International Peer Review of the Environmental Impact Assessment performed for the licence application of the Baltic-1 Nuclear Power Plant, Kaliningrad, Russian Federation

Annexes to the
Final Report of the
IAEA International Review Team
January 2015

INTRODUCTION

The following Annexes comprise information complementing the peer review of the Environmental Impact Assessment prepared for the licence application of the Baltic-1 Nuclear Power Plant, Kaliningrad, Russian Federation.

Annex I provides a copy of the Terms of Reference for the International Peer Review of EIA Materials for the Baltic-1 NPP.

Annexes II, III and IV provide compilations of questions to Rosenergatom and the related responses. The questions were identified during the review of the EIA Materials and from the discussions during the three review meetings held in Kaliningrad (Russian Federation) from 24-28 February 2014, in Vienna (Austria) from 21-23 July 2014 and in St. Petersburg (Russian Federation) from 5-7 November 2014, respectively.

The questions and answers are attached to document the additional information. This information has not been edited by the IAEA and is presented as provided by the counterpart.

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ANNEX I.

TERMS OF REFERENCE FOR THE INTERNATIONAL PEER REVIEW OF EIA MATERIALS FOR THE BALTIC NPP

The State Atomic Energy Corporation of the Russian Federation (ROSATOM) requested the services of the IAEA to conduct an international peer review of the Environmental Impact Assessment for the Baltic NPP against the IAEA safety standards and against the requirements of the Espoo Convention, Environmental Impact Assessment in a Transboundary Context. The modalities of the review were agreed in the following Terms of References.

1. Background

The State Atomic Energy Corporation ROSATOM of the Russian Federation (hereinafter referred to as "ROSATOM") has requested the International Atomic Energy Agency ("the IAEA") services on an international peer review of the document "Materials of Environmental Impact Assessment for Baltic NPP" dated 30.11.2012 (hereinafter referred to as "EIA materials"). Original of the EIA materials has been submitted in Russian. Rosenergoatom Concern OJSC (hereinafter – Rosenergoatom") has been assigned the organization responsible for provision of the EIA materials and for conclusion an agreement on extrabudgetary contribution on the review purposes.

The Baltic NPP is a new nuclear installation with two VVER-1200 power units, which is under construction in the Kaliningrad Region of the Russian Federation. The EIA materials were developed, as per Rosenergoatom order, by the Open Joint-Stock Company "St. Petersburg Scientific Research and Design Institute ATOMENERGOPROEKT" (hereinafter –OJSC "SPbAEP").

The IAEA as a UN Specialized Agency provides safety evaluations against its standards to any Member State maintaining required confidentiality as requested.

2. Objective of the review

The objective of the requested international peer review is to provide Rosenergoatom with a report on the consistency of the EIA materials with the IAEA Safety Standards in the field of radiation protection of the public and the environment, and other international documents (hereinafter – "the review reference documents").

The review will also facilitate the sharing of good practices, identified in the review and will provide feedback on the development of the international standards and recommendations on the preparation of the radiological parts of the environmental impact assessment.

3. Organization of the review

A project approach will be utilized for carrying out of the review. The project on "International peer review of Baltic NPP EIA materials" (hereinafter – "the Project") will be managed from IAEA's Headquarters in Vienna. The project will be managed on the IAEA side by the Project Manager, a staff member of the Waste & Environmental Safety Section, Division of Radiation, Transport and Waste Safety (NSRW), who will be responsible for execution of the work identified in this Annex. IAEA will organize and provide necessary secretarial, administrative and IT services as required.

The IAEA will use for the Project execution their best technical resources, i.e. IAEA in-house expertise and expertise of qualified consultants from different Member States with developed nuclear programmes. The IAEA Project Manager will be responsible for setting

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up and coordination of the team, including arrangement of contracts for the peer review, and for other financial and managerial aspects of the programme. If requested, the IAEA provides a list of their in-house staff and the names of the external experts being considered in carrying out this work. The list will be finalised in consultations with Rosenergoatom. An IAEA Confidentiality Agreement will be signed by all external experts.

Results of the work will be documented in a Review Report to be issued to Rosenergoatom. The report will provide a summary of the EIA materials and the evaluation against the review reference documents.

To extent possible the review team will use the unofficial English translation of the EIA materials that is to be provided by Rosenergoatom. In a case of ambiguity, the original in the Russian language will be used as a reference text. In this connection, the review team shall comprise a Russian-speaking expert.

4. Review Scope

The review should be conducted within the scope of the IAEA statutory functions and should evaluate the scope and content of the EIA materials on the consistency with the applicable requirements and guidance of the IAEA Safety Standards related to radiation protection of the public and the environment. Additionally, the review will evaluate the content of the radiological part of the EIA materials with regard to the requirements of the Espoo Convention on the Environmental Impact Assessment in a Transboundary Context.

The topics, which are beyond the scope of radiation protection issues of EIA - such as the nuclear safety and security of the installation, justification of the practice, evaluation of the source term parameters, occupational exposure, etc. - are not included in the review.

The review reference documents are listed below:

(a) INTERNATIONAL ATOMIC ENERGY AGENCY, Fundamental Safety Principles, IAEA Safety Standards Series No. SF-1, IAEA, Vienna (2006)

(b) INTERNATIONAL ATOMIC ENERGY AGENCY, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards. General Safety Requirements No. GSR Part 3. IAEA, Vienna (2011).

(c) Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety, GS-R-1, IAEA, Vienna, 2000

(d) INTERNATIONAL ATOMIC ENERGY AGENCY, Generic Models for Use in Assessing the Impact of Discharges of Radioactive Substances to the Environment, Safety Report Series No. 19, IAEA, Vienna (2001).

(e) INTERNATIONAL ATOMIC ENERGY AGENCY, Regulatory Control of Radioactive Discharges to the Environment, IAEA Safety Standards Series No. WS-G-2.3, IAEA, Vienna (2000).

(f) INTERNATIONAL ATOMIC ENERGY AGENCY, Environmental and Source Monitoring for Purposes of Radiation Protection, Safety Guide, Safety Standards Series No. RS-G-1.8, IAEA, Vienna (2005).

(g) INTERNATIONAL ATOMIC ENERGY AGENCY, Dispersion of Radioactive Material in Air and Water and Consideration of Population Distribution in Site Evaluation for Nuclear Power Plants, Safety Guide, Safety Standards Series No. NS-G-3.2, IAEA, Vienna (2002).

(h) Site Evaluation for Nuclear Installations NS-R-3, IAEA, NS-R-3, Vienna 2004.

(i) The Convention on the Environmental Impact Assessment in a Transboundary Context. Espoo, Finland, 1991.

http://live.unece.org/ fileadmin/DAM/env/eia/documents/legaltexts/conventiontextenglish.pdf

This list constitutes the entire set of the review reference documents.

5. Review Process

The EIA materials in English and other appropriate (as considered by the Donor) supporting documents (the unofficial translation) will be submitted to the IAEA within 1 month after the transfer of the extra budgetary contribution to the IAEA account.

In order to facilitate the experts' preparation to review the EIA materials, Rosenergoatom will arrange a presentation of the EIA materials at the Baltic NPP site.

The review work is conducted by the external experts mainly at their base locations. The IAEA Waste and Environmental Safety Section of the Division of Transport, Radiation and Waste Safety will apply reliable measures to ensure that the EIA materials are reviewed in a consistent manner. The work of the IAEA review team will be discussed during expert a meeting in Vienna. The Project Manager arranges the review work to ensure compliance with the Project schedule, which is given below.

