Installations	2015
SSG-9	Seismic Hazards in Site Evaluation for Nuclear Installations	2010
SSG-18	Meteorological and Hydrological Hazards in Site Evaluation for Nuclear Installations	2011
NS-G-3.6	Geotechnical Aspects of Site Evaluation and Foundations for Nuclear Power Plants	2004
NS-G-3.1	External Human Induced Events in Site Evaluation for Nuclear Power Plants IAEA	2002
NS-G-3.2	Dispersion of Radioactive Material in Air and Water and Consideration of Population Distribution in Site Evaluation for Nuclear Power Plants	2002
SSG-21	Volcanic Hazards in Site Evaluation for Nuclear Installations	2012

2.3. SEED MISSION

The SEED mission took place from 16 to 20 January 2017 at the Ministry of Energy in Minsk, Belarus. Participants included the Minister and Vice Minister of the Ministry of Energy, directors, managers and technical staff from Belarusian Nuclear Power Plant (operator) supported by Atomstroyexport (contractor), Atomproekt (general designer) and other national institutions. A list of participants is available in Appendix I and the mission programme in Appendix II.

The identified issues were presented in detail following a standard process in line with SEED Guidelines. All safety issues were presented as following:

- Issue identification
- Issue clarification
- Counterpart views and measures (self-assessment by the Counterpart)
- Assessment by the Review Team (comments/recommendations)

The issue clarification part of the presentation explained the safety relevance by referencing the applicable IAEA safety standards' paragraphs, and highlighted which safety requirements the Counterpart appears not to have met. After safety issues are identified the Review Team provides recommendations for actions to resolve any such issues and discuss these with the Counterpart. The Review Team also made suggestions for less safety relevant issues to improvement of practices and documentation in line with IAEA Safety Standards. Examples of good practices were also highlighted.

The counterpart provided excellent support for conducting this mission and responded to all IAEA requests for clarifications in a comprehensive and timely manner.

3. MAIN FINDINGS

3.1. SCREENING PROCESS

The review process is summarized in Table 1, Appendix III.

The review led to the general conclusion that the Counterpart performed a systematic and comprehensive screening of external hazards using sound and well-documented criteria. The Review Team has recognized this screening process as a good international practice.

In addition, the Review Team reached the following specific conclusions:

- the screening criteria were adequate for the selection of hazards and these were considered in a detailed assessment; and
- the screening processes for electro-magnetic interference and lightning need to be better documented in Chapter 2 of the PSAR.

3.2. SITE CHARACTERIZATION AND SITE DESIGN PARAMETERS

The review process is summarized in Table 2, Appendix III.

The Review Team assessed information provided by the Belarusian counterpart and affirmed that appropriate steps were followed to adequately address all necessary aspects of site safety and site-specific design parameters for the Belarusian NPP for relevant external hazards. In addition, the Review Team concluded that:

- site specific parameters are enveloped by the NPP design parameters;
    - meteorological parameters are enveloped by the design parameters with sufficient margin to accommodate climate change effects, and
    - the seismic design parameters are enveloping the site specific conditions, and
    - the site-specific seismic ground motion response spectra derived from site response analysis, in the low frequency range, show potentially inconsistency with the soil profile dynamic characteristics;
- protection against aircraft crashes is provided by design and by administrative measures to control and restrict the aircraft traffic (i.e., by a no-fly-zone) in the region near the site.

3.3. SITE MONITORING

The review process is summarized in Table 3, Appendix III.

The review led to the general conclusion that hazard monitoring programmes are adequate and properly documented in the PSAR.

3.4. LESSONS LEARNED FROM THE FUKUSHIMA DAIICHI ACCIDENT

The team and the Counterpart shared views and experiences to improve protection of people and environment against consequences of impact of external events on nuclear installations. The discussion focused on IAEA Safety Requirements[1][2][3] revised in 2016 to enhance protection against external events and accidents and mitigate consequences should an accident occur. These measures include assessment of external hazards and design basis, safety margins, and beyond design basis provisions for accident prevention and mitigation in relation to external hazards.

