ENSREG
European Nuclear Safety Regulators Group

Preliminary
EU Peer Review Report
Implementation of Belarusian Stress Test National Action Plan

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Contents

1 INTRODUCTION and BACKGROUND

The purpose of this document is to record the results and conclusions from the first phase of the peer review of the National Action Plan (NAcP) of Belarus. The results and conclusions in this document are based on information received via documents provided by Belarusian counterparts upon ENSREG PRT request, discussions in online meetings between both parties and visit to the Belarusian nuclear power plant (BelNPP) on 9 and 10 February 2021. Information received was verified during the site visit to the BelNPP, which included both document reviews and walk downs. The NAcP, the content and implementation status of which is being evaluated, was produced thanks to the EU stress test approach being applied in Belarus.

Due to the Covid-19 pandemic, it was not possible to carry out the peer review of the NAcP as originally planned. The pandemic resulted in limitations on travelling and organising face-to-face meetings, so the PRT was unable to organise a full scope fact-finding mission to Belarus in December 2020. Therefore, the peer review had to be divided into two phases. In the first phase, the goal was to complete the review of issues, which were recognized by PRT as high priority (see chapter 4.1 for further information). The focus of this preliminary report is on evaluating the overall comprehensiveness of the NAcP and the implementation status of recommendations related to the high priority issues.

The PRT underlines that all recommendations formulated in its report as a result of the 2018 Stress Test Peer Review[1] (2018 PRT report) are important. Their implementation will be fully addressed in the second phase of the peer review, which is expected in the spring or summer of 2021, depending on the situation with the Covid-19 pandemic. The peer review's final report will be compiled at the end of the second phase.

Following the 2011 Fukushima accident, Europe took the lead in carrying out comprehensive risk and safety assessments (stress tests) of nuclear power plants (NPPs) to assess how they could withstand extreme external events.

The results of the EU stress tests provided important technical insights for safety improvements that have been or are well under way to being implemented in all 17 participating countries in order to achieve a higher level of nuclear safety.

The EU stress tests have been carried out in a transparent manner and the results have been actively shared, in the interests of our people and a stronger global safety culture. In addition, the aim is to contribute to a more robust and solid nuclear framework worldwide.

At the time of the original EU stress tests, a number of non-EU countries expressed their interest in following the same peer review process but were not ready to join and immediately submit a report. The European Commission has always indicated its willingness to support non-EU countries, in particular in the EU neighbourhood, in the peer review process in collaboration with the European Nuclear Safety Regulators Group (ENSREG), whenever that country is ready.

[1] http://www.ensreg.eu/sites/default/files/attachments/2017-10-31_belarus_stress_test_final_report_eng_final_end.pdf

In June 2011, Belarus confirmed its willingness to voluntarily undertake the stress tests, which were to be carried out in line with the specifications agreed by the European Commission and ENSREG. Belarus stepped into the process in 2017 when it submitted its national report.

It has been emphasised that a stress test exercise remains a targeted process reviewing the safety of certain aspects of an NPP (see stress test specifications[2]) with the objective of further enhancement of safety. A stress test and the implementation of follow-up actions should not be used to justify or authorise the safe operation of an NPP nor its long-term operation or lifetime extension. Such authorisations have to be in line with the procedures prescribed in the national law and under the full responsibility of the national regulatory authorities.

2 PROCESS OF PEER REVIEW FOR BELARUS

The peer review of the national report was completed in 2018. The first step was a desktop peer review of the report that led to questions being presented to and answers being received from the Belarusian nuclear regulatory authority, Gosatomnadzor (GAN). The second step consisted of a visit to Belarus by the team of experts, including a visit to BelNPP to follow-up their lines of enquiry.

The PRT issued a report assessing the national report (NR) and recommendations for increasing safety in BelNPP[3].

In 2019, GAN submitted an NAcP, converting recommendations in their national report and the stress test peer review report into concrete actions to enhance safety together with a timeline for implementation.

2.1 Peer review of the NAcP

The peer review of the Belarusian NAcP began after GAN provided the PRT with an updated NAcP in January 2020[4]. It was the second peer review of an NAcP (after Armenia in 2019) since the two workshops that took place in 2013 and 2015 to review of the NAcPs during the ‘first wave’ of stress tests, i.e. EU Member States, Switzerland and Ukraine.

The objective of the peer review was to consider how the actions in the NAcP were developed from the national report, the stress test PRT’s recommendations and other relevant recommendations. The peer review also considered whether adequate progress was made in implementing the actions identified.

Despite having the same objective and rules as the workshop reviews, the review of the Belarusian NAcP differed from these exercises in two main areas:

- it covered both the NAcP, as developed following the national report and the stress test PRT’s recommendations, and the information on its implementation after approximately a year since its official publication;
- it was divided into two phases due to the Covid-19 pandemic.

[2] http://ensreg.eu/node/289/

[3] http://www.ensreg.eu/document/belarus-stress-test-final-report

[4] https://gosatomnadzor.mchs.gov.by/upload/iblock/f65/natsplan-stress_testy.rar

As with the national stress test report, the peer review of the NAcP started with a desktop exercise, with questions prepared by a team of experts and ENSREG members. A team of 12 was established from the experts nominated by ENSREG. The European Commission provided a rapporteur to assist the team. Their review led to a total of 93 questions[5] on the NAcP's content that were submitted to GAN on 24 July 2020. GAN subsequently provided written responses on 30 October and 30 November 2020.

On 24 November 2020, the PRT provided GAN with a first draft of its report. It was based on the written answers received from GAN to the PRT's questions and the online discussions seeking to obtain further clarification on the written answers. Due to the Covid-19 pandemic, a full fact-finding mission to Belarus planned for December 2020 including expert meetings and a site visit had to be cancelled. An updated draft report focussing on high priority issues was provided to GAN on 22 December 2020 and used as a basis for further work in phase 1. A hybrid fact-finding mission with online expert meetings and a site visit focusing on the implementation status of high priority issues was conducted in January and February 2021. The full fact-finding mission to Belarus is expected to happen in 2021, depending on the situation with the Covid-19 pandemic. The goal of the fact-finding mission is to discuss the status of all recommendations, particularly those not addressed in this report, and to evaluate and verify their implementation status. The final report on the peer review on the NAcP will be issued at the end of the second phase.

2.2 Experience in Belarus

This part will be completed at the end of phase 2 of the peer review.

2.3 Site visit

The site visit to the BelNPP on 9 and 10 February 2021 was well prepared and organised. The peer review team had access to the requested documents and plant locations via walk downs. In addition, site visit programme enabled further discussions between the PRT experts and GAN/BelNPP experts.

The documents reviewed and plant locations visited were selected to support verifying the information related to the high priority issues. Plant walk downs included visits to the reactor building, building housing safety systems, control rooms, simulator, emergency diesel generators and mobile diesel generator, JNB50 pump room, electrical equipment and battery compartments, and fire brigade premises. Documents reviewed included seismic studies and reports, drawings, emergency operating procedures (EOPs), severe accident management guidelines (SAMGs) and other documentation.

The site visit was an important part of the phase 1. It verified the information provided earlier and demonstrated progress with the implementation of the recommendations related to the high priority issues.

2.4 Peer review report structure

The PRT sought to follow the reporting template adopted by ENSREG for the workshops of 2013 and 2015.This report has chapters aligned to the 2012 stress tests template, covering the following topics:

i) assessment of the NAcP's structure;

[5] Whereby all sub-questions relating to one NAcP action or PRT recommendation were counted as one question. This is in line with the practice adopted earlier in the NAcP peer review. The total number of sub-questions was 245.

ii) assessment of the NAcP's content;

iii) peer review conclusions.

The report contains some additional details explaining the process adopted, as well as a short summary of the findings for each high priority issue of the three topic areas. It also includes a set of tables recording each action and a short evaluation of its implementation by the PRT. The comprehensive assessment together with further recommendations on how to achieve the safety improvements addressed in the NAcP are contained in the Appendix below – '*PRT Assessment of Belarusian National Action Plan*'. This Appendix forms an integral part of this report. The Appendix of this preliminary report includes evaluation only on recommendations related to the high priority issues. The remaining recommendations will be evaluated and reported after additional information has been obtained and the full site visit has been conducted.

3 ASSESSMENT OF THE STRUCTURE OF NATIONAL ACTION PLAN

GAN produced the NAcP on behalf of Belarus in 2019 to address the findings of the stress tests. The sources used for the preparation of the NAcP were:

- National Report – Belarus Stress Test National Report – 2017;
- ENSREG Peer Review of Belarus Stress Tests – June 2018;
- comments and proposals received from the environmental organisation Ecohome (via letters nr 46 (of 18 May 2018) and nr 130 (of 10 October 2018)) based on the principle of intelligent ownership that was recommended by European experts.

As a result of the EU stress tests, ENSREG issued a report – '*Compilation of Recommendations and Suggestions from the Review European Stress Tests – July 2012*'. In addition, an extraordinary meeting was organised in August 2012 by the Contracting Parties to the Convention on Nuclear Safety. This meeting resulted in the issuing of the '*Summary Report of the 2nd Extraordinary Meeting of the Contracting Parties to the Convention on Nuclear Safety – August 2012*'. The conclusions from these reports are typically used in compiling action plans. The PRT will review in the second phase of the peer review how these were taken into account in the Belarusian NAcP.

The NAcP contains a range of actions based on the recommendations made in the peer review. The structure of the NAcP is in line with that suggested by ENSREG:

- Part I - external hazards, loss of safety systems and severe accident management;
- Part II - national organisation, emergency preparedness and emergency response, and international cooperation;
- Part III gives the list of measures aimed at implementing all the recommendations contained in parts I – II.

An update to the NAcP was issued in January 2020. This contains information about the state of implementation of the NAcP actions and tasks. These are listed in detail in the Appendix below along with the PRT evaluation of the high priority issues.

4 ASSESSMENT OF THE CONTENT OF NATIONAL ACTION PLAN

As discussed in the introduction and chapter 2 of this report, the process and the focus of the peer review had to be changed due to the Covid-19 pandemic. This chapter evaluates the comprehensiveness of the NAcP to ensure it addresses all recommendations from the 2018 PRT report related to the high priority issues. In addition, an evaluation of how the recommendations related to the high priority issues were implemented is carried out.

The results and conclusions in this chapter are based on information received via documents provided by Belarusian counterparts, discussions in online meetings between both parties and visit to the Belarusian nuclear power plant (BelNPP) in February 2021. Results and conclusions have been verified by means of further discussions and a fact-finding mission to BelNPP in February 2021.

4.1 High priority issues

The PRT has identified the following seven high priority issues. They are related to one or more recommendations identified in the 2018 PRT report. The PRT considers that these recommendations are important for enhancement of safety and that they should be implemented in the short term. The PRT underlines the importance of implementing all recommendations formulated in the 2018 PRT report in a timely manner. A full evaluation of the implementation of all remaining recommendations will be carried out in the second phase.

For natural hazards, there is one high priority issue:

- verification of the adequacy of the Design Basis Earthquake (DBE with a PGA_H of 0.1059 g) and verifying that this DBE is used as basis for evaluating seismic margins to cope with the seismic Design Extension Condition (DEC)[6].

For loss of safety functions, there are two high priority issues:

- additional measures for enhancing the reliability of the JNB50 subsystem
- completing the permanent connection of the diesel generator devoted to Channel 7.

For severe accident management, there are four high priority issues:

- development, validation and implementation of symptom-based EOPs and SAMGs
- evaluation of adequacy and/or enhancement of means for depressurization of the reactor coolant system
- review and/or enhancement of habitability of control areas (main and emergency control rooms) during a severe accident combined with SBO
- prevention and mitigation measures for severe accidents under open reactor conditions

4.2 Natural hazards

The Belarusian NAcP (Table 4 and Annex 1) contains actions linked to 12 PRT recommendations that concern natural hazards (Topic 1).

Earthquakes

Out of the 12 recommendations related to natural hazards, nine actions are related to earthquakes (reference to PRT's recommendations of 2018 in parenthesis).

- No. 2: Review of the seismic PSA taking into account the probabilistic seismic hazard assessments (PSHA) of 2018 and 2020 and ensure appropriate safety upgrading measures are implemented to conform with Western European Nuclear Regulators Association (WENRA) safety objectives for new NPPs which were taken as a reference by the PRT (R-1).

[6] In this PRT report, the term design extension condition (DEC) in connection with external hazards has the same meaning as the term beyond design basis event (BDBE) used in the IAEA safety standards.