Review results will be open to the whole team for comment and discussion to ensure the comprehensiveness of assessments, the consistency of the approach, and the application of logical assessment framework. Based on the review results, a consolidated Interim Review Report will be issued to Rosenergoatom for comments. A final meeting of the IAEA review team and Rosenergoatom experts will be arranged in St. Petersburg to discuss the review results.

Finally, the IAEA review team will address Rosenergoatom comments on the Interim Report and produce the Final Report, which is sent then to Rosenergoatom.

The deliverables will be considered as Rosenergoatom proprietary information.

The distribution of the final report is initially restricted to the IAEA, the IAEA review team and to Rosenergoatom. Any further distribution at this time is the discretion of the Rosenergoatom. Ninety days after the final report is issued, it is automatically released for unrestricted dissemination, unless Rosenergoatom requests otherwise. In the interest of transparency Rosenergoatom is encouraged to allow publication of the report by the IAEA.

6. Estimated Schedule and Costs

It is estimated that the work identified in this work plan can be performed within the schedule outlined below:

12 Feb 2013	Letter from SC Rosatom DDG, Mr.N.Spassky to IAEA DDG-NS, Mr.D.Flory concerning the EIA materials international peer review implementation issues
15 April 2013	The EIA in Russian officially submitted to the IAEA
18-19 April 2013	IAEA-Rosenergoatom/Rosatom meeting to prepare in detail this Agreement
July 2013	Both parties signed this Agreement
Time "0"	100% of the agreed extra-budgetary contribution received by the IAEA
+ 1 month	Submission of unofficial translation of the EIA and initial set of supporting materials to the IAEA

+ 4 months	The service agreements and contracts with the IAEA contributors to the peer review are signed and material provided to the IAEA review team
+ 6 months	Meeting of the IAEA review team with Rosenergoatom experts (presentation of the EIA materials for initial familiarization) and visit of the Baltic NPP site
+ 11 months	The draft Interim Review Report prepared
+ 11 months	Meeting of the IAEA review team for finalization of the Interim Review Report (Vienna)
+ 12 months	The Interim Report submitted to Rosenergoatom
+ 14 months	Final meeting of the IAEA review team with Rosenergoatom experts to discuss the Interim Review Report (St Petersburg)
+ 16 months	The Final Review Report sent to Rosenergoatom

The total duration of the work should not exceed 16 months. Both parties should avoid any delays in execution of the project and should try to perform the work as fast as possible.

The IAEA as a non-commercial organization will charge, under IAEA rules, mainly for the principal costs associated with use of external services, travel expenses (including tickets and DSA) and administrative expenses. IAEA staff costs are not included.

ANNEX II.

ADDITIONAL QUESTIONS FROM THE REVIEW TEAM TO ROSENERGATOM IDENTIFIED DURING THE 1ST REVIEW MEETING, HELD IN KALININGRAD (RUSSIAN FEDERATION) FROM 24–28 FEBRUARY 2014 AND ANSWERS FROM ROSENERGATOM

The questions and answers are included in the report to document the additional information in its original form, as it was provided by the counterpart on request of the Review Team.

Topic	Review Team's question	Answer
Topic: Discharges of radionuclides		
Details on the source term for normal operation	100 radionuclides are mentioned as radiation significant, but only a few are given in the text (page 87, Vol. 1/Book 2) **List of all radionuclides and their discharges per year (Bq/a) to the atmosphere** — Detailed list of noble gases — Detailed list of aerosol bound radionuclides — Detailed list of halogen radionuclides — Tritium — Carbon-14 **List of all radionuclides and their discharges per year (Bq/a) to the river** — Detailed list of all radionuclides — Tritium	Design calculation values for the main radiologically significant nuclides annual ingress to the environment due to both gas aerosol releases to atmosphere and liquid discharges under normal operation conditions of the Unit are given in the Tables AII.1 and AII.2 of this Annex to these answers.
	The following issues need clarification — What are the licensed discharges for the Baltic NPP? — In how far are anticipated operational occurrences	Permissible releases (PR) and permissible discharges (PD) of radioactive substances under normal operation conditions are set in accordance to Russian regulations (paras 5.11–5.19 of the SP AS-03) for a NPP as a whole (irrespectively to a number of units at the site) based on the minimum significant dose for the

Topic	Review Team's question	Answer
	covered in the licensed discharges? — What is the meaning of the permissible release (SP-AS-03) — Tritium (Is this the value given for blow down water header on slide 35 of the presentation on Presentation 3 (25.2.2014)	public which is 10 mSv/a, for each exposure factor (releases/discharges). For some radiologically significant nuclides or nuclide groups, the PR values are established by Russian regulations (SP AS-03), and these values are given in the Table 6.4.1.2.2 of the EIA report. As per Russian regulations, final PR and PD values for a particular plant are calculated and justified by the operating organization or an organization specialized in the subject matter, with NPP parameters (installed capacity, reactor type, etc.) and placement region characteristics (regional demography, population consumption conditions, etc.) taken into account, and such values are subject to approval by the regulatory body as per established procedure. The PR values set for Balakovo NPP (4 WWER units) in operation are given in the Table 6.4.1.2.3 of the EIA report and in the Table AII.2 of this Annex for reference. Actual PR and PD values for Baltic NPP are to be set at subsequent stages of the design process. For abnormal operation conditions (anticipated operational occurrences) there is a target dose limit established in the AES-2006 design as follows: Not more than 100 mSv/a per event for members of the public. Tritium ingress to the environment due to releases and discharges is not regulated by Russian norms. The calculated design values for tritium ingress to the environment with non-radioactive drainage water (via cooling tower blowdown water header) are given at the slide 35 of the presentation entitled ”Baltic NPP: Radiation Safety of Population” and in the Table AII.2 of this Annex A to these answers.

Topic	Review Team's question	Answer
Radionuclide releases for Beyond Design Base Accidents (BDBA)	**List of all radionuclides and their discharges per year (Bq/a) to the atmosphere** — Detailed list of all radionuclides • Aerosol bound radionuclides • Iodine isotopes • Noble gases — Fractions of iodine forms — Duration of the releases — Release heights	Data for emergency release of radiologically significant nuclides at various phases of a severe accident progression as considered in the design are given in the Table AII.3 of this Annex to these answers. The height of a near surface release at an early accident phase due to leaks through the double wall containment is assumed to be 30 meters. The height of a high altitude release through the vent stack one day after the accident onset is assumed to be 100 meters. Detailed information related to calculation estimations of radiological consequences of a severe accident is presented in the section 15.7.5 of the PSAR, while the main provisions and outcomes are reproduced in para 6.4.2.2 of the EIA report.
Topic: Meteorological conditions		
Dispersion of radionuclides	**Hourly data for a period of 5 years in electronic form (e.g. Excel sheets)** — Wind speed (m/s) at a height of 10 and/or 100 m — Wind direction — Precipitation (mm/h) — Stability class — Name and location of the meteorological station at which the meteorological data have been determined	The extract from meteorological observations database (the meteorological station in Sovetsk town) for period 2000–2007 is given at the end of this Annex (the file containing the electronic database).
	Additional questions — Is the height of the stack 100 m or 110 m? — The height of the cooling tower is 170 m, whereas the stack height is 110 m: • Has the influence of the cooling tower on the	The stack height is 100 m, and the height of the cooling tower is 167 m. Influence of the cooling towers (as well as any other buildings at the site) on the dispersion of both short term and long term radioactive releases was studied for the Baltic NPP site by a specialized organization. The study has shown that for distances less than 3 km the cooling towers influence results in