The Counterpart presented design safety features that had been introduced because of lessons from the Fukushima Daiichi accident, and an outline of its ongoing Stress Test programme. The Counterpart also confirmed its commitment to finalize Level 1 and 2 PSA before starting commercial operation.

The Review Team suggested that consideration should be given to future developments of safety improvements related to challenges highlighted in the IAEA Director General's Report on the Fukushima Daiichi Accident, and its five technical volumes.

The Review Team noted also that the commitment to finalize Level 1 and Level 2 PSA for both internal and external events is in line with good international practice.

[1] Site Evaluation for Nuclear Installations (NS-R-3 Rev.1, IAEA, 2016)
http://www-pub.iaea.org/books/IAEABooks/10882/Site-Evaluation-for-Nuclear-Installations
[2] Safety of Nuclear Power Plants: Design (SSR-2/1 Rev.1, IAEA, 2016)
http://www-pub.iaea.org/books/IAEABooks/10885/Safety-of-Nuclear-Power-Plants-Design
[3] Safety Assessment for Facilities and Activities (GSR Part 4 Rev.1, IAEA, 2016)
http://www-pub.iaea.org/books/IAEABooks/10884/Safety-Assessment-for-Facilities-and-Activities

4. CONCLUSIONS

Based on the review of the PSAR Chapters 2 and 3 related to site specific hazard characteristics and design parameters and discussions held with the Counterpart, the Review Team concluded that appropriate steps were followed to adequately address all necessary aspects of site safety and site-specific design parameters for the Belarusian NPP for relevant external hazards. Furthermore, the Review Team concluded that:

- systematic and comprehensive screening of external hazards was performed using sound and well-documented criteria;
- site specific parameters are enveloped by the NPP design parameters
- hazard monitoring programmes are adequate and properly documented in the PSAR; and
- appropriate measures have been taken to address challenges related to external events in light of lessons from the Fukushima Daiichi accident.

The Review Team offered also the following suggestions:

- the section documenting electro-magnetic interference and lightning should be improved in the Chapter 2 of the final SAR;
- the site-specific seismic ground motion response spectrum should be properly documented in the final SAR, taking into account soil conditions and international practice (IAEA Safety Standard Series SSG-9); and
- consideration should be given to future developments of safety improvements related to challenges highlighted in the IAEA Fukushima Daiichi Accident Report following completion of the stress test and PSA Level 1 and 2.

The Review Team noted that the Counterpart's practices in the following areas are in line with good international practice:

- commitment to conduct Level 1 and Level 2 PSA for both internal and external events before starting the commercial operation of the NPP; and
- comprehensive screening of site-specific external hazards.

5. REFERENCES

1. Preliminary safety analysis report of Belarusian NPP
2. SF-1 Fundamental Safety Principles, IAEA 2006
3. NS-R-3 (Rev.1) Site Evaluation for Nuclear Installations, IAEA 2016
4. SSG-35 Site Survey and Site Selection for Nuclear Installations, IAEA 2015
5. SSG-9 Seismic Hazards in Site Evaluation for Nuclear Installations, IAEA 2010
6. SSG-18 Meteorological and Hydrological Hazards in Site Evaluation for Nuclear Installations, IAEA 2011
7. NS-G-3.1 External Human Induced Events in Site Evaluation for Nuclear Power Plants, IAEA 2002
8. NS-G-3.2 Dispersion of Radioactive Material in Air and Water and Consideration of Population Distribution in Site Evaluation for Nuclear Power Plants, IAEA 2002
9. NS-G-3.6 Geotechnical Aspects of Site Evaluation and Foundations for Nuclear Power Plants, IAEA 2005
10. SSG-21 Volcanic Hazards in Site Evaluation for Nuclear Installations, IAEA 2012