- No. 1: A comprehensive margin assessment based on the hazard curve from the PSHA and fragility evaluations, taking into account the more precise seismotectonic model, should be carried out to ensure all structures, systems and components (SSCs) margins with respect to the design basis and beyond are adequate in order to ensure their integrity and function in line with their role in support of defence-in-depth (DiD) levels (R-2).
- No. 3: The regulator should ensure that the seismic resistances of SSCs credited for coping with accident conditions (DiD levels 3 and 4) induced by a seismic event are adequate enough to carry out their function (R-3).
- No. 4: Clarify the nature of the 1908 Gudogay seismic event and update the seismicity catalogue for the region in which BelNPP is located (R-4).
- No. 5: Increase the number of stations in the seismic observation network to also cover the Quaternary Oshmiyansky fault (R-5).
- No. 7: Provide free access to the data recorded by the seismic observation network (R-6).
- Annex 1, line 7: Implement the measures and actions defined in the Section 3.2.4 of the NR (R-7).
- Nos 1, 2, and 3: Reconsider the adequacy of seismic margins of SSCs for beyond design basis earthquakes of the plant equipment ultimately needed for prevention of core melt (R-12) and large releases (R-18).

The high priority issue was mostly addressed by action No. 2 (R-1). In addition, actions No. 1 (R-2) and 3 (R-3) contain elements of the high priority issue.

External flooding

There are two actions related to external flooding:

- Annex 1, line 8: ensuring that plant measures against water ingress into safety-related buildings and underground galleries are robustly designed and implemented (R-8);
- Annex 1, line 8: ensuring that the plant site can be drained via the surface by gravity (R-10).

There was no high priority issue related to external flooding.

Extreme weather

There is one action related to extreme weather:

- Annex 1, line 8(a): having specific operating procedures for extreme weather in place (R-9).

There was no high priority issue related to extreme weather.

From the overview above, it can be concluded that the PRT's recommendations from 2018 PRT report related to the high priority issues were reflected in the NAcP.

As stated in the 2018 PRT report, the plant under review in Belarus is a new NPP under construction. Therefore, the PRT experts considered that highest safety standards should be taken into account during the stress test process for Belarus even though the construction licence for BelNPP was issued before WENRA established its approach for new reactors. The 2013 WENRA report on the '*safety of new NPP designs'* stipulates that for new NPP designs '*accidents with core melt which would lead to early or large releases have to be practically eliminated'*. WENRA further specifies '*For that reason, rare and severe external hazards, which may be additional to the general design basis, unless screened out (…), need to be taken into account in the overall safety analysis'*. WENRA further states that '*rare and severe external hazards are additional to the general design basis, and represent more challenging or less frequent events. This is a similar situation to that between Design Basis Conditions (DBC) and*

Design Extension Conditions (DEC); they need to be considered in the design but the analysis could be realistic rather than conservative'.

These WENRA safety expectations require the external hazards in the plant design to be considered more broadly and extensively, as well as the consideration of events with occurrence probabilities below 10^{-4} per year in the safety demonstration. The review of actions related to the WENRA safety objectives are not included in the high priority issues and remain open for the second phase of the NAcP review.

Verification of the adequacy of the design basis earthquake

With regard to earthquakes, the peer review in this first phase focused on the following high priority issue: '*verification of the adequacy of the DBE'* (with a PGA_H of 0.1059 g). Elements of this high priority issue are contained in several recommendations, mainly in R-1, but also in R-3.

In the 2018 PRT report, the PRT recommended that GAN should consider the 2018 PSHA results in the beyond design basis safety evaluation of the plant and ensure appropriate safety upgrading measures are implemented. According to GAN, the 2018 PSHA was reviewed and found acceptable for the physical start-up. For the operating license, the licensee was requested to prepare '*a more precise seismographic model, adequately corresponding to the geodynamic conditions of Belarus'*. This led to the updated 2020 PSHA. The differences between the 2018 PSHA and the 2020 PSHA are small in the area of the exceedance frequency of 10^{-4} per year, mean, free-field, which is decisive for determining the DBE.

According to information obtained during the desktop review, the 2020 PSHA uses input data that are updated compared to those used for the 2018 PSHA[7], which formed the basis of the stress tests peer review in 2018. The differences between the 2018 PSHA and the 2020 PSHA with respect to input parameters were explained during the site visit to BelNPP. Both hazard assessments reveal values for the DBE which are higher than 0.1 g (currently set as a design basis for BelNPP), therefore require an update of the seismic design base[8]. The resulting hazard values for the exceedance frequency of 10^{-4} per year, mean, free-field, which is decisive for determining the DBE, differ only slightly between PSHA 2018 and 2020. GAN envisages that the value resulting from the 2020 PSHA as DBE with 0.1059 g could be accepted as DBE, but the review is still ongoing.

The PRT considers that selecting the DBE from one of these above-mentioned PSHAs from the hazard level 10^{-4} per year, mean, free-field, is in line with internationally used approaches. It is also in line with the references used during the peer review of the EU stress tests. The engineering design basis for seismic category 1 SSCs is 0.12 g. This is above the envisaged DBE value (0.1059 g). The envisaged DBE value and the underlying hazard assessment should be used as a basis for the seismic margin assessment for DEC.

However, the regulatory process and decision making on the hazard assessment (PSHAs) is still ongoing. GAN is expected to finalise its review and assessment in March 2021, endorse the updated DBE and the underlying hazard assessment accordingly, before issuing operating license to BelNPP. Regulatory review, assessment and decision should be based on scientific justification. Based on the

[7] 2018 PSHA: Topical Report Belarus NPP Calculation of seismic hazard curves etc. Schmidt Institute of Physics of the Earth of the Russian Academy of Sciences, Report No. 01 / 2018-03-10.

[8] WENRA safety reference level issue T.

discussions during online meetings and the site visit it is expected that the results of PSHA 2020 will be endorsed by GAN.

Setting the DBE and underlying hazard assessment is particularly important for seismic margins assessment regarding DEC and will provide a clear basis for the evaluation of the adequacy of seismic margins. This will be assessed by the PRT in phase 2 of the peer review.

With regard to the actual design of SSCs to meet the DBE, discussions were also held on indirect effects of earthquakes in line with ENSREG's stress tests specifications, relevant IAEA safety standards and WENRA applicable documents. During the site visit, the PRT noted the presence of pipes and components with lower seismic category in spaces containing SSCs important to safety classified as seismic category 1. Examples include parts of the fire water extinguishing system located in the UKD building (hosting safety systems such as the containment spray system and the safety injection system) or in the UBS building (hosting the EDGs).

The PRT also noted that indirect effects of earthquake (such as seismic induced internal fire and flooding) are recommended for additional consideration, including in the context of the PSA.

The PRT appreciates the efforts by the Belarusian counterparts in answering these concerns related to the DBE. The PRT concluded that more comprehensive information and analyses are needed to clarify the situation with respect to indirect effects of earthquake. Demonstration should be made that all potential earthquake-induced indirect effects are adequately addressed. This demonstration should include for instance:

- earthquake-induced fires
- earthquake-induced internal flooding
- earthquake-induced interactions of SSCs having lower seismic category with items in seismic category 1
- housing of mobile means (including those used to supplement the JNB50 pump)

This will be assessed by the PRT in phase 2 of the peer review.

The PRT considers that this high priority issue is adequately addressed, provided that GAN independently reviews, assesses and endorses the PSHA for the operating license, and that the DBE is updated accordingly.

Summary on Topic 1 - Natural hazards

Based on the review of the NAcP against 2018 PRT report recommendations it can be concluded that PRT's recommendations related to the high priority issues were reflected in the NAcP.

Earthquakes.

Based on currently available information, the PRT concluded that the envisaged DBE value (PGA_H = 0.1059 g for the hazard level 10^{-4} per year, mean, free-field) is enveloped by the engineering design basis of BelNPP (0.12 g). The envisaged DBE value, the underlying PSHA results and its application as basis for the seismic margin assessment for DEC is in line with international approaches.

However, the regulatory process and decision making on the hazard assessment (2020 PSHA) is still ongoing. GAN is expected to finalise its review and assessment in March 2021, endorse the updated DBE and the underlying hazard assessment accordingly, before issuing operating license to BelNPP. This review, assessment and decision should be based on scientific justification. Based on the discussions during online meetings and the site visit it is expected that the results of the 2020 PSHA will be endorsed by GAN.

Setting the DBE and underlying hazard assessments is particularly important for seismic margin assessment and DEC analysis. It will provide a clear basis for the evaluation of the adequacy of seismic margins. This will be assessed by the PRT in phase 2 of the peer review.

Moreover, the PRT concludes that more comprehensive information and analyses are needed to clarify the situation with respect to indirect effects of earthquake. It should be ensured that all potential earthquake-induced effects are adequately addressed. This should include e.g. consequent fire, internal flooding and potential spatial interactions, housing of mobile means. This will also be assessed by the PRT in phase 2 of the peer review.

The PRT considers that the high priority issue is adequately addressed, provided that GAN independently reviews and assesses the PSHAs, endorses one of them, and that the DBE is updated accordingly.

Flooding and extreme weather. No high priority issues were analysed as regards these hazards. The review of the related actions is scheduled for the second phase of the peer review.

4.3 Loss of safety systems

Regarding loss of safety systems (Topic 2), the NAcP of Belarus comprises six actions dealing with measures to increase the reliability of electrical power supply for safety relevant consumers as well as water supply for the heat removal under a DEC situation. Out of these, the PRT identified three actions which can be considered as belonging to the two high priority issues listed in chapter 4.1. These actions are a subject of the current review. The rest are expected to be reviewed and discussed in phase 2.

The NAcP of Belarus provides a general description of measures for Topic 2 – loss of safety systems (SBO and loss of ultimate heat sink) – explaining the actions listed in Table 4 of the NAcP.

The actions presented in Table 4 of NAcP and listed below reflect the recommendations of the 2018 PRT report.

- No. 8 – Consideration of the desirability of equipping the NPP with alternative stationary AC power sources (for BDBA), taking into account the adopted safety concept for BelNPP (taking into consideration the passive safety systems providing autonomy of operation) (R-11).
- No. 9 – Assessment of the reliability of the SG PHRS after installation of another redundant pump in addition to JNB50AP001, compared with the characteristics of the existing system (R-13).
- No. 10 – Implementation of necessary organizational and technical actions in accordance with the results of assessment in point 9 (R-13)
- No. 11 – Implementation of organizational and technical measures for stationary connection of one DG set to each BelNPP power unit - Unit 1 - 01.01.2020; Unit 2 - 01.01.2021 (n/a);
- No. 12 – Development for further implementation of technical and organizational measures ensuring restoration of water supply in time necessary to prevent severe accidents arising in the open reactor condition in the case of a SBO (R-14).
- No. 13 – Assessment of the reliability of auxiliary power supply to safety-related consuming sources, from an emergency standby auxiliary transformer SN (ARTSN) 110/10 KW, with a power of 16 MVA, which can be connected to a cable line 110 kV in the “Viliya” substation and assessment of “Viliya” substation’s resistance to internal and external events (R-15).

From the overview above, it can be concluded that the PRT’s recommendations from 2018 PRT report related to the high priority issues were reflected in the NAcP.

There are three actions related to high priority issues as listed in chapter 4.1. These are actions No. 9 and 10 (combined in recommendation R-13 in the Appendix to this report; second indent in chapter 4.1) and action No. 11 (action NAcP 4-11 in the Appendix of this report; third indent in chapter 4.1). These actions are subject to further review and commenting.

Note that action No. 12 (corresponding to PRT recommendation R-14) has also been identified as a high priority issue but has been taken under Topic 3 as the action also addresses PRT recommendation R-19.

Additional measures for enhancing the reliability of the JNB50 subsystem

For the associated actions No. 9 and No. 10, BelNPP developed a technical solution to be applied in both units of the NPP. The proposal is that an alternative mobile device will be used to replenish the SG PHRS and containment (C) PHRS as well as the spent fuel pool under SBO conditions instead of using a permanently installed redundant JNB50 pump. Should the existing 10/20JNB50AP001 pump fail, a mobile fire engine driven pump would be connected using two installed hook-up connectors from the JNB50 system located outside the steam chamber building UJE of each unit. Via this connection, water will be transported from the makeup water system (LCU tanks 10/20LCU01,02,03,04BB001), which were originally envisaged for this purpose, in case of an SBO.