Topic	Review Team's question	Answer
	dispersion of radionuclides in the atmosphere been considered?	reduced release dilution factors, while for distances more than 3 km the cooling towers influence becomes negligible (±10–20%). The reason for such a reducing short range effect of the buildings erected at the site is an increased rate of pollutants dispersion due to a greater turbulence conditions in vicinity of buildings as well as a building induced effect of pollutant plume displacement in upward direction. In a conservative manner, this influence of the site buildings and cooling towers has not been taken into account in calculations of public doses.
Topic: Assessment of exposures		
Assessment of exposures during normal operation	**Definition of a representative person for which the exposures are estimated** — Which location has been assumed relative to the Baltic NPP (distance in km, direction) for the estimation of the exposures to the public due to discharges to the atmosphere? — Which location has been assumed relative to the entry point of the liquid discharges of the Baltic NPP to the Neman river (distance from the entry point in km) for the estimation of the exposures to the public due to discharges to the Neman river?	Doses for normal plant operation were estimated for various population groups in a distance range from 0.25 to 15 km from the point of release, for the 16 rhumb direction. For estimation of doses from two power units it was assumed that the distance measuring reference point is a geometric center of vent stacks of Unit 1 and 2, and that the release from two units is the sum of two releases. As concerned to population exposure due to liquid discharges from Baltic NPP to Neman river, it was assumed in the assessment that water usage takes place at distance of 500 m downstream the point of discharge. The calculations have been performed in accordance with the SRS 19 [II-1] methodology, which considers the following parameters: — River depth; — River velocity; — Distance from the discharge point and the water usage place;

Topic	Review Team's question	Answer
		— Discharge flow rate. It was assumed in calculations that liquid discharge is executed from the river bank in the downstream direction, thus increasing conservatism of the assessments.
	Age(s) of the representative person — Which age group(s) have been considered for estimating exposure to the public? **Ingestion** — Dietary habits (kg/a) as function of age • Leafy vegetables • Root vegetables • Fruit and fruit vegetables • Cereals • Milk • Meat • Any other typical local food stuffs • Freshwater fish • Crustaceans and mollusks • Drinking water — From which survey have the dietary data been derived? — Origin of the food consumed (local/fraction of local)	In the calculations of doses from gas aerosol releases and liquid discharges, the following two groups of population were taken into consideration: children of 1–2 years of age and adults. In the calculations of doses from gas aerosol releases from Baltic NPP, the dietary structure was assumed in accordance to methodic recommendations of [II-2] and is given in the Table AII.4. For the goal of assessment of internal exposure of the public from liquid radioactive discharges to Neman river, levels of consumption of freshwater fish, crustaceans, mollusks, and drinking water were assumed as per the IAEA publication SRS 19 [II-1]. The dietary structure used in the calculations has followed the methodic recommendations of [II-1] and is given in the Table AII.5. It was assumed that the population consume foodstuffs produced locally, close to the point of residence (the design point), and the share of foodstuffs of local origin is 100%.
	Inhalation — Breathing rates as function of age **External exposure**	Annual volume of breathed air was accepted as per NRB-99/2009 [II-3], namely: 1900 m^3/year for children of 1–2 years of age, and 8100 m^3/year for adults. The calculated doses do not account that the public members

Topic	Review Team’s question	Answer
	— Time spent indoors and outdoors — Shielding factors of houses	stays at open air only a part of time, nor the effect of shielding of external exposure from radioactive plume and surface sediments due to existing buildings and structures.
	Additional information — Has the recreational use of river water (boating, swimming, fishing, staying on river banks) been included in the assessment? — Has the use of river water for irrigation been taken into account? — Has the use of river sediments as fertilizer been taken into account? — Where are the real locations where water is withdrawn on both sides of the river?	In calculations of radiological impact to the public due to ingress of radioactive substances to Neman river under conditions of normal operation, the impacts from boating, swimming, fishing, and staying on river banks were considered. The uses of river water for irrigation as well as the use of river sediments for fertilizing applications were not taken into account. In calculations of doses to the public it was conventionally assumed that Neman river water is used as drinking one in the point located 500 m downstream the discharge point. The calculations were performed in accordance with the methodology provided in the reference publication [II-1].
Assessment of exposures during accidental releases	**Definition of a representative person for which the exposures are estimated** — Which location has been assumed relative to the Baltic NPP (distance in km, direction) for the estimation of the exposures to the public due to discharges to the atmosphere — Which location has been assumed relative to the entry point of the liquid discharges of the Baltic NPP to the Neman river (distance from the entry point in km) for the estimation of the exposures to the public due to discharges to the Neman river **Age(s) of the representative person**	Population doses for emergency plant conditions were estimated for various distances in the range from 0.25 to 15 km from the point of release, for the 16 rhomb direction. Ingress to surface waters of radioactive substances due to liquid discharges under conditions of abnormal operation, design basis accident and beyond design basis accident is excluded by engineering means. The age groups of population, their dietary structures, breathing rates are the same as for normal operation dose assessments. In calculations of population doses due to external exposure from contaminated surface in case of a severe BDBA, the effects of shielding and partial presence of individuals at the

Topic	Review Team's question	Answer
	— Which age group(s) have been considered for estimating exposure to the public? **Ingestion dose: Dietary habits of the representative person (if included in the estimation)** — Dietary habits (kg/a) as function of age • Leafy vegetables • Root vegetables • Fruit and fruit vegetables • Cereals • Milk • Meat • Any other typical local food stuffs • Freshwater fish • Crustaceans and mollusks • Drinking water — From which survey have the dietary data been derived? — Origin of the food consumed (local/fraction of local) **Inhalation** — Breathing rates as function of age **External exposure** — Time spent indoors and outdoors — Shielding factors of houses	open ground were taken into account by means of introduction of an averaged correction factor of 0.4. Analysis of radiological consequences of a severe accident was carried out in the design in order to make predictions as regard to scope of urgent measures needed to protect the population at an early stage of the accident, with direct exposure paths (external exposure from the release plume and surface sediments, internal exposure due to inhalation) taken into account while excluding from calculations the impacts of foodstuff consumption. At subsequent accident stages, the population protection measures are determined on the basis of radiological surveillance of adjacent territories.
	Additional information — Relevance of the statement on page 96 (Vol 1/Book2), 6.4.2.2.9, which highlights the	Adjustment of the calculated doses for severe accident conditions as well as revision of sizes of the urgent protective action planning zone can be performed as necessary based on

Topic	Review Team's question	Answer
	preliminary nature of the assessments given. Will these estimation be revised, and if so, when? — Tables 6.4.2.2.2: Which quantities are given? Is it the effective dose? — Page 153 (Vol1/Book2): A potential release of 100 TBq ^{137}Cs is given. For which case?	the PSA level 2 results for Baltic NPP and refinement of the reference severe accident scenario. Development of PSA level 2 for Baltic NPP is planned to be done at the stage of preparation of license application for fuel uploading. Based on PSA level 2 results for a similar plant, Tianwan NPP, the severe accident scenario considered in EIA report and PSAR for Baltic NPP has a probability of occurrence much lower than 1×10^{-7} (1/year). In the Table 6.4.2.2.2 of the EIA report there are given results of calculation of effective dose for the first year after accident. This is indicated in the table header. Para 6.7.4.1.2 of the EIA report contains the target limit as established in the Baltic NPP design for severe BDBAs having a probability less than 1×10^{-7} (1/year), which reads as follows: release of ^{137}Cs not more than 100 TBq.