APPENDIX 1 – LIST OF PARTICIPANTS

A.1 IAEA REVIEW TEAM:

IAEA Staff Member	
1. Greg Rzentkowski	Director NSNI, IAEA/NSNI
2. Ovidiu Coman	Senior Nuclear Safety Officer, IAEA/NSNI/EESS
3. Ayhan Altinyollar	Nuclear Safety Officer IAEA/NSNI/EESS
4. Jeffrey Donovan	Press and Public Information Officer OPIC
IAEA EXTERNAL Experts	
1. Pierre Sollogoub	External Expert, France
2. Tamas Katona	External Expert, Hungary

A.2 COUNTERPART:

Belarusian Nuclear Power Plant, Republican Unitary Enterprise – the customer for NPP construction and the operator	
1. Vitali Malisheuski	Deputy chief engineer for engineering support, head of industrial-technical department
2. Nikolai Grusha	Head of team for cooperation with state agencies and organizations
3. Mikhail Pigoulevski	Lead specialist for cooperation with state agencies and organizations
4. Alexandr Parfyonov	Deputy chief engineer for safety and reliability
5. Rinat Valeev	Head of reliability and safety analysis department
6. Sergey Zubov	Deputy head of radiation safety department
7. Andrey Vorobiov	Head of individual dosimetry control laboratory
Atomstroyexport Engineering Company, JSC (Contractor)	
1. Sergey Prikhodko	Director for designing Belarusian NPP
2. Evgeniy Tolstov	Lead specialist
3. Evgeniy Krasnov	1st category engineer of engineer survey department

4. Sergey Popov	Deputy head of engineer survey department
Atomproekt Company (General designer)	
1. Dmitriy Shkitelev	Director for designing Belarusian NPP
2. Pavel Bezrukov	Deputy director for designing Belarusian NPP
3. Yuriy Ermakovich	Deputy chief engineer of the project
4. Georgiy Kostrov	Lead specialist of construction department
Ministry of Natural Resources and Environmental Protection	
1. Nadezhda Zdanevich	Head of urban projects evaluation department
Republican Center for Hydrometeorology, Radiation Control and Environmental Monitoring	
1. Maria Germenchuk	Head of the centre
2. Olga Zhukova	Head, department of R&Ds for radiation and environmental monitoring
3. Viktar Melnik	Head, service of scientific and methodological support to hydrometeorological surveys
4. Lyudmila Zhuravovich	Head, service of hydrology and agrometeorology
Centre of Healthy	
1. Alena Nikolaenko	Head of radiation safety laboratory
Belnipienergoprom, Republican Unitary Enterprise	
1. Andrei Katanayev	Lead specialist of industrial-technical department
Centre of Geophysical Monitoring	
1. Arkady Aronov	Director
2. Rustyam Seroglazov	Deputy director
Geoservice, Production Republican Unitary Enterprise	
1. Oleg Lazhevich	Director
2. Yury Zaika	Chief geologist
Sosny Joint Institute for Power and Nuclear Research	
1. Alexander Trifonov	Deputy general director
Institute for Nature Management	
1. Valery Khomich	Deputy director
2. Natalia Tomina	Research specialist
Research and Production Centre for Geology	
1. Alexandr Belyashov	Lead geophysicist with Belarusian Integrated Geological Survey Expedition
Department for Nuclear and Radiation Safety (Gosatomnadzor), Belarusian Ministry of Emergency Situations	
1. Sergey Tretyakevich	Deputy head, department for assessing safety of nuclear facilities' systems and facilities


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APPENDIX 2 - MISSION PROGRAMME