As stated by the NPP, the pipelines, the vents (fixtures) and the pump of the JNB50 system for the feed of the SG PHRS tanks or the spent fuel pool are classified as seismic category 1. The tanks, heat exchanger and the vents of the SG PHRS JNB system also belong to seismic category 1. Therefore, also in case of an earthquake the functionality of the system is ensured.

A basis for evaluation and application is provided in the WENRA documents that were developed for new reactors after the Fukushima accident. In particular, the 2013 report from WENRA's Reactor Harmonisation Working Group (WENRA/RHWG) – '*Safety of new NPP designs'* – sets the objectives for sufficient redundancy for active components such as the JNB50 system. However, in WENRA's safety reference levels Issue F 4.7 an expectation is set: '*There shall be sufficient independent and diverse means including necessary power supplies available to remove the residual heat from the core and the spent fuel'*.

Taking into account the status on engineering and construction of BelNPP during the 2018 peer review, the PRT considers the prepared alternative technical solutions improves safety of the BelNPP. Although this alternative does not provide a permanent redundancy to the JNB50 pump, it fulfils the expected safety function and provides diversity to a permanently installed JNB50 pump.

The technical and organizational rules and procedures for connecting and operating the mobile firefighting pump are provided in instructions. In order to ensure the permanent operability, the necessary equipment, i.e. the firefighting vehicle with pump equipment, undergoes checks according to the '*Rules of technical support in the authorities and divisions of the extraordinary situations of the Republic of Belarus*' and the procedure for connecting the vehicle is practised periodically in training drills.

The presence and the arrangement of the technical mobile devices and the operability of the connecting point have been surveyed by the PRT during the February site visit to BelNPP and, also the existence of respective documents describing the measures to be taken and the conditions for these have been checked by the PRT.

The essential prerequisite for implementation of this solution is the availability of the mobile equipment at all times, which must not be endangered by external impacts such as extreme weather conditions or earthquake. This remains to be demonstrated and the PRT will evaluate this in phase two (see topic 1).

The PRT considers this high priority issue as adequately addressed provided that availability of the mobile equipment needed for pumping can be ensured at all times.

Completing the permanent connection of a mobile diesel generator (MDG) to Channel 7

In the answers it provided to PRT's written questions, GAN stated that the associated action No. 11 '*Implementation of organisational and technical measures for stationary connection of one DG set to each NPP power unit*' was fully implemented for Unit 1. As originally planned and presented in the national report as well as discussed during the peer review of 2018, the MDG in each unit (10/20XKA70) serves as the electricity support for the BDBA consumers (Russian terminology) which are served via Channel 7. According to GAN's answers, the MDG supports:

- electric gate valves and valves of the JNB, JEF, KTP, FAK systems;
- hydrogen control devices under the containment (the JMU system);
- emergency instrumentation;
- radiation monitoring devices;
- the BDBA panel located in the main control room (MCR);
- the JNB50AP001 pump; and
- the illumination of the operator's workplace above the BDBA panel.

Reflecting the 2018 PRT recommendation the MDG (10/20XKA70) at unit 1 has been connected and will be connected at unit 2 permanently to the buses of Channel 7 by means of a flexible cable to the assembly 10/20BKS12GH570 at the outer wall of the 10/20UJE.

To provide for the function of the mobile equipment in adherence to the '*Regulations for checks and tests of safety relevant systems'*, the personnel of BelNPP carry out required checks (tests) of the MDG station 10/20XKA70 according to the schedule and programmes, approved by the chief engineer of the NPP:

- Tests with the nominal power with a connected specific load device (once a month);
- Comprehensive check with a connection of the DG on the 0.4kV section of Channel 7 I&C system (once a year).

The presence and the arrangement of the MDG 10XKA70 in unit 1 and the permanent connection to the connecting point 10BKS12GH570 have been surveyed by the PRT during the site visit in February and the existence of respective documents describing the measures to be taken for assuring the operability have been checked by the PRT.

Therefore, the PRT considers this high priority issue as adequately addressed.

Summary on Topic 2 – loss of safety function

Based on the review of the NAcP against 2018 stress test PRT report recommendations it can be concluded that PRT's recommendations related to the high priority issues were reflected in the NAcP.

Based on the written answers, results of the online meetings and site visit in February 2021, the PRT recommendations related to the two high priority issues formulated in second and third indent in chapter 4.1 can be considered addressed, provided that the availability of mobile equipment at all times (following external impacts such as extreme weather or earthquake) can be demonstrated.

4.4 Severe accident management

Proposals to further enhance the safety of BelNPP reflect the fact that the design of the plant includes a number of advanced hardware features to cope with severe accidents and that the organisation of emergency planning and response covering the onsite/offsite coordination had been developed prior to the NPP construction.

The NAcP Table 4 includes nine actions that can be assigned to the topic of severe accident management (the numbering of the items is the same as in the NAcP). The items listed below are not copied verbatim from the NAcP, but they are simplified to characterise their key objectives.

- No. 12 - Prevention and mitigation measures for severe accidents under open reactor conditions (R-19).
- No. 14 – Assessment of adequacy of provisions for practical elimination of early or large radioactive releases (R-16).
- No. 15 – Refilling of the secondary side of SG to protect integrity of SG tubes and to prevent fission product releases by-passing the containment.,
- No. 16 – Qualification of devices for depressurization of the RCS under severe accident conditions.,
- No. 17 – Evaluation of adequacy and/or enhancement of means for depressurization of the reactor coolant system (R-17).
- No. 18 – Evaluation of adequacy and/or enhancement of instrumentation needed for management of severe accidents.
- No. 19 – Review and/or enhancement of habitability of control areas (MCR and ECR) during a severe accident combined with SBO (R-21).
- No. 20 – Review of the effectiveness of the emergency ventilation system of the containment annulus (R-22) in beyond design basis accidents.
- No. 21 – Development, validation and implementation of symptom based EOPs and SAMGs (R-23).

In parentheses in the bullets above, there are numbers representing six particular recommendations (R-16, R-17, R-19, R-21, R-22, R-23) formulated by the PRT after the review of the national report. There were two other PRT recommendations resulting from the review of the management of severe accidents, namely:

- R-13 (recommending the installation of a redundant pump in addition to the JNB50AP001 pump for refilling heat exchangers of PHRS and the spent fuel pool (SFP)); and
- R-18 (recommending a demonstration of adequate seismic resistance of plant equipment ultimately needed for preventing early or large radioactive releases).

The status of implementation of these two items is evaluated in this report within the Topic 1 and Topic 2 reviews.

Another recommendation derived from the PRT report was the need for experimental demonstration of the effectiveness of the innovative SG PHRS and C PHRS. This action was not explicitly included in the NAcP, but it was addressed by the plant designer, as confirmed in the Appendix to this report.

Other actions of the NAcP (No. 15, 16, 18) were added after upon a decision made by the plant operator and the designer. These actions complement the recommendations explicitly listed in the PRT report and the review of status of their implementation contributes to comprehensiveness of the evaluation.

Summary on Topic 3 - severe accident management

Based on the review of the NAcP against 2018 PRT report recommendations it can be concluded that PRT's recommendations related to the high priority issues were reflected in the NAcP.

The status of implementation of the four actions of the NAcP identified as high priority issues, evaluated using information available to PRT prior the visit to the BelNPP and verified during the visit, is briefly summarised below.

Development, validation and implementation of symptom-based EOPs and SAMGs

The symptom based EOPs and SAMGs have been developed, validated and implemented before plant commissioning in accordance with the PRT recommendation. The issue is considered as adequately addressed.

Evaluation of adequacy and/or enhancement of means for depressurisation of the reactor coolant system

It is recognised that safety implications of high-pressure severe accident sequences for BelNPP are less significant than for other reactor designs due to the depressurisation effect of passive heat removal capability by the SG PHRS. Nevertheless, there are further means to ensure depressurisation under severe accident conditions including a dedicated control line for opening pressurizer valves from the main control room, and multiple venting lines connected to the reactor coolant system. Such possibilities in combination with other depressurisation measures ensure adequate compliance with the requirements of the IAEA safety standards on independence between the levels of defence. The issue is considered as adequately addressed.

Review and/or enhancement of habitability of control areas (MCR and ECR) during a severe accident combined with SBO

Based on the information provided by BelNPP, the available design provisions adequately ensure the habitability of control places within the plant, including in situations involving station blackout conditions, for a sufficiently long period of time allowing the staff to carry out actions for safe shutdown and cooldown of the plant. The issue is considered as adequately addressed. Nevertheless, to further enhance plant safety in the long term, additional improvements aimed at extending the time for habitability e.g. up to 72 hours, should be encouraged, in order to have better balance in autonomy of different plant systems.

Prevention and mitigation measures for severe accidents under open reactor conditions

The PRT concluded that should an SBO potentially develop into a severe accident in the open reactor, this could not start earlier than about 2.5 hours after the loss of cooling. A severe accident could be further delayed by 8 hours using coolant from the hydro accumulators, or could be prevented by the use of low-pressure ECCS pumps if the power supply is successfully recovered. The required staff actions are specified in the relevant operating procedures and guidelines. If the preventive actions fail, the accident could evolve into a severe accident at low pressure, with molten corium possibly relocated to the core catcher with the heat removal through the containment passive heat-removal system. There is a possibility to mitigate consequences of a severe accident taking place in open reactor and open containment by re-establising containment isolation. This could take 30 minutes to 1 hour, which is significantly less than the time it could take to potentially develop into a severe accident. The issue is considered as adequately addressed. Nevertheless, to further enhance safety, the plant is encouraged to look for additional means and ways to deliver coolant into the reactor in order to provide more time before the fuel in the open reactor is damaged, thereby enhancing the preventive part of accident management.

5 SCHEDULE FOR IMPLEMENTATION, TRANSPARENCY AND COMMENDABLE ASPECTS

5.1 The schedule of the implementation of the NAcP

This part will be completed at the end of phase 2 of the peer review.

5.2 Transparency of the NAcP

This part will be completed at the end of phase 2 of the peer review.

5.3 Commendable aspects (good practices, experiences, interesting approaches) and challenges

This part will be completed at the end of phase 2of the peer review.

6 PEER REVIEW CONCLUSIONS

The purpose of this report is to record the results and conclusions of the first phase of the peer review of the NAcP of Belarus. The PRT highlights that the results and conclusions in this document are based on information received via documents provided by Belarusian counterparts, discussions in online meetings between both of these parties and the site visit to BelNPP in February 2021. The conclusions and results in this report have been verified during the site visit to BelNPP in February 2021.

The Covid-19 pandemic prevented the peer review of the NAcP from being carried out as planned. The pandemic resulted in limitations on travelling and in organising face-to-face meetings, preventing the PRT from organising a full scope fact-finding mission to Belarus as planned. As BelNPP is expected to start commercial operations in early 2021, the ENSREG Stress Test Board decided in its November 2020 meeting to focus the first phase of the peer review on high priority issues and requested the PRT to complete the peer review on the high priority issues before BelNPP starts commercial operations. The full peer review addressing all remaining recommendations will be finalised when Covid-19 pandemic has abated and a full fact-finding mission has been carried out in Belarus.

The PRT identified seven high priority issues which were considered both important for safety and implementable in the short term. The status of the recommendations related to the seven high priority issues has been already discussed in depth in chapter 4. As a result of the evaluation, the following conclusions can be made.

- For natural hazards, the high priority issue was related to the evaluation of the adequacy of design basis earthquake and verifying that this DBE and the underlying PSHA are used as basis for evaluating seismic margins to cope with the seismic DEC. Based on the available information this high priority issue has been adequately addressed provided that GAN endorses an updated DBE based on the review and assessment of the available PSHAs. In the second phase of the peer review, the PRT will continue evaluating seismic margins for DEC as well as how potential earthquake-induced indirect effects (e.g. consequent fire, internal flooding and potential spatial interactions, housing of mobile means) are addressed in the design and safety demonstration of BelNPP.
- For loss of safety systems, there were two high priority issues. The first related to enhancing the water supply to the passive heat-removal systems with additional redundant pumping

capability. The second related to enhancing the reliability the of power supply of MDG by establishing a permanent connection to the Channel 7 busbar. Based on the available information both high priority issues have been adequately addressed provided that the availability of the mobile equipment can be ensured in all conditions.