ADDENDUM A OF ANNEX II

Table AII.1. Annual releases of radioactive gases and aerosols from the plant under normal operation conditions of the Unit (in GBq/year per Unit)

Radionuclide	Vent stack					Above the roof
	Reactor building ventilation systems	Special gas treatment systems KPL-2	Special gas treatment systems KPL-3	Ventilation system of the auxiliary building	Total release	Turbine building
H-3	3.9 E3	–	–	5.0 E1	3.9 E3	1.2 E0
C-14	–	–	–	–	3.0 E2	–
Kr-83m	5.6 E2	–	1.1 E2	2.9 E0	6.7 E2	2.7 E1
Kr-85m	2.0 E3	3.6 E-1	2.4 E2	8.4 E0	2.3 E3	6.1 E0
Kr-85	5.5 E0	3.5 E2	2.6 E-1	1.6 E-2	3.6 E2	6.6 E-2
Kr-87	1.1 E3	–	2.5 E2	6.6 E0	1.4 E3	6.4 E1
Kr-88	4.4 E3	–	5.8 E2	2.1 E1	5.0 E3	1.5 E2
Xe-131m	1.0 E2	1.4 E2	6.6 E0	3.1 E-1	2.5 E2	1.6 E0
Xe-133	2.6 E4	2.1 E2	1.8 E3	7.9 E1	2.8 E4	4.7 E2
Xe-135	6.2 E3	–	1.3 E3	2.2 E1	7.6 E3	3.3 E2
Xe-138	1.7 E2	–	1.2 E2	1.5 E0	2.9 E2	3.1 E1
I-131	1.6 E-2	–	2.0 E-2	3.6 E-2	7.3 E-2	3.1 E-3
I-132	3.3 E-2	–	–	6.4 E-2	9.7 E-2	1.0 E-2
I-133	4.3 E-2	–	–	9.4 E-2	1.4 E-1	9.3 E-3
I-134	2.4 E-2	–	–	4.2 E-2	6.6 E-2	2.8 E-3
I-135	3.6 E-2	–	–	7.7 E-2	1.1 E-1	7.1 E-3
Cr-51	3.4 E-6	–	–	7.5 E-5	7.9 E-5	1.5 E-7
Mn-54	2.1 E-7	–	–	4.6 E-6	4.8 E-6	2.1 E-7
Co-60	1.3 E-6	–	–	3.1 E-5	3.1 E-5	2.4 E-6
Sr-89	1.3 E-5	–	–	3.1 E-4	3.35 E-4	1.4 E-5
Sr-90	2.6 E-8	–	–	5.7 E-7	6.0 E-7	4.4 E-8
^{134}Cs-134	8.6 E-4	–	–	1.9 E-2	2.0 E-2	1.0 E-3
^{137}Cs-137	1.3 E-3	–	–	2.9 E-2	3.0 E-2	1.3 E-3
Noble gases	4.1 E4	7.0 E2	4.4 E3	1.4 E2	4.6 E4	1.1 E3
Iodines	1.5 E-1	–	2.0 E-2	3.1 E-1	4.9 E-1	3.2 E-2
Aerosols	2.2 E-3	–	–	4.9 E-2	5.1 E-2	2.3 E-3
Total	**4.1 E4**	**7.0 E2**	**4.4 E3**	**1.4 E2**	**4.6 E4**	**1.1 E3**

Table AII.2. Radioactive substance ingress to the environment due to liquid discharges under normal operation conditions of the Unit

Radionuclide	**Annual radioactive substance ingress to the environment, GBq/year per Unit**				**Permissible Discharge for Balakovo NPP (in operation)**
	Drainage water from Controlled Access Area		**Drainage water from Free Access Area**	**Total discharge**	
	Excessive water of KBF, KPF systems	**Filters (LCQ, KPF40) regeneration water**	**Filters (LD) regeneration water**		**GBq/year (4 Units)**
H-3	9.1 E3	–	–	9.1 E3	–
I-131	1.8 E-3	1.7 E-5	2.1 E-2	2.3 E-2	–
I-132	3.9 E-3	2.3 E-9	4.5 E-4	4.3 E-3	–
I-133	4.6 E-3	1.7 E-7	5.8 E-3	1.0 E-4	–
I-134	3.5 E-3	–	9.6 E-5	3.6 E-3	–
I-135	4.0 E-3	–	1.5 E-3	5.5 E-3	–
Sr-89	1.4 E-5	2.0 E-4	8.0 E-4	1.0 E-3	–
Sr-90	1.1 E-7	8.1 E-7	2.2 E-6	3.1 E-6	
Cs-134	2.6 E-2	1.8 E-2	6.6 E-2	1.1 E-1	3.0 E0
Cs-137	4.0 E-2	2.8 E-2	1.0 E-1	1.7 E-1	8.4 E-1
Cr-51	6.4 E-4	3.0 E-5	1.5 E-4	8.2 E-4	
Mn-54	6.0 E-4	1.0 E-5	1.4 E-5	6.2 E-4	1.6 E1
Co-60	2.4 E-3	5.5 E-5	9.7 E-5	2.5 E-3	1.4 E0
Co-58	4.2 E-4	5.9 E-5	2.3 E-4	7.1 E-4	
Total (except tritium)	**8.8 E-2**	**4.6 E-2**	**2.0 E-1**	**3.3 E-1**	–

ADDENDUM B OF ANNEX II

Table AII.3. Emergency release to the environment under severe accident conditions as a function of time in TBq