Time	Day 1	Day 2	Day 3	Day 4	Day 5
9:30-10:30	Opening Introduction of Participants Approval of the Agenda Preliminary comments on External Hazard Screening	Preliminary comments on Site Specific Natural External Hazards Characterization Results	Preliminary comments on Site Specific Human Induced External Hazards Characterization Results	Preliminary comments on Site Monitoring Discussions and clarifications Conclusions on Site Monitoring	Presentation of the Summary Report Discussions on the main conclusions of SEED Safety Review Mission
10:30-11:00	Coffee Break				
11:00-12:30	Discussions and clarifications on the process arriving to screened out and screened in hazards	Discussions related to: Flood Tornado Strong winds Other Meteorological Hazards	Discussion Related to: Aircraft crash Offsite Explosion External fire	Summary of The Review Findings	Closing Session Meeting with the Ministry of Energy Media Event Adjourn
12:30-14:00	Lunch Break				
14:00-15:30	Discussions and clarifications regarding Basis for screening Hazard	Discussions related to: Seismic hazard Geotechnical Characteristics and Hazards	Discussion Related to other human induced hazards e.g. explosive or toxic clouds, Electromagnetic interference, etc. Preliminary Comments And Discussions on Specific Concerns Related to Fukushima Accident External Events	IAEA Team working on the Summary Report	
15:30-16:00	Coffee Break				
16:00-17:00	Conclusions on External Hazards Screening	Conclusions on Natural External Hazards Characterization Results	Conclusions on Human Induced External Hazards Characterization Results and Fukushima Concerns	IAEA Team working on the Summary Report	

APPENDIX 3 - REVIEW TABLES

TABLE 1 SCRRENING OF HAZARDS

No.	**Hazards Screening**	Screening Criteria	Screening Results	Remarks
1	Aircraft crash	Probability Screening Value = T=10E-6 (per one year) Ref P-SAR Chapter 2 Sub-chapter 2.2.1.1	Screened in for detailed hazard assessment.	Detailed Aircraft Hazard Assessment was carried out. Protection measures for big aircrafts are: admin measure – establishing No Fly Zone and diversion of the air corridors. Ref. P-SAR Chapter 2.2.1.1.8 Design protection measures implemented for small aircrafts (military aircrafts are not considered). Ref. P-SAR Chapter 3.5.1.1.2 The design provides safety conditions in case of a crash of a light aircraft of 5.7 tons at 100 m/s. Considered and estimated a possibility of a crash into the NPP site and a direct crash into the NPP unit of aircraft of all types including military aircraft. Administrative measures include no-fly zone and diverting flight corridors. Ref.: P-SAR 2.2.1.1. Conclusion: no safety issues
2	Offsite Explosions	DP < 30 KPa НП-064-05 Ref. P-SAR Chapter 2.2.1.3	Screened out	Conservatively design protection for 30KPa pressure wave was done (part of the standard design). Ref. P-SAR 2.2.1.3, 2.2.3 Conclusion: no safety issues
3	External fire	SDV = 2km НП-064-05 Ref. P-SAR Chapter 2.2.1.2, 2.2.3	Screened out	No protective measures needed. Ref. P-SAR Chapter 2.2.1.2, 2.2.3 Conclusion: no safety issues
4	Accidental discharge of explosive or toxic clouds	SDV= 5 and 10x km НП-064-05 Ref. P-SAR Chapter2.2.1.6, 2.2.3	Screened out	No protective measures needed. Ref. P-SAR Chapter 2.2.1.6, 2.2.3 Conclusion: no safety issues
5	Electromagnetic	No sources in site	Screened out	Suggestion = add this in Chap. 2