- For severe accident management there were four high priority issues. The first was related to the development, validation and implementation of symptom-based EOPs and SAMGs. The second was related to the reliability of depressurisation of the primary system to prevent high-pressure core melt scenarios. The third priority issue was related to potential improvements to the habitability of main and emergency control rooms to ensure operators can work in the control rooms during a severe accident combined with a station blackout. The fourth was related to capabilities to prevent and mitigate severe accidents under open reactor conditions. Based on the available information, all four high priority issues have been adequately addressed, although the PRT encourages that possibilities for further safety enhancements be sought.

In conclusion, based on the available information and the site visit, progress has been made in addressing all recommendations related to the seven high priority issues.

In addition to the evaluation of the implementation of recommendations related to the seven high priority issues, the PRT evaluated the comprehensiveness of the Belarusian NAcP against PRT recommendations and other sources of relevant information. Based on the available information, it can be concluded that the NAcP has addressed all PRT recommendations related to the high priority issues. In phase 2, the PRT will conduct a full review of the comprehensiveness of the Belarusian NAcP, including all other PRT recommendations and how sources relevant to the preparation of national action plans have been used, namely the *Compilation of Recommendations and Suggestions from the Review European Stress Tests* from 2012 and the summary report of the extraordinary meeting of the Convention on Nuclear Safety in 2012.

Last but not least, the PRT underlines the safety significance of all recommendations formulated in the 2018 PRT report and encourages its Belarusian counterparts to continue working on them to ensure and enhance the safety of BelNPP in a timely manner. Evaluation of the implementation of all recommendations will be fully addressed in the second phase of the peer review, which is expected to take place in spring and summer of 2021, depending on the situation with the Covid-19 pandemic. The final report of the peer review will be compiled at the end of the second phase.

- # APPENDIX

PRT Assessment of Belarusian National Action Plan

1. Earthquakes

Action (Source[9]:)	PRT recommendation, action in NAcP and NAcP update	Implementation and evaluation of action
R-1, PRT p. 68; NAcP 4-2	**Recommendation:** The regulator should consider the PSHA 2018 results in the beyond design basis safety evaluation of the plant and ensure the implementation of appropriate safety upgrading measures. The results of the PSHA may require an update of the protection concept with respect to seismic impacts to conform with WENRA safety objectives for new nuclear power plants which were taken as a reference by the PRT. **Action:** Review the results of the seismic PSA-2018 in the assessment of NPP safety and determine the need for appropriate actions in order to improve safety. **Status:** Belarusian NPP developed a PSA in cooperation with the General Contractor: PSA-2018 Level 1 and PSA-2018 level 2 for Unit 1 of Belarusian NPP as part of the licensing package. The	**High priority issue – approval of the hazard levels for DBE** **Implementation:** The design basis earthquake (DBE) was originally established in line with NP-031-01 and the seismic hazard map GSZ-97-D26 revealing a DBE (exceedance frequency 10^{-4} per year) of Intensity 7° MSK-64 = 0.10 g PGA_H. In 2018, a new PSHA was carried out to develop a seismic PSA (2018 PSHA) which revealed a DBE of about 0.1 g for the occurrence probability of 10^{-4} per year. The 2018 PSHA also developed hazard curves reaching frequencies well below 10^{-4}. The PRT deemed this study as conforming with the current state of science and technology while it expressed reservations regarding the older hazard studies that were in line with Russian and Belarusian regulatory standards, but different from international guidelines. The PRT consequently suggested that the 2018 PSHA results be used for any further evaluation of the seismic margin of the plant. GAN found it necessary for the operating licence to '*prepare a more precise seismographic model, adequately corresponding to the geodynamic conditions of Belarus*'. This led to the updated 2020 PSHA. The new updated PSHA 2020 has been compiled by the Russian Institute of Physics of the Earth in Moscow. Some of the results are presented in the document '*Appendix R-2_Заключение отчета.pdf*'. The PSHA 2020 could be consulted by the PRT during the site visit. Here, the new free-field peak ground acceleration (PGA) is noted with 0.1059 g at hazard level 10^{-4} per year, mean value.

[9] The brackets indicate the sources of the respective action.

- NR: National Report - Stress Test for Belarussian Nuclear Power Plant – 2017,
- PRT: EU Peer Review Report of the Belarussian Stress Tests - June 2018,
- EU: ENSREG '*Compilation of Recommendations and suggestions - Peer review of stress tests performed on European nuclear power plants', 26/07/2012,*
- NAcP: number of Recommendation of the National Action Plan of Belarus, 2019,
- p: page.

Action (Source[9]:)	PRT recommendation, action in NAcP and NAcP update	Implementation and evaluation of action
	materials for PSA-2018 Level 1 and PSA-2018 Level 2 for Unit 1 of Belarusian NPP are reviewed by experts as part of a safety report with a view to obtaining a licence to operate Unit 1. The licensing procedure for that Unit is ongoing.	The differences between the 2018 PSHA and the 2020 PSHA with respect to input parameters were explained during the site visit. Both studies seem only differing by the assumed soil properties, while source zones models and ground motion prediction equations are apparently identical. According to GAN, the 2018 PSHA did not take into account the detailed site response analyses with respect to input seismic motion, while the 2020 PSHA took it into the account according to modern standards including non-linear behaviour of soil profile. The resulting hazard values for the exceedance frequency of 10^{-4} per year, mean, free-field, which is decisive for determining the DBE, differ only slightly with the respective 2018 PSHA results. GAN envisages accepting the PGA_H value of 0.1059 g from the 2020 PSHA as DBE. This value is slightly higher than 0.1 g, which was initially inferred as a design basis derived from the minimum value suggested by IAEA and WENRA reference documents. This DBE value and the underlying PSHA results should also be used as the basis for evaluating seismic margins to cope with DECs as required by IAEA and WENRA reference documents. According to GAN, the 2018 PSHA was reviewed and found acceptable for the physical start-up. For the operating license, the licensee was requested to prepare '*a more precise seismographic model, adequately corresponding to the geodynamic conditions of Belarus*'. This led to the updated 2020 PSHA. The regulator has stated that it expects to complete the corresponding reviews and assessments prior to issuing the operating licence. **Evaluation:** In the 2018 PRT report, the PRT recommended that GAN should consider the 2018 PSHA results in the beyond design basis safety evaluation of the plant and ensure appropriate safety upgrading measures are implemented. According to the NAcP (p. 31), GAN instead requested the licensee to prepare '*a more precise seismographic model, adequately corresponding to the geodynamic conditions of Belarus*'. This led to the updated 2020 PSHA. The differences between the 2018 PSHA and the 2020 PSHA are marginal in the area of the exceedance frequency of 10^{-4} per year, mean, free-field, which is decisive for determining the DBE. According to information obtained during the review, the 2020 PSHA uses input data that are updated compared to those used for the 2018 PSHA, which formed the basis of the stress tests peer review in 2018. The differences between the 2018 PSHA and the 2020 PSHA with

Action (Source[9]:)	PRT recommendation, action in NAcP and NAcP update	Implementation and evaluation of action
		respect to input parameters were explained during the site visit. Both hazard assessments reveal values for the DBE which are higher than 0.1 g (currently set as a design basis for BelNPP), therefore require an update of the seismic design base. The resulting hazard values for the exceedance frequency of 10^{-4} per year, mean, free-field, which is decisive for determining the DBE, differ only slightly. GAN envisaged that the value resulting from the 2020 PSHA as DBE with 0.1059 g could be accepted as DBE. Selecting the DBE from one of these above-mentioned PSHAs from the hazard level 10^{-4} per year, mean, free-field, is in line with internationally used approaches. It is also in line with the references used during the peer review of the EU stress tests. The engineering design basis for seismic category 1 SSCs is 0.12 g. This is above the envisaged DBE value (0.1059 g). The envisaged DBE value and the underlying hazard assessment should be used as a basis for the seismic margin assessment for DEC. However, the regulatory process and decision making on the hazard assessment (2020 PSHA) is still ongoing. GAN is expected to finalise its review and assessment in March 2021, endorse the updated DBE and the underlying hazard assessment accordingly, before issuing operating license to BelNPP. This review, assessment and decision process should be based on scientific justification. Based on the discussions during online meetings and the site visit it is expected that the results of PSHA 2020 will be endorsed by GAN. Setting the DBE and underlying hazard assessment is particularly important for seismic margins assessment regarding DEC and will provide a clear basis for the evaluation of the adequacy of seismic margins. This will be assessed by the PRT in phase 2 of the peer review. With regard to the actual design of SSCs to meet the DBE, discussions were also held on indirect effects of earthquakes in line with ENSREG's stress tests specifications, relevant IAEA safety standards and WENRA applicable documents. During the site visit, the PRT noted the presence of pipes and components with lower seismic category in spaces containing important seismic category 1 systems. Examples include parts of the fire water extinguishing system located in the UKD building (hosting safety systems such as the containment spray system and the safety injection system) or in the UBS building (hosting the EDGs).

Action (Source[9]:)	PRT recommendation, action in NAcP and NAcP update	Implementation and evaluation of action
		The PRT also noted that indirect effects of earthquake (such as seismic induced internal fire and flooding) are not covered by the PSA. The PRT appreciates the efforts performed by the Belarusian counterparts to try answering these concerns related to the DBE. The PRT concluded that more comprehensive information and analyses are needed to clarify the situation with respect to indirect effects of earthquake. Demonstration should be made that all potential earthquake-induced indirect effects are adequately addressed. This demonstration should include: − earthquake-induced fires − earthquake-induced internal flooding − earthquake-induced interactions of SSCs having lower seismic category with items in seismic category 1 − housing of mobile means (including those used to supplement the JNB-50 pump) This will be assessed by the PRT in phase 2 of the peer review. The PRT considers that the high priority issue *'verification of the adequacy of the Design Basis Earthquake (DBE with a PGA_H of 0.1059 g) and verifying that this DBE is used as basis for evaluating seismic margins to cope with the seismic Design Extension Condition (DEC)'* is adequately addressed, provided that GAN independently reviews, assesses and endorses the PSHA and that the DBE is updated accordingly. In the second phase of the peer review, the PRT will continue evaluating seismic margins for DEC as well as how potential earthquake-induced effects are addressed in the design and safety demonstration of BelNPP.
R-2, PRT p. 68 NAcP 4-1	**Recommendation:** A comprehensive margin assessment based on the hazard curve from the PSHA and fragility evaluations should be performed, to justify the adequacy of the margins of all SSCs with respect to	This item will be reviewed in phase 2.

Action (Source[9]:)	PRT recommendation, action in NAcP and NAcP update	Implementation and evaluation of action
	the design basis and beyond for ensuring their integrity and function in accordance with their role in support of Defence-in-Depth (DiD) levels. **Action:** Carry out additional studies on the construction of seismic hazard curves, to clarify the safety margins of NPP structures, systems and components (SSCs), taking into account the more precise seismotectonic model. Correct the seismic Probabilistic Safety Analysis (PSA) for which initial data will come from adjusted seismic hazard curves, including the assessment of safety margins for parts of safety-critical systems. Determine the need for a comprehensive assessment of seismic risk on the basis of more refined seismic hazard curves and existing equipment safety margins. **Status:** The State enterprise “Belorusskaya AES” (hereinafter: “Belarusian NPP”) set the budget for work on this item, conducted competitive tender procedures and selected the contractors to work on the construction of a seismotectonic model and refinement of the seismic hazard curves, taking into account the alternative seismotectonic model. Work on the construction of a seismotectonic model and refinement of the seismic hazard curves, taking	