Nuclide	**Nature of the release / time since the accident onset**								
	Low altitude release							**High altitude release**	
	0–8 hours		**8–24 hours**		**1–7 days**		**7–30 days**	**1–7 days**	**7–30 days**
	Via containment leaks	**Containment bypass**	**Via containment leaks**	**Containment bypass**	**Containment bypass**	**KLC* filters bypass**	**KLC filters bypass**	**Through KLC filters**	
Gases									
Kr-85m	2.3E+01	2.2E+00	1.3E+01	8.3E-01	7.2E-02	3.6E-01	–	3.6E+01	–
Kr-87	8.8E+00	1.8E+00	2.6E-01	4.6E-02	–	–	–	–	–
Kr-88	4.6E+01	5.2E+00	1.1E+01	8.3E-01	1.9E-02	1.1E-01	–	1.1E+01	–
Xe-133	4.8E+02	3.4E+01	1.8E+03	7.9E+01	4.8E+02	5.7E+02	2.0E+02	5.7E+04	2.0E+04
Xe-135	1.1E+02	9.0E+00	4.7E+02	2.3E+01	1.8E+01	2.9E+01	–	2.9E+03	–
Xe-138	3.1E-01	4.7E-01	8.1E-03	3.2E-03	–	–	–	–	–
Ru-103	1.1E+00	6.2E-02	7.0E+00	2.9E-01	1.3E-01	3.1E-01	2.1E-01	3.1E+01	2.1E+01
Molecular iodine									
I-131	7.4E-01	4.8E-02	8.2E+00	4.0E-01	6.2E-02	3.5E-01	–	3.5E-01	–
I-132	4.9E-01	2.4E-02	2.6E-01	1.6E-02	2.4E-03	2.8E-03	–	2.8E-03	–
I-133	1.5E+00	8.9E-02	1.1E+01	5.3E-01	1.7E-02	2.9E-01	–	2.9E-01	–
I-134	2.4E-01	1.3E-02	1.1E-02	1.1E-04	–	–	–		–
I-135	1.1E+00	6.4E-02	3.7E+00	2.0E-01	9.4E-04	7.7E-02	–	7.7E-02	–
Organic iodine									
I-131	3.6E-01	2.5E-02	1.3E+00	5.7E-02	3.9E-01	4.5E-01	4.7E-01	4.5E+00	4.7E+00
I-132	1.3E-01	1.7E-02	2.1E-01	1.9E-02	1.5E-02	1.6E-02	–	1.6E-01	–
I-133	6.1E-01	4.6E-02	1.6E+00	7.3E-02	1.1E-01	1.8E-01	5.9E-04	1.8E+00	5.9E-03
I-134	2.2E-02	6.6E-03	4.8E-04	1.1E-03	–	–	–		–
I-135	3.9E-01	3.4E-02	4.4E-01	2.4E-02	5.9E-03	1.8E-02	–	1.8E-01	–
Aerosols									
I-131	2.3E+01	5.9E+00	1.3E+01	2.3E+00	6.3E-01	6.2E+00	–	6.2E-01	–
I-132	1.8E+01	7.9E+00	6.2E+00	2.1E+00	2.6E-02	5.3E-02	–	5.3E-03	–
I-133	4.2E+01	1.2E+01	1.8E+01	3.4E+00	1.7E-01	5.5E+00	–	5.5E-01	–
I-134	3.1E+00	2.6E+00	6.4E-02	4.0E-02	–	–	–		–
I-135	2.8E+01	8.7E+00	6.7E+00	1.5E+00	9.7E-03	9.1E-01	–	9.1E-02	–
Cs-134	5.7E+00	1.5E+00	3.3E+00	5.8E-01	1.2E-01	1.5E+00	2.5E-01	1.5E-01	2.5E-02
Cs-137	2.7E+00	6.9E-01	1.6E+00	2.7E-01	7.5E-02	7.3E-01	1.6E-01	7.3E-02	1.6E-02
Sr-90	6.4E-02	1.6E-02	2.6E-02	4.5E-03	6.0E-03	6.2E-03	1.3E-02	6.2E-04	1.3E-03
Te-131m	3.5E+00	9.3E-01	1.1E+00	2.0E-01	4.5E-03	5.4E-01	6.0E-05	5.4E-02	6.0E-06
Ba-140	1.5E+00	3.8E-01	5.8E-01	1.0E-01	1.3E-01	4.5E-01	1.3E-01	4.5E-02	1.3E-02
La-140	1.2E-01	2.9E-02	1.4E-01	2.5E-02	2.2E-02	1.6E-01	2.7E-02	1.6E-02	2.7E-03
Ce-141	3.5E-02	8.7E-03	1.4E-02	2.4E-03	4.5E-03	1.3E-02	7.1E-03	1.3E-03	7.1E-04
Total:									
Gases	6.7E+02	5.3E+01	2.3E+03	1.0E+02	5.0E+02	6.0E+02	2.0E+02	6.0E+04	2.0E+04
Iodines	1.2E+02	3.7E+01	7.1E+01	1.1E+01	1.4E+00	1.4E+01	4.7E-01	8.6E+00	4.7E+00
Aerosols (except iodines)	1.4E+01	3.5E+00	6.8E+00	1.2E+00	3.7E-01	3.4E+00	5.9E-01	3.4E-01	5.9E-02

* The KLC filters are a system to reduce the pressure in the reactor building, which is equipped with effective iodine and aerosol filters.

ADDENDUM C OF ANNEX II

Table AII.4. Main foodstuff consumption by various age groups of the population [II-2] in kg(l)/year

Foodstuff group	Age group, years	
	1–2	**> 17**
Milk and dairy products	246	190
Meat	27	60
Wheat	54	112
Potato	84	110
Cabbage	10	21
Cucumber	5	6.8

Table AII.5. Main foodstuff consumption by various age groups of the population according to methodic recommendations of SRS-19 [II-1], kg(m^3)/year

Foodstuff group	Age group, years	
	1–2	**> 17**
Freshwater fish, kg/year	15	30
Mollusks, kg/year	0	15
Drinking water, m^3/year	0.26	0.6

Meteorological observations database (the meteorological station in Sovetsk town) for period 2000–2007 is contained in < SOV00_07.txt> file in a text format. The database structure is described in < Struktura_eng> file.

REFERENCES

[II-1] INTERNATIONAL ATOMIC ENERGY AGENCY, Generic models for use in assessing the impact of discharges of radioactive substances to the environment, Safety Reports Series No. 19, IAEA, Vienna (2001).

[II-2] NTD 38.220.56-84 “Methods for calculation of NPP-generated radioactive substances dispersion and exposure of local population”. Part 1. Annexes. MHO Interatomenergo, Moscow, Energoatomizdat (1984).

[II-3] Radiation Safety Standards (NRB-99/2009). Sanitary Rules and Standards SanPiN 2.6.1.2523-09. Moscow (2009).

ANNEX III.

RESPONSES PROVIDED IN RESPONSE TO QUESTIONS POSED FOLLOWING MEETING OF INTERNATIONAL PEER REVIEW TEAM DURING THE 2ND REVIEW MEETING HELD IN VIENNA FROM 21–23 JULY 2014

The questions and answers are included in the report to document the additional information in its original form, as it was provided by the counterpart on request of the Review Team.

Topic	Expert's question	Answer
Topic: Airborne discharges		
Topic: Expected annual discharges and discharge limits (source term)	Expected annual airborne discharges of nuclides have been provided by the Russian Federation in answer to questions from the Experts [III-1] (Table AIII.1). The expected airborne discharges from some radionuclides are very low and may be below the limit of detection. Please provide details of detection limits for the monitoring of airborne discharges. Please describe how releases of nuclides that are below the detection limits will be reported, and how they are taken into account in dose assessments.	For gas and aerosol discharges control, continuous and periodic remote monitoring as well as periodic sampling and laboratory analyses of samples are performed. Periodical and laboratory monitoring allow for high sensitivity measurements. Monitored parameters and measurements ranges are given in Appendix A. When the nuclide discharge is below the detection limit under continuous release monitoring it is recorded that release is at the level of detection limit. In the design of Baltic NPP under Construction the predicted public dose rates are calculated on the basis of rated design values of radionuclides airborne discharge which have a certain design margin in relation to the data obtained during operation of the existing NPPs.
	Table 6.4.1.2.2 of the EIA Report [III-2] provides discharge limits for four individual nuclides and inert gases. No limits are provided, for example, for Tritium or ^{14}C. 1. Please provide details of discharge limits for nuclides other than those noted in Table 6.4.1.2.2 (^{60}Co, ^{131}I, ^{134}Cs, ^{137}Cs, inert gases).	In compliance with current Russian normative documents (SP AS-03, para 5.12–5.14) the discharges of only those nuclides and groups of nuclides are standardized which are presented in Table 6.4.1.2.2 of EIA Report (the group of inert radioactive gases includes Xe, Kr, Ar). Permissibility of design discharge values for the rest of nuclides under normal operation of NPP is justified in the design based on the precondition that the public dose limit of 10 μSv/year shall