No.	**Hazards Screening**	Screening Criteria	Screening Results	Remarks
	interference	vicinity. P-SAR Chapter 8.3.2.7		of FSAR. Ref. P-SAR Chapter 8.3.2.7 No protective measures needed. Conclusion: no safety issues
6	Corrosive/chemical aggressive liquid accidental discharge into surface and ground water	No sources in site vicinity Ref. P-SAR2.2.1.5, 2.2.3	Screened out	No protective measures needed. Conclusion: no safety issues
7	External Flood	Dry site River mean elevation=117.4 m Design Base Flood=127.8 m Site Elevation=179.3 m P-SAR Chapter 2.3.2 page336	Screened out	Dry site demonstrated. Ref. P-SAR Chapter 2.3.2 Conclusion: no safety issues
8	Seismic Hazards: Ground Motion	Cannot be screened out PGA=0.1g	Screened in SL2 PGA=0.1g T=10,000y	Detailed SHA done. Design provisions PGA=0.12g (BAL 7) Ref. P-SAR 1.7.5.3, 2.4.2 Main reactor equipment: 0.12g Safety system equipment and piping: 0.12g Engineering structures, buildings and facilities 0.12g Conclusion: no safety issues
9	Seismic Hazards: Fault Displacement	No capable faults within 5 Km radius. Ref. PSAR Ch. 2.4.2	Screened out	Based on Site Vicinity Detailed Investigations P-SAR Ch. 2.4.2 Conclusion: no safety issues
10	Geotechnical: Liquefaction	Low seismicity and ground water level НП-064-05	Screened out Low seismicity and deeply occurring water level НП-064-05	Based on geotechnical and seismic assessment No site/soil improvement measures are necessary P-SAR Ch. 2.4.1.7.3 Conclusion: no safety issues
11	Geotechnical: Slope Stability	No natural slopes / flat site P-SAR Ch. 2.4.1	Screened out	Conclusion: no safety issues
12	Geotechnical: Cavities/Karstic Formations	No karst/Cavities P-SAR Ch. 2.4.1	Screened out	Based on Site Vicinity Detailed Investigations P-SAR Chapter 2.4.1 Conclusion: no safety issues
13	Meteorological: Extreme precipitation	T=100 y	Screened in	Detailed investigations carried out. Ref. PSAR Ch. 2.3.1.1 Conclusion: no safety issues

No.	**Hazards Screening**	Screening Criteria	Screening Results	Remarks
14	Meteorological: Extreme temperatures	T=100 y	Screened in	Detailed investigations carried out Ref. PSAR Ch. 2.3.1.1 Conclusion: no safety issues
15	Meteorological: Extreme winds	T=100 y НП-064-05	Screened in	Detailed investigations carried out Design protection provided. Ref. PSAR Ch. 2.3.1.1 Conclusion: no safety issues
16	Meteorological: Tornadoes	T=10,000 y НП-064-05	Screened in	Detailed hazard assessment done. Design protection provided Ref PSAR 2.3.1.1 Conclusion: no safety issues
17	Meteorological, rear straight winds Hurricanes	T=10,000 y НП-064-05	Screened in	Detailed hazard assessment done. Design protection provided Ref PSAR Ch. 2.3.1.1 Conclusion: no safety issues
18	Meteorological: Lightning	НП-064-05 Ref. P-SAR Chapter 8.3.2.7	Screened in	Hazard Assessment done Design protection provided Ref. P-SAR Chapter 8.3.2.7 Conclusion: no safety issues
19	Dust Storms	НП-064-05	Screened out	No design protection needed. Conclusion: no safety issues
20	Volcanic Hazards	No active volcanos Ref. НП-064-05	Screened out	No design protection needed. Conclusion: no safety issues