Action (Source[9]:)	PRT recommendation, action in NAcP and NAcP update	Implementation and evaluation of action
	into account the alternative seismotectonic model, is currently ongoing. Deadline for completion of the work: March 2020. The deadline for adjusting the PSA for seismic impacts, taking into account the revised seismic hazard curves, has been postponed until December 2020.	
R-3, PRT p. 68 NAcP 4-3	**Recommendation:** The regulator should ensure that the seismic resistances of SSCs credited for coping with accident conditions (DiD levels 3 and 4) induced by a seismic event are adequate to ensure their performance. **Action:** Based on the completion of the actions in point 1, assess the characteristics of seismic stability of SSCs to ensure their function in an accident situation (levels DiD 3 and 4). **Status:** As part of the commissioning works, ATOMTECHENERGO AO is assessing the seismic stability of safety-critical equipment using the 'Programmes for determining the dynamic characteristics and seismic stability of safety-critical equipment'. The work is expected to be completed by 31 March 2020. As part of the adjustment to the seismic PSA (Point 1 of the National Plan), work on seismic stability	**Partly belongs to the high priority issue – approval of the hazard levels for DBE** **Implementation:** The assessment of the seismic stability of safety-critical equipment is expected to be finalised by the designer by 31 March 2020. GAN will need to review and assess these analyses consequently. **Evaluation:** In this phase 1 of the peer review the PRT has only reviewed and assessed the situation up to the seismic resilience necessary to cope with a DBE. The engineering design basis for seismic category 1 SSCs is PGA_H = 0.12 g. This is above the envisaged DBE value of PGA_H = 0.1059 g. The engineering design of the seismic category 1 SSCs envelopes the DBE value. GAN's written answers to the PRT questions and additional information prepared during the country visit gave an overview of the seismic category 1 SSCs. For example, in answer 37, GAN provided a list of SSCs necessary for a safe shutdown in the event of a design basis earthquake. With regard to the actual design of SSCs to meet the DBE, discussions were also held on indirect effects of earthquakes in line with ENSREG's stress tests specifications, relevant IAEA safety standards and WENRA applicable documents. During the site visit, the PRT noted the presence of pipes and components with lower seismic category in spaces containing

Action (Source[9]:)	PRT recommendation, action in NAcP and NAcP update	Implementation and evaluation of action
	analyses is in hand. The results will form the basis for a list of components, and the probabilistic parameters of their seismic damage to Unit 1 will be determined. (The work is being done by "TsKTI-VIBROSEYSM OOO" and "ATOMPROYEKT AO" and is scheduled for completion by 31 May 2020.	important seismic category 1 systems. Examples include parts of the fire water extinguishing system located in the UKD building (hosting safety systems such as the containment spray system and the safety injection system) or in the UBS building (hosting the EDGs). The PRT also noted that indirect effects of earthquake (such as seismic induced internal fire and flooding) are not covered by the PSA. The PRT appreciates the efforts performed by the Belarusian counterparts to try answering these concerns related to the DBE. The PRT concluded that more comprehensive information and analyses are needed to clarify the situation with respect to indirect effects of earthquake. Demonstration should be made that all potential earthquake-induced indirect effects are adequately addressed. This demonstration should include: – earthquake-induced fires – earthquake-induced internal flooding – earthquake-induced interactions of SSCs having lower seismic category with items in seismic category 1 – housing of mobile means (including those used to supplement the JNB-50 pump) These will be assessed by the PRT in phase 2 of the peer review. Furthermore, demonstration still needs to be done that all potential earthquake-induced effects are adequately addressed for DBE as mentioned above. The PRT expects this demonstration to be available in phase 2 of the PRT review. In this phase 1 of the peer review the PRT has only reviewed and assess the situation up to the seismic resilience necessary to cope with a DBE. The further PRT evaluations with respect to DEC and seismic margins are scheduled in phase 2.
R-4, PRT p.68 NAcP 4-4	**Recommendation:** The PRT is aware of the different interpretations of the 1908 seismic event published in seismological literature and catalogues. Keeping this in mind, the PRT recommends performing a study on this seismic	This item will be reviewed in phase 2.

Action (Source[9]:)	PRT recommendation, action in NAcP and NAcP update	Implementation and evaluation of action
	event to clarify its nature and completing a review of the zoning and seismic catalogues. **Action:** Perform R&D entitled "Exploring the nature of the Gudogay seismic event of 1908 and updating the seismicity catalogue for the region in which Belarusian NPP is located". **Status:** The Geophysical Monitoring Centre of the National Academy of Sciences of Belarus has carried out research entitled "Exploring the nature of the Gudogay seismic event of 1908". The findings were sent to Belarusian NPP for further implementation of Point 4 of the Plan, with a view to updating the catalogue of seismicity in that location.	
R-5, PRT p. 68 NAcP 4-5 Planning of the network (part 1 of R-5, PRT p 68)	**Recommendation:** Extend the number of stations of the seismic observation network to also cover the Quaternary Oshmiyansky fault. **Action:** Perform R&D on the "Assessment of the optimal location and resolution of the local seismic monitoring network in the region of the Belarusian NPP site location to monitor possible geodynamic activity in the Oshmiyansky fault zone". In the light of the results of the R&D exercise, take the	This item will be reviewed in phase 2.

Action (Source[9]:)	PRT recommendation, action in NAcP and NAcP update	Implementation and evaluation of action
	necessary measures with the option of increasing the number of stations. **Status:** Belarusian NPP issued a call for technical and commercial proposals for implementation of the work. Proposals were received from the State University "TsGM" of the National Academy of Sciences of Belarus and IFZ "RAS" (Schmidt Institute of Terrestrial Physics of the Russian Academy of Sciences).	
R-6, PRT p. 68 NAcP 4-7	**Recommendation:** Provide free access to the data recorded by the seismic observation network for scientific purpose to profit from research results that had better constrain the seismotectonic model for future updates of the PSHA. **Action:** Perform R&D ("Study of international experience in conducting research with observational data from a seismic observation network monitoring in the area where a nuclear power plant is located and developing technology and a procedure for processing data from the Belarusian network"). **Status:** Belarusian NPP issued a call for technical and commercial proposals for implementation of the work. Proposals were received from the State	This item will be reviewed in phase 2.

Action (Source[9]:)	PRT recommendation, action in NAcP and NAcP update	Implementation and evaluation of action
	University "TsGM" of the National Academy of Sciences of Belarus and IFZ "RAS".	
R-7, PRT p. 68 NAcP Annex 1, line 7	**Recommendation:** Implement the measures and actions defined in the Section 3.2.4 of the NR. **Action:** As part of preparation for commissioning, seismic probabilistic safety assessment 1 has been drawn up (requirements under the licensing process). Currently, as part of the implementation of Measure 1 in table 4, the seismic probabilistic safety assessment 1 is being amended, and a seismic probabilistic safety assessment 2 is being drawn up. As part of commissioning, the seismic resistance of the design of systems and components vital to safety is being evaluated using the 'Method for validating the dynamic characteristics of NPP power unit systems and elements which are vital to safety'. As part of the drafting of the seismic probabilistic safety assessment, the seismic resistance of equipment is being evaluated using the SMA methods set out in EPRI-NP-6041 and NS-G-2.13. Following the evaluation, to develop and implement measures for improving the seismic resistance of equipment, if necessary. **Status:**	This item will be reviewed in phase 2.

Action (Source[9]:)	PRT recommendation, action in NAcP and NAcP update	Implementation and evaluation of action
	n/a	
R-5 PRT p. 68 NAcP 4-6 Implementation of the network (part 2 of R-5, PRT p. 68)	**Recommendation:** Extend the number of stations of the seismic observation network to also cover the Quaternary Oshmiyansky fault. **Action:** Implement a permanent (fixed) local seismic observation network for the operating period of Belarusian NPP to monitor the stability of the parameters for the design basis and obtain objective, up-to-date information on changes in the geodynamic situation in the area of the facility including: - search for and selection of places (from among 20-25 alternative locations) within a radius of 30 km of the site of Belarusian NPP for the placement of observation points; - preparatory work; - construction and auxiliary works (including design work appropriate to the selected location); - purchase of basic and auxiliary equipment, its installation and configuration at the observation points and at the Data Collection and Processing Centre. Implement connections to reserve power supplies, equipment security alarms and other, related work, preparation and debugging of	This item will be reviewed in phase 2.

Action (Source[9]:)	PRT recommendation, action in NAcP and NAcP update	Implementation and evaluation of action
	software, commissioning and operation of the system. **Status:** Belarusian NPP issued a call for technical and commercial proposals for implementation of the work. Proposals were received from the State University “TsGM” of the National Academy of Sciences of Belarus and IFZ “RAS”.	
R-12, PRT p. 70 NAcP 4-1, 4-2, 4-3	**Recommendation:** The adequacy of margins of SSCs for beyond design basis earthquakes of the plant equipment ultimately needed for prevention of core melt should be reconsidered and the robustness of the systems increased, if necessary, based on the results of seismic PSA under preparation. **Action:** Carry out additional studies on the construction of seismic hazard curves, to clarify the safety margins of NPP structures, systems and components (SSCs), taking into account the more precise seismotectonic model. Correct the seismic Probabilistic Safety Analysis (PSA) for which initial data will come from adjusted seismic hazard curves, including the assessment of safety margins for parts of safety-critical systems. Determine the need for a comprehensive assessment of seismic risk on the basis of more	This item will be reviewed in phase 2.

Action (Source[9]:)	PRT recommendation, action in NAcP and NAcP update	Implementation and evaluation of action
	refined seismic hazard curves and existing equipment safety margins. Review the results of the seismic PSA-2018 in the assessment of NPP safety and determine the need for appropriate actions in order to improve safety. Based on the completion of the actions in point 1, assess the characteristics of seismic stability of SSCs to ensure their function in an accident situation (levels DiD 3 and 4) **Status:** The State enterprise “Belorusskaya AES” (hereinafter: “Belarusian NPP”) set the budget for work on this item, conducted competitive tender procedures and selected the contractors to work on the construction of a seismotectonic model and refinement of the seismic hazard curves, taking into account the alternative seismotectonic model. Work on the construction of a seismotectonic model and refinement of the seismic hazard curves, taking into account the alternative seismotectonic model, is currently ongoing. Deadline for completion of the work: March 2020. The deadline for adjusting the PSA for seismic impacts, taking into account the revised seismic hazard curves, has been postponed until December 2020.	

Action (Source[9]:)	PRT recommendation, action in NAcP and NAcP update	Implementation and evaluation of action
	Belarusian NPP developed a PSA in cooperation with the General Contractor: PSA-2018 Level 1 and PSA-2018 level 2 for Unit 1 of Belarusian NPP as part of the licensing package. The materials for PSA-2018 Level 1 and PSA-2018 Level 2 for Unit 1 of Belarusian NPP are reviewed by experts as part of a safety report with a view to obtaining a licence to operate Unit 1. The licensing procedure for that Unit is ongoing. As part of the commissioning works, ATOMTECHENERGO AO is assessing the seismic stability of safety-critical equipment using the 'Programmes for determining the dynamic characteristics and seismic stability of safety-critical equipment'. The work is expected to be completed by 31 March 2020. As part of the adjustment to the seismic PSA (Point 1 of the National Plan), work on seismic stability analyses is in hand. The results will form the basis for a list of components, and the probabilistic parameters of their seismic damage to Unit 1 will be determined. (The work is being done by "TsKTI-VIBROSEYSM OOO" and "ATOMPROYEKT AO" and is scheduled for completion by 31 May 2020.	

2. Flooding

Action (Source[10]:)	PRT recommendation, action in NAcP and NAcP update	Implementation and evaluation of action
R-8, PRT p. 69 NAcP Annex 1, line 8	**Recommendation:** The Regulatory Body should check that plant measures against water ingress into safety related buildings and underground galleries are robustly designed and implemented **Action:** Monitoring and oversight over the construction of the foundations, their waterproofing, and the flooding of building structures, is carried out systematically as part of oversight functions, in accordance with the requirements laid down in construction norms and rules. At the stage of acceptance of the completed Belarusian NPP buildings, a comprehensive evaluation of the conformity of buildings and equipment is planned, including their waterproofing, design documentation and the requirements of the Technical Normative Legal Acts (Технические нормативные правовые акты). **Status:** n/a	This item will be reviewed in phase 2.

[10] The brackets indicate the sources of the respective action:

- NR: National Report - Stress Test for Belarussian Nuclear Power Plant - 2017,
- PRT: EU Peer Review Report of the Belarussian Stress Tests - June 2018,
- EU: ENSREG '*Compilation of Recommendations and suggestions - Peer review of stress tests performed on European nuclear power plants', 26 July 2012*,
- NAcP: number of Recommendation of the National Action Plan of Belarus, 2019,
- p: page

Action (Source[10]:)	PRT recommendation, action in NAcP and NAcP update	Implementation and evaluation of action
R-10 PRT p. 69 NAcP Aug 2019, Annex 1, line 8	**Recommendation:** During the plant visit, the site was under construction, so the PRT could not confirm the final civil work of the site and the adequacy of the drainage arrangements. It should be ensured that the plant site can be drained via the surface by gravity (streets, catch water ditches). **Action:** Monitoring and oversight over the construction of the foundations, their waterproofing, and the flooding of building structures, is carried out systematically as part of oversight functions, in accordance with the requirements laid down in construction norms and rules. At the stage of acceptance of the completed Belarusian NPP buildings, a comprehensive evaluation of the conformity of buildings and equipment is planned, including their waterproofing, design documentation and the requirements of the Technical Normative Legal Acts (Технические нормативные правовые акты). **Status:** n/a	This item will be reviewed in phase 2.