Topic	Expert's question	Answer
		not be exceeded (the limit is related to a plant as a whole, regardless the number of power units).
Topic: Results of the dose assessment	Section 6.4.1.4.2 of the EIA Report [III-2] finds that the maximum direct exposure to routine discharges occurs in the North-Westerly direction. However, the annual wind rose given in Figure 3.1.4.1 of the EIA Report [III-2] suggests that the maximum direct exposure would occur in the North-Easterly direction. 1. Please provide an explanation of the apparent discrepancy in the direction of maximum direct exposure and the prevailing wind as given in the wind rose.	Section 6.4.1.4.2 of the EIA Report [III-2] contains the editing mistake: it should read "North-Easterly direction" instead of "North-Westerly direction". The correct information was presented on slide No.36 of presentation: "Baltic NPP: Radiation Safety of Population" presented at the meeting with experts on 25.02.2014 in Kaliningrad.
Topic: Liquid discharges		
Topic: Exposure Pathways	The description of the models and parameters used to assess routine liquid discharges provided in the EIA Report [III-2] and in answer to questions from the Experts [III-1] is insufficiently detailed for the Experts to make an appropriate judgement. 1. Please provide further details on the models and parameters used to assess the dose from routine liquid discharges. 2. Please clarify why irrigation and use of Neman River bottom sediment have not been taken into account as exposure pathways. 3. Please confirm that the stated consumption of mollusc from the Neman River (Table AII.5) is realistic. 4. Re Tables AII.4 and AII.5, please provide a more detailed description of food consumption rates.	1. For detailed calculation of public dose loads due to discharges from Baltic NPP into Neman River (including description of calculation model and parameters) see Appendix B. 2. These exposure pathways have not been taken into account during calculation due to unavailability of information about use of water from Neman River for irrigation purposes and use of bottom sediment as fertilizers, as well as low probability of using the bottom sediment from the point of discharge into Neman River or using the water for irrigation (it is not expected to transfer bottom sediment around the discharge point to radwaste category, on the other hand this sediment is considered as a "limited use material" for which the values of $^{134,137}Cs$ specific activity exceed the allowed value 10^{-1} Bq/g). 3. Statistical data on consumption of mollusc from Neman River by population are unavailable, therefore the averaged

Topic	Expert's question	Answer
		data as per the IAEA Safety Report Series, No 19 were used in calculations. 4. Table AII.4 contains data which was used for calculation of public dose rates due to gas aerosol discharges from NPP. The data presented meets the averaged conservative recommendations specific for residents in Eastern Europe (see Ref. [III-2] of Addendum C to the Responses to Expert's Questions [III-1]).
Topic: Expected annual discharges and discharge limits (source term)	In answer to questions from the Experts [III-1], expected annual discharges of nuclides have been provided for each unit (Table AII.2). The Experts note that no discharges of ^{14}C are mentioned. Table AII.2 also specifies discharge limits for the Balakovo NPP, but the values given are different from those given in the EIA Report [III-2] for the Balakovo NPP (Table 6.4.1.2.1) 1. Please confirm that no discharge of ^{14}C is expected in the Nieman River. 2. Please explain the derivation of the discharge limits of the Balakovo NPP. 3. Please explain the difference in discharge limits for the Balakovo NPP given in the answer to the Experts [III-1] and in the EIA Report [III-2]. 4. Please explain what limits will be applied to liquid discharges from the Baltic NPP — will the Balakovo discharge limits be applied, or will other limits be applied. 5. Please explain the derivation of the discharge limits that will be applied for the Baltic NPP.	Based on the researches carried out at the existing NPPs with WWER it is expected that most part of ^{14}C is released into environment with gas aerosol releases in the form of CO, CO_2 and compounds of C_nH_m type. Level of ^{14}C intake with liquid discharges is expected to be insignificant. Limits for admissible discharges from NPP are specified by an operating organization on the basis of dose limit of 10 μSv/year (for critical population group) taking into account peculiarities of nuclides distribution in surface and ground waters and the population life conditions in the area of NPP location.. Limits for admissible discharges are specified by Authorities (Rostechnadzor of Russian Federation). Table 6.4.1.2.3 of EIA Report contains the values of permissible discharges for Balakovo NPP as of 2008 (used in the first edition of EIA Report). The actual permissible discharges in Balakovo NPP as of 2014 are provided in the Responses to Expert's Questions [III-1]. For Baltic NPP the values of permissible discharges will be specified during the stage of operating license receipt and shall be approved by the Authorities (Rostechnadzor of Russian Federation). See above the answer to item 2 in this topic.

Topic	Expert’s question	Answer
Topic: Accidental Releases		
Topic: Source Term	In answer to questions from the Experts [III-1], nuclide releases as a function of time have been provided (Table AII.3). It is important for the Experts to understand the extent to which the data may have been simplified. 1. Please clarify why no alpha emitters (e.g. Pu, Am) appear in the table. 2. Please clarify whether ^{90}Sr, ^{10}3Ru, ^{131m}Te, and ^{141}Ce are representative of releases of other Sr, Ru, Te, and Ce nuclides. 3. Please clarify which nuclides have been neglected (e.g. Mo, Rb). 4. Please clarify if the source term provided corresponds to the severe accident (BDBA accident with probability < 10^{-7}/year) that has the highest releases/consequences.	1. The technical measures implemented in the design (double wall containment, core catcher, system of passive heat removal from the containment, etc.) allow to predict the absence of radiation significant environmental release of heavy non-volatile compounds incl. alpha active aerosols. Radiation consequences of severe accidents considered in the design are determined by release of gaseous and volatile compounds. 2. For the goal of estimation of fission products release in case of severe accident, various chemical elements were united in 7 groups by their physical chemical properties (see slide No.51 of the presentation "Baltic NPP: Radiation Safety of Population" presented in the meeting with Experts on 25.02.2014 in Kaliningrad). It was assumed that the physical chemical properties of all nuclides are identical within any specific group. Differences between various nuclides of the same group are completely defined by their half-life period. 3. Both the nuclides with low coefficients of release from corium (see slide No. 51 of presentation) and the radiation insignificant nuclides with small contribution to gross activity accumulated in fuel were not taken into account in estimation of the radiological consequences. 4. The "reference" severe accident considered in the design is selected proceeding from the precondition of maximum radiation consequences with release probability at level of 10^{-7} (1/year).
	The EIA Report [III-2] provides two references that were used in the development of the source term [III-3, III-4]. The Experts note that these references are	5. The mentioned documents [III-3, III-4] were used in the source term estimations in part of the following recommendations:

Topic	Expert's question	Answer
	applicable for Generation 2 Reactors and the Baltic NPP is a Generation 3 reactor. 5. Please confirm if other references were used in the generation of the source term.	– selection of "reference" scenario of severe accident; – release of fission products from corium at various stages of severe accident; – ratio of various forms of iodine inside the containment during severe accident. Approaches used for the calculation of accident release generally follow the recommendations of EUR rev.D.
Topic: Atmospheric dilution factors	Section 6.4.2.2.7 of the EIA Report [III-2] mentions that a "maximum atmospheric dilution factor" has been used for the dose assessment of accidental releases, but does not provide a value. Please provide the value of the atmospheric dilution factor at different distances from the NPP (e.g. 1 km, 2 km, 5 km, 10 km).	See Appendix C for the values of accidental release dilution factors (with credibility of 95%) for various distances, which were used in calculations of public dose loads in case of severe accident.
Topic: Exposure Pathways	Table 6.4.2.2.1 of the EIA Report [III-2] (10 day doses) does not show ingestion as contributing to the exposure. Similarly, Table 6.4.2.2.2 of the EIA Report [III-2] (1 year doses) does not show ingestion as contributing to the exposure. This does not appear consistent with the assessment of the doses from accidental releases from the LAES-2 NPP (Section 6.4.2.2.3 of the EIA Report [III-2]), which found that 99% of dose in the first year came from the consumption of agricultural products. Please explain why ingestion is not taken into account in the assessment of the accidental doses for the Baltic NPP.	Para 6.4.2.2.3 of EIA Report covers the radiation consequences of design basis accidents, whereby all the exposure pathways of population are considered, including consumption of local foodstuffs. Tables 6.4.2.2.1 and 6.4.2.2.2 contain the severe accident caused public doses due to direct exposure pathways only. This analysis is carried out for justification of urgent protection measures for population (emergency evacuation, iodine prophylaxis, sheltering) at an early phase of accident. In compliance with Russian normative documents (para 5.9 of NP-032-01) and recommendations of IAEA [III-5, III-6] it is planned to restrict consumption of local foodstuffs within up to 300 km radius area in case of an accident with significant release while implementing the measures for emergency response. Taking into account the introduction of restrictions on consumption of local contaminated foodstuffs in case of a