TABLE 2 SITE CHARACTERIZATION AND DESIGN PARAMETERS

№	Site Parameter	Site Characteristics	Design Parameters	Remarks
	Hydrological parameters			
1	Maximum Flood Elevation	+127.8 m(Baltic Sea) T=10,000 Ref. PSAR Ch. 2.3.2	+179.3m(Baltic Sea) Ref. PSAR Ch. 2.2.1.4	Design site level mark is 51.5 m higher than the maximum estimated water level. Conclusion: no safety issues
2	Maximum Elevation of Groundwater	159.69-167.88m Ref. PSAR Ch. 2.4.1.7.2	+179.3m (Baltic Sea) Ref. PSAR Ch. 2.2.1.4	Conclusion: no safety issues
	Meteorological parameters			
	Air Temperature			
3	Maximum dry bulb temperature and coincident wet bulb temperature 1% annual frequency of exceedance 2%annual frequency of exceedance 100 year return period	0.01% = 37.4 ^{0}C Ref. PSAR Ch. 2.3.1.1	Design 52 ^{0}C Ref. PSAR Ch. 3.10.6	Conclusion: no safety issues
4	Maximum non-coincident wet bulb temperatures 1% annual frequency of exceedance 2% annual frequency of exceedance 100 year return period	0.01% = 37.4 ^{0}C Ref. PSAR Ch. 2.3.1.1	Design 52 ^{0}C Ref. PSAR Ch. 3.10.6	Conclusion: no safety issues
5	Minimum dry bulb temperature 98% annual frequency of exceedance 99% annual frequency of exceedance 100 year return period	0.01% = -50 ^{0}C Ref. PSAR Ch. 2.3.1.1	Design -61 ^{0}C Ref. PSAR Ch. 2.3.1.1	Conclusion: no safety issues
	Ultimate heat sink			
6	Meteorological conditions resulting in the minimum water cooling during any 1 day (5 days)	Non-exceedance level: -25,5 0C – 2% -22.2 0C – 8%	Non-exceedance level: 10% = -22,0 0C	Conclusion: no safety issues

	Historic worst case	Relative humidity 80% Construction climatology СНБ- 2.04.02-2000	Relative humidity 81% 1.4 m/s Ref.: Calculation 'Specification of cooling capability of spray cooling ponds. PSAR Ch. 12.3.2.1.5.4	
7	Meteorological conditions resulting in the maximum evaporation and drift loss during any consecutive 30 days. Historical worst case	Non-exceedance level: 10% T 23,9 Relative humidity 69% Wind velocity at 10 m height: 1.4 m/s Ref.: Calculation 'Specification of cooling capability of spray cooling ponds'. PSAR Ch. 12.3.2.1.5.4	T = 23,90C Relative humidity 69% Wind velocity at 10 m height: 1.4 m/s Ref.: Calculation 'Specification of cooling capability of spray cooling ponds'. PSAR Ch. 12.3.2.1.5.4	Conclusion: no safety issues
	Wind speed			
8	3 second gust wind speed 100 year return period	Ultimate gust wind speed recorded: 36 m/s 54 m/s for T=10,000y Ref. PSAR Ch. 2.3.1.1	61 m/s Ref. PSAR Ch. 3.10.6	Conclusion: no safety issues
	Precipitation (liquid equivalent)			
9	Local intense precipitation Probable maximum precipitation 100 year return period	Maximum precipitation recorded: 101 mm/day 1075 mm/year Ref. PSAR Ch. 2.3.1.1	160 mm/day for T=10,000y 1160 mm/year for T=10,000y Ref. Belarusian NPP Design, vol. 1, 5.3.1.1.4.	Conclusion: no safety issues

	Snowpack			
10	Ground snowpack weight 100 year return period	Maximum storage of water in snowpack: 195 mm 3 kPa for T=10,000y Ref. PSAR Ch. 2.3.1.1	4.3 kPa 270 mm PSAR Ch. 3.10.1.1	Conclusion: no safety issues
	Freezing precipitation (Ice storms)			
11	Ice thickness and concurrent wind Speed 100 year return period	2.1 mm for a wire cable of 10 mm thick at 10 m height Ref. PSAR Ch. 2.3.1.1.48	5 mm for a wire cable of 10 mm thick at 10 m height СП 20.13330.2011 Ref. PSAR Ch. 2.3.1.1.48	Conclusion: no safety issues
	Lightning			
12	Lightning strike frequency Lightning strikes per year	0.5/km^{2}per year According to Gidromet (Belarus) statistics	3/km2per year According to СО 153-34.21.122-2003	Considered in the design Conclusion: no safety issues
	Tornado			
13	Maximum horizontal Wind speed Translational speed Rotational Speed Radius of Maximum Rotational Speed 10 000 year return period	17 m/s 70 m/s 80 m 2,94*10^{-6} per year Ref. PSAR Ch. 2.3.1.1	24 m/s 95 m/s 285 m Ref. PSAR Ch. 3.10.1.1.3	Conclusion: no safety issues
14	Pressure drop 10 000 year return period	6 kPa Ref. PSAR Ch. 2.3.1.1	11.1kPa Ref. PSAR Ch. 3.10.1.1.3	Conclusion: no safety issues
15	Massive tornado missile 10 000 year return period	No missiles Fujita scale tornado intensity rating for Belarusian NPP = 2,5 According to РБ-022-	1800 kg Ref. PSAR Ch. 3.10.1.1.3	Conclusion: no safety issues