3. Extreme Weather

Action (Source[11]:)	PRT recommendation, action in NAcP and NAcP update	Implementation and evaluation of action
R-9 PRT p. 69 NAcP Aug 2019, Annex 1, line 8(a)	**Recommendation:** It was stated during the country visit that operational procedures for extreme weather conditions are under development. The PRT recommends having specific operating procedures in place before commissioning of the Belarusian NPP. **Action:** As part of licensing, the documents demonstrating the safety of the Belarusian NPP are analysed by experts. These documents include operational documentation comprising operational procedures in extreme weather conditions. **Status:** n/a	This item will be reviewed in phase 2.

[11] The brackets indicate the sources of the respective action:

- NR: National Report - Stress Test for Belarussian Nuclear Power Plant - 2017,
- PRT: EU Peer Review Report of the Belarussian Stress Tests - June 2018,
- EU: ENSREG '*Compilation of Recommendations and suggestions - Peer review of stress tests performed on European nuclear power plants', 26 July 2012*,
- NAcP: number of Recommendation of the National Action Plan of Belarus, 2019,
- p: page.

4. Station black out and loss of ultimate heat sink

Action (Source[12]:)	PRT recommendation, action in NAcP and NAcP update	Implementation and evaluation of action
R-11 PRT p. 70 NAcP 4-8 And PRT p. 63-64; NR p. 52	**Recommendation:** The PRT recommends that an alternative permanent power source to supply the necessary power in design extension conditions should be provided. This alternative AC power supply should include necessary connecting points, to protect electrical power systems against the simultaneous failure of off-site and emergency AC power supplies. [PRT] The additional use of mobile means should be further considered as a valuable component of operational accident management. **Action:** Assess the expediency of equipping the NPP with an alternative stationary power source (for BDBA), taking into account the safety concept adopted for the AES-2006 project (taking into consideration the passive safety systems providing autonomy of operation).	This item will be reviewed in phase 2.

[4] The brackets indicate the sources of the respective action:

- NR: National Report - Stress Test for Belarussian Nuclear Power Plant - 2017,
- PRT: EU Peer Review Report of the Belarussian Stress Tests - June 2018,
- EU: ENSREG '*Compilation of Recommendations and suggestions - Peer review of stress tests performed on European nuclear power plants', 26 July 2012*,
- NAcP: Number of Recommendation of the National Action Plan of Belarus, 2019,
- p: page.

Action (Source[12]:)	PRT recommendation, action in NAcP and NAcP update	Implementation and evaluation of action
	Status: Belarusian NPP issued a call for technical and commercial proposals for implementation of the work. Proposals were received from JSC "ASE" AO. (10 May 2020) Undertake organisational and technical measures for stationary connection of one DG set to each NPP power unit. Unit 1: done; Unit 2: 01.01.2021.	
R-13, PRT p. 70 NAcP 4-9, 4-10	**Recommendation:** Despite the system autonomy of the passive heat removal system (PHRS) which is designed to cope with SBO scenarios the SG PHRS, the C PHRS tanks and the spent fuel pool are refilled with water using a single low -pressure pump JNB50AP001 (only 1 pump per unit is designed). [...] Owing to the importance of ensuring the functionality of SG PHRS in SBO, the PRT recommends enhancing the reliability by installing an additional redundant pump. **Action:** NAcP 4-9: Assess the improvement in the reliability of the passive heat removal system (PHRS SG) after installation of a further redundant pump in addition to JNB50AP001, compared with the characteristics of the existing system. NAcP 4-10: Based on the results of the assessment in Point 9, carry out the necessary organisational and technical measures. **Status:**	**High priority issue – additional measures for enhancing the reliability of the JNB50 subsystem** **Implementation:** Responding to the PRT's questions on Recommendation R-13, GAN stated that instead of the recommended second redundant JNB50 pump being an alternative technical measure, a mobile DG powered firefighting pump was chosen. Should the existing 10/20JNB50AP001 pump fail, a mobile fire engine driven pump would be connected using two installed hook-up connectors from the JNB50 system located outside the steam chamber building UJE building of each unit (at elevations +0.690 and +0.730). Via this connection, water will be transported from the makeup water system (LCU tanks 10/20LCU01,02,03,04BB001), which were originally envisaged for this purpose, in case of an SBO. The suction side of the firefighting pump will be connected to the tanks 10/20LCU02,03BB001 by means of the fixture 10/20JNB50AA001,002,005,006, and the pressure side of the firefighting pump will be connected to the fixture 10/20JNB50AA003,004. By bypassing the 10/20JNB50AP001 pump, with this connection the supply of deionized water to the SG PHRS tanks as well as the spent fuel pool will be performed. The volumetric capacity of the 10/20LCU02,03BB001 tanks is 700 m^3 each. If necessary, the tanks 10/20LCU01,04BB001, which each have the same 700 m^3 capacity, can also be

Action (Source[12]:)	PRT recommendation, action in NAcP and NAcP update	Implementation and evaluation of action
	Belarusian NPP issued a call for technical and commercial proposals for implementation of the work. Proposals were received from JSC "ASE" AO.	connected to the suction side of the firefighting pump. The temperature in LCU tanks is held automatically at the range of 20-÷25°C. If necessary, additional water could be provided from other reserves available at the NPP site with an amount of 170400 m^3. For this purpose, the suction side of the firefighting pump would be connected to the vessels or basins of the resources via flexible tubes. These reserves, without any replenishment from off-site sources, would allow the LCU tanks to be fully refilled many times, and which would ensure the safety of the power unit by the function of the SG PHRS tanks as well as replenishment of the spent fuel pool during not less than 240 days. **Evaluation:** Based on the requirements of the 2013 WENRA Report '*Safety of new NPP designs*', the SG PHRS can be considered as Level 3.b equipment of the DiD concept '*Control of accident to limit radiological releases and prevent escalation to core melt conditions under postulated multiple failure events*'. This corresponds also to the rating in compliance with the DiD of IAEA TECDOC 1791, where either the rating as Level 3.b or as Level 4.a '*Control of design extension conditions to prevent core melt*' was given. Regarding level 3b, the above WENRA Report highlights that systems designed to comply with the WENRA objective O2 – '*Accidents without core melt*' – should have '*sufficient redundancy of active components to reach adequate reliability*' (WENRA report, p. 21). While applying the requirements highlighted in the WENRA Report, installing an alternative mobile option for refilling the SG PHRS and the SFP cannot be considered as complying with the WENRA requirements. Therefore, the installation of a pump redundant to the JNB50 pump was advised, unless it can be demonstrated that without such a pump there can still be a sufficiently reliable supply of coolant.

Action (Source[12]:)	PRT recommendation, action in NAcP and NAcP update	Implementation and evaluation of action
		The engineering and design of the NPP began as early as in 2006, i.e. prior to the Fukushima accident and was adapted step-by-step to new safety requirements, which were developed and internationally agreed upon after Fukushima. Initially, the JNB50 pump was intended to be a single device. Therefore, the single failure concept was not applied for the components of SG PHRS, which is a BDBA system (Russian terminology) according to the classification provided in the design. This was also reported to the PRT by the designer and the future operator during the review of the national report in 2018. By the time the national report was reviewed, BelNPP was under construction and the engineering was completed. Therefore, the constructor and the operator – also in agreement with GAN – refused to accept the PRT's proposal, even as early as 2018 when the peer review was being carried out. However, they expressed that they were prepared to give thought to compensating measures and to implementing them. This was reflected in Actions 4-9 and 4-10, which the operator sees as implemented in the presented concept. Observing the status of engineering and the conceptual initial situation of BelNPP, which was effective by the time of the peer review of the national report in 2018, the PRT can consider these proposed and implemented technical solutions as a safety improvement. Although not providing a permanently available redundancy to the installed JNB50 pump, the proposed technical solution together with a mobile redundancy, provides diversity and reliability. The essential prerequisite is the availability of the firefighting equipment at all times, which must not be endangered by external events as extreme weather or earthquake. Instructions describing detailed requirements and steps to be performed for handling the equipment in case of an event have been presented to the PRT. This includes also the timely connection of the mobile firefighting pump to the safety building. The PRT considers the chosen solution as an appropriate measure in order to address the recommendation, under the condition that the above-mentioned prerequisite is satisfied.

Action (Source[12]:)	PRT recommendation, action in NAcP and NAcP update	Implementation and evaluation of action
R-14, PRT p. 70 NAcP 4-12	**Recommendation:** The PRT recommends a suitable alternative solution is implemented to ensure that restoration of water supply is achieved within necessary time to prevent core damage. **Action:** Develop, for subsequent implementation, technical and organisational measures ensuring restoration of the water supply in time to prevent serious accidents occurring in an open reactor in the event of a total loss of external and emergency power supply to the power unit. **Status:** Belarusian NPP issued a call for technical and commercial proposals for implementation of the work. Proposals were received from JSC IC "ASE".	**High priority issue – prevention and mitigation measures for severe accidents under open reactor conditions** **Implementation:** See description in R-19. **Evaluation:** See PRT statement in R-19.
R-15, PRT p. 70 NAcP 4-13	**Recommendation:** The PRT recommends that analysis is undertaken to demonstrate the reliability of these off-site powers sources in seismic condition. **Action:** Assess the reliability of the auxiliary power supply to responsible consumers, from a 110/10 KW emergency standby auxiliary transformer with a power of 16 MVA which can be connected via a 110 kV cable to the "Viliya" substation; and assess the "Viliya" substation's stability in the face of internal and external events. **Status:**	This item will be reviewed in phase 2.

Action (Source[12]:)	PRT recommendation, action in NAcP and NAcP update	Implementation and evaluation of action
	Belarusian NPP issued a call for technical and commercial proposals for implementation of the work. Proposals were received from the State Enterprise Belenergo.	
NAcP 4-11	**Action:** Take organisational and technical measures for the stationary connection of one MDGU to each nuclear power unit. **Status:** Unit 1: Belarusian NPP made the necessary adjustments to the design documentation, installed a stationary connection line for the mobile diesel generator unit (hereinafter: 'MDGU') and a distribution device (connection point) on the wall of building 10UJE. The MDGU is located at the entrance inspection point of the Belarusian NPP construction site. Installation of the MDGU is scheduled for 28 February 2020. Unit 2: The necessary adjustments to the project documentation have been made. The equipment is at the manufacturing stage.	**High priority issue – completing the permanent connection of the diesel generator devoted to Channel 7** **Implementation:** Under NAcP Action 4-11, it is envisaged that each unit will be equipped with a mobile DG with a permanent connection, while the mobility of DG will be preserved. This has already been completed for Unit 1**.** **Evaluation:** The MDG in each unit (10/20XKA70) provides electricity to the Channel 7 busbar for supporting the BDBA consumers (Russian terminology) of each unit. Reflecting the 2018 PRT recommendation, the MDG (10XKA70) at unit 1 has been connected and (20XKA70) will be connected at unit 2 permanently to the buses of the channel 7 by means of a flexible cable. The cable connects the MDG`S and the assembly 10/20BKS12GH570. Protection of the cable from external hazards is provided by its installation in an underground metallic fire-resistant tray, which is zinc coated, with a coat thickness of 80 µm. The assembly 10/20BKS12GH570 is located on the outer wall of the building 10/20UJE. The construction of the assembly provides for protection of the integrated commutation device from external impacts. In the assembly 10/20BKS12GH570 there is a load switch made by the manufacturer ABB. Functionality of the mobile equipment will be checked in adherence to the '*Regulations for checks and tests of safety relevant systems*'. The personnel of NPP Belarus is carrying

Action (Source[12]:)	PRT recommendation, action in NAcP and NAcP update	Implementation and evaluation of action
		out required checks (tests) of the MDG stations 10/20XKA70 according to the schedule and programmes, approved by the chief engineer of the NPP. The presence and the arrangement of the MDG 10XKA70 in unit 1 and the permanent connection to the connecting point 10BKS12GH570 have been surveyed by the PRT during the February site visit and, also the existence of respective documents describing the measures to be taken for assuring the operability have been checked by the PRT. Therefore, the PRT considers this high priority issue as addressed.
PRT p. 63-64; NR p. 52	**Recommendation** [PRT] The additional use of mobile means should be further considered as a valuable component of operational accident management. [NR] Two mobile DG sets (1 per NPP Unit) with a power of 500 kW will be provided, which presumably will be located outdoors at the NPP site. In terms of organisational measures for preparation of operation and commissioning of a mobile DG set it is required to develop appropriate operational instructions and sections of emergency procedures for their use in case of complete loss of AC power supply**.** **Action:** n/a **Status:** n/a	This item will be reviewed in phase 2.