Topic	Expert's question	Answer
		severe accident, the dose rates for population through the ingestion pathway are not considered when justifying the introduction of urgent protection measures (evacuation, etc.) and deferred protection measures (resettlement of population).
Topic: Shielding/Occupancy Time	In answer to questions from the Experts [III-1], it was stated that, for in assessing exposure from normal operations, no account was taken of the fraction of time an individual may spend outdoors or shielding effect of building. In assessing exposure from accidental releases, it was stated that a factor of 0.4 was used to account for the effects of shielding and the partial presence of individuals outdoors. Please explain why a factor of 0.4 was used to account for shielding/occupancy time in assessing exposure from accidental releases, when no such factor was used in assessing exposure from normal operations.	The assessment of dose loads under normal operation of Baltic NPP was performed conservatively without consideration of both shielding factor and limited time of population staying outdoors. The shielding factor 0.4 was taken into account in the realistic assessments (as per requirements of ORB-88/97, para 1.2.16) when analysing beyond design basis accidents.
Topic: Regulations	To enable the completion of the Review Report, it will be necessary to reference the applicable regulations of the Russian Federation. Please provide details of the regulations of the Russian Federation that define radiological release criteria for normal operations and accidents, and the definition of the Representative Person (or Critical Group).	The main Russian regulatory documents which set the criteria for radiation impact of NPP are as follows: – Radiation safety standards (NRB-99/2009); SANPIN 2.6.1.2523-09; – Sanitary rules for nuclear plants design and operation (SP AS-03). SANPIN 2.6.1.24-03; – General safety provisions for nuclear power plants (OPB-88/97). NP-001-97 (NP AZG-01-011-97); – Siting of nuclear power plants. Basic criteria and requirements for safety assurance. NP-032-01. Definition of a critical group of population is set in the NRB-99/2009 (Appendix 7 "Terms and definitions") in

Topic	Expert’s question	Answer
		compliance with the relevant definition of the IAEA Safety Series 115 [III-7]: "Critical group is a group of individuals of population (not less than 10 individuals), uniform as regards one or several features – gender, age, social or professional conditions, place of residence, food ration, which is subject to the most significant radiation impact in the given exposure pathway from the given source term."

ADDENDUM A OF ANNEX III

For gas and aerosol discharges control, continuous and periodic remote monitoring as well as periodic sampling and laboratory analyses of samples are performed.

(1) The following parameters are subject to Continuous remote monitoring:

- Activity concentration of aerosols within the ranges 1 to10^7 Bq/m^3 for β-emitters and 10^{-2} to10^4 Bq/m^3 for α-emitters;
- Activity concentration of iodine within the range of 3.7 to 3.7×10^6 Bq/m^3;
- Activity concentration of radioactive inert gases within the range of 3.7×10^4 to 3.7×10^{10} Bq/m^3;
- Dose rate for γ-radiation within the range of 10^{-8} to 10^1 Sv/h.

(2) The following parameters are subject to Periodic remote monitoring:

- radionuclide composition of radioactive inert gases within the range of 3.7×10^2 to 3.7×10^{12} Bq/m^3.

(3) The following parameters are subject to Periodic sampling and laboratory analyses:

Composition and activity concentration:

- γ-emitting radionuclides within the range of 10^{-3} to10^4 Bq/dm^3;
- β-emitting radionuclides within the range of 10^{-3} to10^4 Bq/dm^3;
- Tritium within the range of 10^{-3} to10^4 Bq/dm^3;
- Carbon-14 within the range of 10^{-3} to10^4 Bq/dm^3;
- α-emitting radionuclides within the range of 10^{-3} to10^4 Bq/dm^3.

Special samplers are used for sampling.

ADDENDUM B OF ANNEX III

PREDICTED RADIATION DOSES OF THE POPULATION CAUSED BY DISCHARGES FROM THE BALTIC NPP TO THE NEMAN RIVER UNDER NORMAL OPERATION CONDITIONS

Assessment of radiation doses to the population caused by discharges from the Baltic NPP under normal operation conditions is made according to methodological recommendations of the IAEA publications on Generic models for use in assessing the impact of discharges of radioactive substances to the environment. Safety Report Series, No. 19. IAEA, Vienna, 2001 [III-8], Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards – Interim Edition, IAEA Safety Standards Series No. GSR Part 3 (Interim), IAEA, Vienna (2011) [III-9], and the specification and technical documentation NTD 38.220.56-84 by Interatomenergo association [III-10], using values of radioactive substances intake into the environment with liquid non-radioactive discharges under rated operating conditions of a power unit, GBq/(year and unit) (AES-2006. Baltic NPP. Unit 1. Preliminary Safety Analyses Report. Chapter 10. Radioactive waste handling Rev. 2 20.02.2013 [III-11]).

The following pathways of radionuclide exposure and ingress into the human body:

- Swimming, boating, staying on the beach;
- Use water from the Nieman river as drinking water (in this case, it was assumed that the water use area is located downstream the monitoring section arranged at a distance of 500 m from the discharge point), eating fish, shellfish.

The analysis was made for two age groups (adults > 17 years old, children 1 year old). Radionuclide discharges from two units of the Baltic NPP is considered in the analysis. Predicted values of specific activity and sediments are given in Table AIII.1.

Table AIII.1. Discharge of radionuclides from two units of the Baltic NPP (Bq/s), predicted radionuclide concentrations in water (Bq/l) and sediments (Bq/kg) at a distance of 500 m of the discharge point (outlet of the discharge culvert)

Radionuclide	**Discharge of radionuclides from two units**		**Concentration in water at a distance of 500m of the discharge point, Bq/l**	**Concentration in sediments at a distance of 500m of the discharge point, Bq/l**
	Bq/s	**Bq/year**		
H-3	5.78E+05	1.82E+13	21.7	0
I-131	1.46E+00	4.60E+07	5.48E-05	1.64E-02
I-132	2.73E-01	8.60E+06	9.65E-06	2.89E-03
I-133	6.35E-03	2.00E+05	2.37E-07	7.11E-05
Sr-89	6.35E-02	2.00E+06	2.39E-06	4.77E-03
Sr-90	1.97E-04	6.20E+03	7.40E-09	1.48E-05
Cs-134	6.98E+00	2.20E+08	2.62E-04	3.59E+01
Cs-137	1.08E+01	3.40E+08	4.06E-04	5.56E+01
Mn-54	3.94E-02	1.24E+06	1.48E-06	1.34E-01
Co-58	4.51E-02	1.42E+06	1.69E-06	1.80E-01
Co-60	1.59E-01	5.00E+06	5.97E-06	6.33E-01

Formulas for calculation of external doses are derived without regard to self-shielding of human organs and tissues. Relevant errors of the effective dose values caused by the simplification used do not exceed 50%.