		01 for values less than F3 tornado missiles are not taken into consideration. Ref. PSAR Ch. 2.3.1.1		
16	Rigid tornado missile 10 000 year return period	No missiles Fujita scale tornado intensity rating for Belarusian NPP = 2,5 According to РБ-022-01 for values less than F3 tornado missiles are not taken into consideration. Ref. PSAR Ch. 2.3.1.1	125 kg 200 mm Ref. PSAR Ch. 3.10.1.1.3	Conclusion: no safety issues
17	Small rigid tornado missile 10 000 year return period	No missiles Fujita scale tornado intensity rating for Belarusian NPP = 2,5 According to РБ-022-01 for values less than F3 tornado missiles are not taken into consideration. Ref. P-SAR Ch. 2.3.1.1	2.5 cm Ref. PSAR Ch. 3.10.1.1.3	Conclusion: no safety issues
	Hail			
18	Historical maximum hail stone size	8-10 cm 11.07.1953 Ref. PSAR Ch. 2.3.1.1	Ref. PSAR Ch. 3.10.1.1.3	Load rate is lower than the design value for tornado missiles. No additional calculation required. Conclusion: no safety issues
19	Concurrent terminal velocity	No data	Ref. PSAR	Load rate is lower than the design value for tornado missiles. No

			Ch.3.10.1.1.3	additional calculation required. Conclusion: no safety issues
	Freezing precipitation and frost related phenomena			
20	Nominal ice thickness;	2.1 mm for cable diameter of 10 mm at 10 m Ref. PSAR Ch. 2.3.1.1.48	5 mm for cable diameter of 10 mm at 10 m СП 20.13330.2011 Ref. PSAR Ch. 2.3.1.1.48 Page 225	Conclusion: no safety issues
	Change of meteorological hazard with time			
21	Changes in air and water temperatures Changes in frequency and intensity of phenomenon	Clarified		Extreme meteorological parameters are well bounded by the design parameters resulting in margins that can accommodate climate changes effects. Conclusion: no safety issues
	Seismic parameters			
22	Ground Motion Response Spectra for SL1	0.055g Ref. PSAR Ch.2.4.2	0.06g Ref. PSAR Ch. 1.7.5.3	Broadband design ground response spectrum accepted as design basis
23	Ground Motion Response Spectra for SL2	PGA=0.10g GRS shape Ref. PSAR Ch. 2.4.2	0.12g GRS Ref. PSAR Ch. 3.10.1.3	Suggestion to derive site specific GRS according to par. 9.3 SSG-9 and include it in FSAR. Conclusion: No safety issue since design GRS envelop site conditions.
	Geotechnical parameters			
24	Minimum Static Bearing Capacity	Vertical force at foundation base. 1) Reactor building Na = 1671316 kN	Foundation ultimate bearing capacity in terms of vertical force. Nu = 26600509 kN	Conclusion: no safety issues