5. Severe Accident Management

Action (Source[13]:)	PRT recommendation, action in NAcP and NAcP update	Implementation and evaluation of action
R-16, PRT p. 71 NAcP 4-14	**Recommendation:** While it is recognised that several advanced safety features are implemented in the design, the overall concept of practical elimination of early and large releases should be more explicitly reflected in an updated plant safety case. Attention should be also devoted to the practical elimination of severe accidents in the spent fuel pool or severe accidents potentially combined with the containment by-pass. **Action:** Assess the adequacy of design solutions ensuring: - practical elimination of early or severe radioactive releases; - practical elimination of severe accidents in the spent fuel storage pool; - practical elimination of containment by-pass events during severe accidents. **Status:**	This item will be reviewed in phase 2.

[13] The brackets indicate the sources of the respective action:

- NR: National Report - Stress Test for Belarussian Nuclear Power Plant - 2017,
- PRT: EU Peer Review Report of the Belarussian Stress Tests - June 2018,
- EU: ENSREG '*Compilation of Recommendations and suggestions - Peer review of stress tests performed on European nuclear power plants', 26 July 2012*',
- NAcP: Number of Recommendation of the National Action Plan of Belarus (NAcP), 2019,
- p: page.

Action (Source[13]:)	PRT recommendation, action in NAcP and NAcP update	Implementation and evaluation of action
	Belarusian NPP issued a call for technical and commercial proposals for implementation of the work. Proposals were received from JSC IC "ASE".	
R-17, PRT p. 71 NAcP 4-17	**Recommendation:** Consideration should be given to the installation of independent means of reactor coolant system depressurisation, or special attention should be given to reliable functioning of existing means under severe accident conditions. **Action:** Carry out a review confirming the adequacy of technical devices envisaged for reducing pressure in the primary circuit under serious accident conditions (in order to eliminate damage resulting from high pressure). **Status:** Belarusian NPP issued a call for technical and commercial proposals for implementation of the work. Proposals were received from JSC IC "ASE".	**High priority issue – evaluation of adequacy and/or enhancement of means for depressurising the reactor coolant system** **Implementation:** The main objective of this measure is to prevent the ejection of molten corium from the ablated/penetrated RPV at high pressure (prevention of HPME). Such an ejection could happen in the event of a severe accident in combination with the RCS being kept at high pressure; usually pressure below 2 MPa is considered as sufficiently low – in Russian designs, a lower value 1 MPa is used. Although the safety implications of such conditions for BelNPP are less significant than for other reactor designs due to the depressurisation effect of heat removal through SG PHRS, there are technical means and procedures to carry out depressurisation of the reactor under severe accident conditions. At present, there are two ways to carry out depressurisation after transition from EOPs to SAMGs. • An operator from the MCR or ECR could open the pressuriser (PRZ) valves. These valves are also used for DBAs. However, they are connected to the additional (dedicated) control line developed and implemented at the NPP to manage design extension conditions. • Valves on gas evacuation (venting) lines could be opened in combination with one PRZ valve. In total, there are 10 venting lines connected to different parts of the RCS (reactor, PRZ, SGs). The studies aimed at verifying the venting capacity of these lines are ongoing. Both of these means can be used also should the power supply be lost, since the power to open the valves comes from the batteries or Channels 7 and 8 of power supply. After opening the valves no further operator actions are needed for depressurisation. As confirmed by BelNPP, the supporting analysis demonstrated that there is sufficient time to carry out these actions. Two types of accidents have been considered for the design

Action (Source[13]:)	PRT recommendation, action in NAcP and NAcP update	Implementation and evaluation of action
		capacity of the depressurisation system: severe accidents caused either by an SBO combined with loss of all heat exchangers of the passive heat removal system, and SBO combined with ruptures of all steam lines. **Evaluation:** For typical existing PWR, this measure for depressurising the primary coolant system is essential, particularly as regards being able to deal with a severe accident caused by an SBO accident. Because of the required independence between the levels of defence, the best solution for intentional depressurisation in the event of a severe accident is to use an independent (dedicated) depressurisation system (a system different from the pressuriser safety valves) or at least ensure the availability of independent means for opening a PRZ safety valve when the electrical power supply is completely lost. In the case of BelNPP, residual heat removal resulting in depressurisation of the RCS in the event of an SBO is ensured via passive means (SG PHRS). In the event of an LBLOCA, one of the consequences is depressurisation. For severe accidents caused by small or medium LOCA combined with failure of the active ECCS, depressurisation of the RCS below 1 MPa is achieved before beginning of fuel melting and no other intentional depressurisation is needed. Based on the information provided by BelNPP, depressurisation of the RCS is needed only for very unlikely accidents. Nevertheless, there are independent means for depressurising the RCS in the event of a severe accident at high RCS pressure (dedicated control line for opening 2 PRZ valves, or 1 valve in combination with opening the RCS's venting lines). This recommendation is considered as adequately addressed.
R-18, PRT p. 71 NAcP 4-1, 4-2, 4-3	**Recommendation:** The adequacy of margins of SSCs for beyond design basis earthquakes of the plant equipment ultimately needed for prevention of large releases in case of a severe accident should be reconsidered and the robustness of the systems	This item will be reviewed in phase 2. .

Action (Source[13]:)	PRT recommendation, action in NAcP and NAcP update	Implementation and evaluation of action
	increased, if necessary, based on the results of seismic PSA under preparation. **Action:** Carry out additional studies on the construction of seismic hazard curves, to clarify the safety margins of NPP structures, systems and components (SSCs), taking into account the more precise seismotectonic model. Correct the seismic Probabilistic Safety Analysis (PSA) for which initial data will come from adjusted seismic hazard curves, including the assessment of safety margins for parts of safety-critical systems. Determine the need for a comprehensive assessment of seismic risk on the basis of more refined seismic hazard curves and existing equipment safety margins. Review the results of the seismic PSA-2018 in the assessment of NPP safety and determine the need for appropriate actions in order to improve safety. Based on the completion of the actions in point 1, assess the characteristics of seismic stability of SSCs to ensure their function in an accident situation (levels DiD 3 and 4). **Status:** The State enterprise “Belorusskaya AES” (hereinafter: “Belarusian NPP”) set the budget for work on this item, conducted competitive tender procedures and selected the contractors to work on the construction of a seismotectonic model and refinement of the seismic hazard curves, taking into account the alternative seismotectonic model.	

Action (Source[13]:)	PRT recommendation, action in NAcP and NAcP update	Implementation and evaluation of action
	Work on the construction of a seismotectonic model and refinement of the seismic hazard curves, taking into account the alternative seismotectonic model, is currently ongoing. Deadline for completion of the work: March 2020. The deadline for adjusting the PSA for seismic impacts, taking into account the revised seismic hazard curves, has been postponed until December 2020. Belarusian NPP developed a PSA in cooperation with the General Contractor: PSA-2018 Level 1 and PSA-2018 level 2 for Unit 1 of Belarusian NPP as part of the licensing package. The materials for PSA-2018 Level 1 and PSA-2018 Level 2 for Unit 1 of Belarusian NPP are reviewed by experts as part of a safety report with a view to obtaining a licence to operate Unit 1. The licensing procedure for that Unit is ongoing. As part of the commissioning works, ATOMTECHENERGO AO is assessing the seismic stability of safety-critical equipment using the ‘Programmes for determining the dynamic characteristics and seismic stability of safety-critical equipment’. The work is expected to be completed by 31 March 2020. As part of the adjustment to the seismic PSA (Point 1 of the National Plan), work on seismic stability analyses is in hand. The results will form the basis for a list of components, and the probabilistic parameters of their seismic damage to Unit 1 will be determined. (The work is being done by “TsKTI-VIBROSEYSM OOO” and “ATOMPROYEKT AO” and is scheduled for completion by 31 May 2020.	

Action (Source[13]:)	PRT recommendation, action in NAcP and NAcP update	Implementation and evaluation of action
R-19, PRT p. 71 NAcP 4-12	**Recommendation:** Further consideration should be given to the prevention and the mitigation of severe accidents under open reactor conditions, when heat exchangers of the SG PHRS system are disabled and time margin to core damage is rather short. **Action:** Develop, for subsequent implementation, technical and organisational measures ensuring restoration of the water supply in time to prevent serious accidents occurring in an open reactor in the event of a total loss of external and emergency power supply to the power unit. **Status:** Belarusian NPP issued a call for technical and commercial proposals for implementation of the work. Proposals were received from JSC IC "ASE".	**High priority issue – prevention and mitigation measures for severe accidents under open reactor conditions** **Implementation:** The current situation as regards managing design extension conditions (beyond design basis accidents) with the potential transition to a severe accident in the open reactor has been described in the responses to PRT questions and in the subsequent discussion with BelNPP. According to full-scope PSA Level 1 (including all operating regimes, events in the spent fuel pool, internal and external hazards), initiating events with open reactor represent 6% of the total core damage frequency ($9.77x10^{-7}$/year). According to the Safety Analysis Report (SAR) the supply of coolant to the open reactor should start not sooner than 2.5 hours from the loss of cooling with the capacity of injection being 11 kg/s. The loss of coolant due to evaporation can be compensated by coolant from the hydro accumulators (sufficient for about 8 hours) or in the long term by low-pressure pumps (if power supply is recovered). All the necessary actions are covered in the EOPs or SAMGs. The actions also include the supply of coolant to the SFP, either by using an existing dedicated power source with a dedicated pump, or a fire truck. The fire truck connections are located on the external walls of the building. The procedure for delivering coolant from the fire truck to the SFP has been verified by testing. The designer is intentionally not considering the use of any external source for injecting non-borated coolant to the reactor because of possible problems with recriticality of the degraded core. If non-borated coolant is supplied to the SFP, the issue of recriticality is not relevant, because absorbers present in the construction materials of the SFP racks prevent recriticality. If all the above-mentioned actions to compensate the loss of cooling fail, the accident can evolve into a severe accident at low pressure in the RCS. If the melting of the core is not halted within the RPV, molten corium will penetrate the RPV and will be relocated to the core catcher. Afterwards, cooling of the corium will be ensured by the cooling system

Action (Source[13]:)	PRT recommendation, action in NAcP and NAcP update	Implementation and evaluation of action
		of the core catcher, with the heat being eventually removed to the environment through the C PHRS. The potentially dangerous situation of a severe accident in open reactor occurring in combination with open containment although not fully ruled out in the plant can be prevented, as the containment can be isolated within 30 minutes to 1 hour according to the SAMGs, which is less than the time of the potential transition into a severe accident. The isolation includes evacuation of personnel, isolation of all pipes and valves penetrating the containment, closing the hatches and gates. With regard to the operation of the material hatch, the PRT was informed that only one of the two gates can be open at any moment. Power is needed to isolate the containment, but there are redundant power supplies for the necessary systems. Power supply and separate batteries exist for each safety system (e.g. ventilation valves isolation). **Evaluation:** In the case of shutdown regimes with an open reactor, the SG PHRS is disabled and the amount of coolant in the RPV is smaller, thus contributing to a higher vulnerability of a transition to a severe accident. On the other hand, in regimes with an open reactor, the residual power is smaller and thus the transition to a severe accident takes longer. The responses to the PRT's questions and the additional explanations received during discussions between the PRT and BelNPP as well as during the plant visit show that the implementation of the action is well advanced. During the plant visit it was demonstrated that in the event of a severe accident, the containment can be reliably isolated in a timely manner. Successful use of the measures described above would ensure that there would be no significant release of radioactive substances to the areas surrounding the plant. This recommendation is considered as adequately addressed. Nevertheless, the plant is encouraged to seek additional sources and means for injecting the borated coolant into the reactor in order to extend the amount of time before the fuel is damaged in an open reactor and thus further step up the preventive part of accident management. Although a severe accident taking place in an open reactor will

Action (Source[13]:)	PRT recommendation, action in NAcP and NAcP update	Implementation and evaluation of action
		be localized inside the containment without major risk for the public it is suggested to put more attention to prevention of a severe accident in situations with an open reactor.
R-21, PRT p. 71 NAcP 4-19	**Recommendation:** Although habitability of control areas (main control room, emergency control room) during a severe accident in combination with station blackout has been assessed in the SAR as satisfactory, it is still advised that this issue be further assessed and habitability enhanced. **Action:** Review the need to equip the management zones (MCR, ECR) with additional systems which ensure survivability and the habitability of the MCR/ECR. **Status:** Belarusian NPP issued a call for technical and commercial proposals for implementation of the work. Proposals were received from JSC IC “ASE”.	**High priority issue – review and/or enhancement of habitability of control areas (main and emergency control rooms) during a severe accident combined with an SBO** **Implementation:** Responses provided to the PRT’s questions described the current situation regarding habitability of control areas should an SBO occur. The implementation of technical measures aimed at ensuring habitability of control areas includes three different tasks: • implementing measures to ensure habitability of MCR/ECR/TSC if their surroundings should be contaminated by radioactive or toxic substances; • assessing the possibility of long-term occupation of control places if they become completely isolated from the external air supply; • developing additional measures to ensure long-term habitability of control places if they become completely isolated from the external supply of fresh air, and If necessary, provide personal protective means for occupants of the control places. Existing design measures ensure protection of the control places against external radiation and the effects of fires. There are ventilation and air conditioning systems, operating either in direct mode (with double filtration) or in recirculation mode, providing adequate living conditions in the control places corresponding to the hygienic norms. If power supply is lost and the ventilation systems are thus not operable, control places are completely isolated from their surroundings. In this case, the temperature and the concentration of CO_2 will start increasing in the control places. For a fully isolated MCR/ECR, the time margin to reach the parameters that require the use of personal protective means was determined as appropriate in the MCR and ECR. In addition to habitability of the MCR/ECR, the habitability of the technical support centre (TSC) (7 occupants) and the emergency centre was also discussed. It was stated that these facilities have suitable habitability conditions, equipped with an appropriately sized

Action (Source[13]:)	PRT recommendation, action in NAcP and NAcP update	Implementation and evaluation of action
		autonomous power supply and resistant against hazards. There are independent diesel generators, ventilation and filtration, food and drinking water, communication, decontamination systems and other systems for ensuring habitability. There is also an independent (twin) emergency centre 20 km away, in the city. **Evaluation:** Suitable living and working conditions in the control places, in particular the MCR, ECR and TSC, are important for the operators to reliably carry out actions under emergency conditions, including for the operators' psychological comfort owing to their personal safety. Implementation of the recommended actions has progressed satisfactorily. Available design provisions ensure that control places in the plant, including in situations involving station blackout conditions, are habitable for a sufficiently long time, allowing actions to be carried out to shut and cool down the plant. In case of a fire in the MCR and the need for transit from MCR to ECR personal protective means are provided, including refillable breathing apparatus. Several types of communication means exist for on- and off-site communication (e.g. video, telephone, voice, radios, vcr, server for data exchange). Also access control is provided and video recording. Batteries and backups are available for situation with loss of power supply. This recommendation is considered as adequately addressed. Nevertheless, to further enhance plant safety in the long term, additional improvements aimed at extending habitability, e.g. up to 72 hours, are encouraged to be looked into, in order for different plant systems to have a better balance in autonomy.
R-22, PRT p. 71 NAcP 4-20	**Recommendation:** In the event of NPP blackout the emergency ventilation system of the annulus is not available. Whether there is a need for the system to be in operation in the event of severe accident in combination with station blackout should be	This item will be reviewed in phase 2.

Action (Source[13]:)	PRT recommendation, action in NAcP and NAcP update	Implementation and evaluation of action
	further investigated, and, if necessary, the emergency ventilation system of the containment annulus should be modified. **Action:** Review the expediency of ensuring operation of the emergency ventilation system of the annulus (inter-containment space) in the event of a serious accident combined with a loss of external and emergency power supply to the power unit. **Status:** Belarusian NPP issued a call for technical and commercial proposals for implementation of the work. Proposals were received from JSC IC "ASE".	
R-23, PRT p. 71 NAcP 4-21	**Recommendation:** Noting that symptom-based emergency procedures (EOPs and SAMGs) are required before a licence to operate is granted and the challenging timescales, it is recommended that there is a clear programme of work in place to develop the symptom-based emergency procedures; to verify and validate the procedures; and to train personnel before core load. **Action:** Prepare a work programme for the development and implementation of symptom-oriented emergency procedures. **Status:**	**High priority issue – development, validation and implementation of symptom-based EOPs and SAMGs** **Implementation:** The responses to the PRT's questions, supported by the discussion, highlighted that the recommendation had been successfully implemented before the commissioning of the plant. The system of procedures is composed of a combination of event and symptom-based procedures. All symptoms are available in the main and emergency control room as well as in the technical support centre. There is a special panel in the MCR for displaying the symptoms applicable for design extension conditions. Three sets of procedures are available: for design basis accidents (ILA), for BDBA (RUZA) and for severe accidents (RUTA). It was confirmed that the set of procedures is of the same type as that currently used in the majority of VVER 1000 reactors as well as in many PWRs in Europe (known as Westinghouse Owner Group type procedures). The procedures cover both power and shutdown operational regimes (including regimes with open reactor) and accidents that originate in the SFP. The EOPs and SAMGs have been developed using

Action (Source[13]:)	PRT recommendation, action in NAcP and NAcP update	Implementation and evaluation of action
	Belarusian NPP prepared a "Work Programme for the Development and Implementation of Symptom-Oriented Emergency Procedures". The Programme activities are currently being implemented, including: - development of a preliminary version of SOEP (AtomRED OOO); - preliminary editions of Belarusian NPP have been reviewed and have been agreed upon, taking into account the results of the preliminary review (Belarusian NPP); - preliminary editions of the SOEP have been verified with the issue of a verification report (Belarusian NPP); - an adjustment has been made to the preliminary edition of the SOEP based on the verification results (AtomRED OOO); - operational personnel have been trained to work with the corrected results of verification of the SOEP (Belarusian NPP); - a review has been carried out and there has been coordination of a preliminary version of the SOEP with the developers of the project AS and RU (NIC "Kurchatov Institute", OKB "Gidropress"); - calculation and analytical substantiation of the SOEP (Kurchatov Institute) is being developed, and preparations are under way for validation of the SOEP (Belarusian NPP has developed a draft programme for validation of the SOEP and a draft order for SOEP validation).	relevant analytical basis. The transition between different procedures is clearly defined. The consistency and transition between procedures is ensured by a special procedure. Transition from ILA to RUZA happens when critical safety functions start to be violated during ILA. Safety functions are similar to those used in Westinghouse type EOPs (subcriticality, core cooling, secondary heat removal, primary circuit integrity, containment integrity, primary circuit inventory). Transition from RUZA to RUTA is based on clear symptoms, including core outlet temperature > 650 °C, hot leg temperature, reactor coolant level (usual way of transition to SAMGs for Westinghouse type procedures).There are also different (specific) SAMGs transition parameters for spent fuel (mainly the coolant level). Experience from the development and implementation of the procedures in the reference plant (Leningrad-2) has been used. The procedures and guidelines were validated (in accordance with a special procedure for performing the validation) and the lessons learned from the validation have been introduced to the updated procedures. The operating staff have undergone training, which consisted of both theoretical and practical parts. Other members of the emergency response organisation, e.g. firemen, were also trained. Severe accident management is an integral part of the plant emergency response. At country level, there is a national system of the responses to emergencies. Several external organisations are involved in emergencies, such as fire response and medical services. At the plant, the emergency response is managed by the emergency director, who in case of a need coordinates the activities with the external support teams. Emergency response plans are tested (drills) and updated regularly. Additional forces can be provided by the Ministry of Emergency and Civil Protection from nearby areas. Several exercises and drills have been made during the previous years (every year since 2017). **Evaluation:** The symptom-based EOPs and SAMGs have been developed, validated and implemented before the plant commissioning in line with the recommendation.

Action (Source[13]:)	PRT recommendation, action in NAcP and NAcP update	Implementation and evaluation of action
		This recommendation is considered as adequately addressed.
NAcP 4-15	**Action:** Examine and supplement the list of severe accident management strategies at the in-vessel stage with a control strategy that ensures the timely supply of water to the steam generator (SG) (in order to protect SG tubes from destruction and, if necessary, ensure heat removal via the secondary circuit). **Status:** Belarusian NPP issued a call for technical and commercial proposals for implementation of the work. Proposals were received from JSC IC “ASE”.	This item will be reviewed in phase 2.
NAcP 4-16	**Action:** Qualify the available technical means of controlling the primary circuit protection function against overpressure under post-design conditions, including serious accidents. **Status:** Belarusian NPP issued a call for technical and commercial proposals for implementation of the work. Proposals were received from JSC IC “ASE”.	This item will be reviewed in phase 2.
NAcP 4-18	**Action:** Review the adequacy of technical measuring devices for the management of serious accidents and develop additional measures if necessary. **Status:**	This item will be reviewed in phase 2.

Action (Source[13]:)	PRT recommendation, action in NAcP and NAcP update	Implementation and evaluation of action
	Belarusian NPP issued a call for technical and commercial proposals for implementation of the work. Proposals were received from JSC IC "ASE".	
PRT p. 70	**Recommendation:** In the NR no information was given regarding the evidence of the efficiency and reliability of the new passive safety systems as the SG PHRS and C PHRS. During the discussion the PRT requested information based on experimental data and commissioning test in similar plants. No additional evidence was available during the review mission. Nevertheless, GOSATOMNADZOR stated, that comprehensive tests, proving the efficiency and functionality of new systems have to be carried out as a part of the commissioning procedure and were requested in the licensing procedure. **Action:** n/a **Status:** n/a	This item will be reviewed in phase 2.

• LIST OF ABBREVIATIONS

AC	Alternating current
BDBA	Beyond design basis accident
BelNPP	Belarusian nuclear power plant
CDF	Core damage frequency
C PHRS	Containment passive heat removal system
CPL	Cable power line
DBA	Design basis accident
DBE	Design basis earthquake
DEC	Design extension condition
DG	Diesel generator
DiD	Defence-in-depth
ECR	Emergency control room
EDG	Emergency diesel generator
ENSREG	European Nuclear Safety Regulators Group
EOP	Emergency operating procedure
EU	European Union
g	standard value of the gravitational acceleration (9.81 m/s^2)
GAN	Gosatomnadzor
GMPE	Ground motion prediction equation
HCLPF	High confidence in low probability of failure
HPME	High pressure melt ejection
HVAC	High voltage alternating current
I&C	Instrumentation and control
IAEA	International Atomic Energy Agency
ILA	Emergency operating procedure for design basis accidents (Russian acronym)
LB	Large break
LBLOCA	Large break LOCA
LCU	Makeup water system
LERF	Large or early radioactive releases
LOCA	Loss of coolant accident
MCR	Main control room
Mmax	Maximum possible magnitude
MSK-64	Medvedev–Sponheuer–Karnik (seismic intensity scale)
NAcP	National Action Plan
NPP	Nuclear power plant
NR	(Stress Test) National Report
OSART	Operational Safety Assessment Review Team
PGA	Peak ground acceleration
PGA_H	Horizontal peak ground acceleration
PHRS	Passive heat removal system
PR	Peer review
PRT	Peer Review Team
PRZ	Pressuriser

PS	Power substation
PSA	Probabilistic safety assessment (also known as PRA)
PSHA	Probabilistic seismic hazard assessment
PWR	Pressurised water reactor
RCS	Reactor coolant system
RPV	Reactor pressure vessel
RUTA	Severe accident management guidelines (Russian acronym)
RUZA	Beyond design-basis accident management procedure (Russian acronym)
SAM	Serious accident management
SAMG	Severe accident management guideline
SAR	Safety Analysis Report
SBO	Station blackout
SFP	Spent fuel pool
SG	Steam generator
SG PHRS	Steam generator passive heat removal system
SMA	Seismic margin assessment
SOEP	Symptom-oriented emergency procedures
SSC	Structures, systems and components
SSE	Safe shutdown earthquake
SV	Safety valve
TSC	Technical support centre
UPS	Uninterruptible power supply
VVER	Russian pressurised water reactor
WENRA	Western European Nuclear Regulators Association
XLPE	Cross-linked polyethylene