		2) Steam chamber Na = 123480 kN 3) Other nuclear island facilities Na = 120000-588000 kN 4) Turbine building Na = 1229406 kN Foundation capacity rating was carried out according to MP 1.5.2.05.999.026-2011 PSAR Ch. 3.12	Nu = 1189192 kN Nu = 933000-39000000 kN Nu = 36319706 kN PSAR Ch. 3.12	
25	Minimum Shear Wave Velocity	300-500 m/s under foundation level Foundation capacity rating was carried out according to MP 1.5.2.05.999.026-2011 'Design standards for foundations of NPP facilities' Ref. PSAR Ch. 2.4.2	250 m/s Ref. PSAR Ch.3.11.1.4	Conclusion: no safety issues
26	Maximum Settlement	1) Reactor building Settlement 205.3 mm Tilt 0.00037 Rad 2) Safety class 1 buildings and facilities (cast reinforced concrete) Settlement 27-153	300 mm 0.001 180 mm 0.001	Conclusion: no safety issues.

		mm Tilt <0.001 3) Safety class 2 and 3 buildings and facilities (frame constructions) Settlement 22-70 mm Tilt <0.005 4) Cast reinforced concrete buildings Settlement 34-100 mm Tilt <0.005 Ref. PSAR Ch. 3.10.5	120 mm 0.005 180 mm 0.005 Ref. PSAR Ch. 3.10.5	
27	Expansion, uplift	Under-dilative soils Ref. PSAR Ch. 2.4.1	None at the base of reactor compartments	During construction, under-dilative soils are excavated This phenomenon may occur at an elevation higher than the foundation level. Conclusion: no safety issues.
	Human Induced external event parameters			
28	Aircraft Hazards on Plant SSCs	Probability Screening Value = T=10E-6 Ref. PSAR Ch. 2.2.1.1	Screened in	Detailed Aircraft Hazard Assessment was carried out. Design protection measures implemented for small aircrafts. (military aircrafts are not considered). Ref. P-SAR Chapter 3.5.1.1.2 The design provides safety conditions in case of a crash of a

				light aircraft of 5.7 tons at 100 m/s. Protection measures for larger aircrafts are: admin measure – establishing No Fly Zone and divert of the air corridors. Ref. PSAR Ch. 2.2.1.1.8 The possibility of aircraft crash of Belarusian military aircraft was screened out. The possibility of aircraft crash of Lithuanian military aircraft is 4.2x10-12 per year (based on the corresponding data provided by the Lithuanian authorities. Conclusion: no safety issues.
29	Human Induced External Hazards on Plant SSCs (e.g. explosions, fires, release of toxic chemicals and flammable clouds, pressure effects)	N/A	Screened out	Conclusion: no safety issues.
30	Grid Stability	Ref. PSAR 8.1.2.13	Screened in	Considered Ref. PSAR Ch. 8.1.2.13 Conclusion: no safety issues.

TABLE 3 HAZARDS MONITORING PROGRAMME

	Hazards Monitoring	Remarks	Remarks
1	Seismic monitoring	Monitoring programme provided. Ref. PSAR Ch. 2.6.2.4	Conclusion: no safety issues.
2	Monitoring of geotechnical parameters (Global positioning system, Settlement monuments, In situ settlement plates etc.)	Monitoring programme provided. Ref. PSAR Ch. 2.6.2.6 and 2.6.2.7	Conclusion: no safety issues.
3	A monitoring programme for groundwater,	Monitoring programme provided. Ref. PSAR Ch. 2.6.2.5	Conclusion: no safety issues.
4	A meteorological monitoring system for basic atmospheric variables,	Monitoring programme provided. Ref. PSAR Ch. 2.6.2.2	Conclusion: no safety issues.
5	A meteorological warning system for rare meteorological phenomena (e.g. hurricanes, typhoons, tornadoes),	Arrangements for meteorological warnings are in place.	Conclusion: no safety issues.
7	A water level gauge system (Hydrology).	Monitoring provisions are provided. Ref. PSAR Ch. 2.6.2.1 (surface water)	Conclusion: no safety issues.