Internal exposure of the population in the NPP vicinity is formed by radionuclides intake via ingestion as a result of their migration to food and biological chains [III-10].

The following assumptions were included in the analysis:

(1) Use of water from the Nieman river as drinking water.
(2) Fish and shellfish from the Nieman river make up 100% of the annual food ration.

Thus, the worst conditions were selected, and the analysis can be considered as conservative one.

Dose factors are defined in compliance with Tables III-2D of GSR Part 3 [III-9].

Table AIII.2 shows the consumption rates of water and aquatic organisms by adults and children [III-8]. They were taken as a basis for analysis of radionuclide ingress into the human body and calculation of internal exposure to potentially critical population groups due to ingestion. Average values of consumption of the above products are used according to Safety Report Series, No. 19. IAEA [III-8].

Table AIII.2. Consumption of staple foodstuff by different age groups of the population [III-8], kg(l)/year

Food category	**Age group, years old**	
	Children, 1 year old	**Adults (> 17 years)**
Fish	15	30
Drinking water	260	600
Shellfish	0	15

Predicted total external and internal doses are given in Tables AIII.3 and AIII.4.

Table AIII..3. Total external exposure H_{ext} of the population, μSv/year

Exposure	**H_{ext}, μSv/year**	
	Children, 1 year old	**Adults (> 17 years)**
Swimming	9.59E-07	2.47E-05
Boating	4.79E-07	1.23E-05
Bottom deposits	2.59E-03	5.83E-02
Staying on the beach	5.19E-04	1.17E-02
Total	**3.11E-03**	**7.00E-02**

Table AIII.4. Total internal exposure H_{int} caused by consumption of water, fish and shellfish, μSv/year

Food item	**H_{intr}, μSv/year**	
	Children, 1 year old	**Adults (> 17 years)**
Water	6.82E-01	5.54E-01
Fish	9.23E-01	1.97
Shellfish	–	8.59E-02
Total	**1.61**	**2.61**

Table AIII.5. Total dose of all types of exposure, μSv/year

Exposure	H, μSv/year	
	Children, 1 year old	**Adults (> 17 years)**
internal	1.61	2.61
external	0.003	0.070
Total	**1.61**	**2.68**

In calculation of dose loads to the population caused by discharge of radionuclides into the Neman river under normal operation of Baltic NPP power units, the following doses were estimated: for external exposure caused by anthropogenic radionuclides in deposits and due to staying on the beach, swimming and boating in the Neman river as well as for internal exposure of adults and children.

For calculation of internal doses, it is assumed that water from the Neman River is used as drinking water, and consumption of this water makes up 100% per year. Besides, 100% of fish and shellfish consumed per year are assumed to be from the Neman River.

External exposure is mostly caused by accumulation of ^{58}Co, ^{54}Mn, ^{134}Cs in sediments. Total external exposure doses due to swimming, boating, staying on the beach, and from sediments of the Neman river are 0.07 μSv/year for adults and 0.003 μSv/year for children.

Internal exposure due to consumption of water, fish and shellfish is analysed using average annual food consumption values based on Safety Reports Series No.19 [III-8].

Internal exposure due to consumption of water and foodstuff is 1.6 μSv/year for 1 year old children and 2.6 μSv/year for adults.

The total exposure of the population due to liquid discharges from two power units of Baltic NPP is mostly caused by consumption of fish, the radiation doses are 2.68 μSv/year for adults and 1.61 μSv/year for children. Due to the fact that water from the Neman river is actually not used as drinking water, actual doses due to discharge of radionuclides to the Neman river will be considerably lower.

The relevant risk due to discharges to the Neman river from Baltic NPP is estimated as 9.2×10^{-8} year^{-1} for children and 1.8×10^{-7} year^{-1} for adults, i.e. at the level of negligible risk (less than 10^{-6} year^{-1}).

The total dose of internal and external anthropogenic exposure of the population does not exceed the de-minimis dose level of 10 μSv/year. That is by an order of magnitude lower than the derived limit of 50 μSv/year set for dose due to discharges from the NPP, and three orders of magnitude lower than the population exposure limit of 1000 μSv/year specified by the NRB-99/2009.

Table AIII.6. Maximum dilution factors with 95% credibility depending on the distance, averaged over 1, 8 and 16 hour intervals, s/m^3

Release height	**Distance (in the most loaded sector – NE), km**	**Time interval** 1 hour	8 hours	16 hours
Ground-level release H=30 m	0.5	2.1 E-4	5.6 E-5	3.5 E-5
	0.8	1.5 E-4	4.0 E-5	2.5 E-5
	1	1.2 E-4	2.9 E-5	1.8 E-5
	2	6.7 E-5	1.3 E-5	7.5 E-6
	3	4.3 E-5	6.7 E-6	3.7 E-6
	5	2.6 E-5	3.4 E-6	1.8 E-6
	10	1.4 E-5	1.1 E-6	5.5 E-7
High-level release H=100 m	0.5	1.4 E-5	2.6 E-6	1.5·E-6
	0.8	1.3 E-5	2.2 E-6	1.3 E-6
	1	1.1 E-5	2.0 E-6	1.1 E-6
	2	7.2 E-6	1.3 E-6	7.3 E-7
	3	5.3 E-6	9.5 E-7	5.0 E-7
	5	3.6 E-6	5.9 E-7	3.0 E-7
	10	2.0 E-6	2.2 E-7	1.0 E-7

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[III-10] NTD 38.220.56-84 "Methods for calculation of NPP-generated radioactive substances dispersion and exposure of local population". Part 1. Annexes. MHO Interatomenergo, Moscow, Energoatomizdat (1984).
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ANNEX IV.

RESPONSES PROVIDED REQUESTED BY THE REVIEW TEAM DURING THE 3RD MEETING ON THE REVIEW OF THE EIA MATERIALS FOR THE BALTIC NPP, ST. PETERSBURG (RUS), 5–7 NOVEMBER 2014

This information was provided by the Russian counterpart as agreed in the minutes of 3rd Meeting on the Review of the EIA Materials for the Baltic NPP, St. Petersburg (RUS), 5–7 November 2014

During the meeting in November 2014, additional information was requested for the following topics:

- Action 3.1-1 (Rosenergoatom to provide a translation of the radiological criteria used after accidents (from NRB-99/2009))
- Action 3.1-2. (Rosenergoatom to provide a translation of the definition of the critical group)
- Action 3.1-3. (Rosenergoatom to provide a summary information in accordance with the updated EIA Report dated 2013, regarding Monitoring; Transportation; Decommissioning; and Quality Assurance.)
  A. Environmental Monitoring
  B. SNF and RW transportation
  C. Decommissioning
  D. Quality assurance

The responses to the questions are summarized below.

The questions and answers are included in the report to document the additional information in its original form, as it was provided by the counterpart on request of the Review Team.

Translation of the radiological criteria used after accidents (from NRB-99/2009))

The following text is an unofficial translation provided by Rosenergatom of selected parts of regulations of the Russian Federation:

The radiological criteria for population protection measures in a radiological accident existing Russian regulatory documents are given below:

1. NRB-99/2009. Radiation Safety Rules (SanPiN 2.6.1.2523 – 09)

Paragraph 6.7.

Decisions on population protection measures in case of a large radiological accident with radioactive contamination of the territory is made based on the comparison of a predicted dose being averted due to a protective measure or a contamination level with the levels A and B specified in the Tables 6.3 to 6.5.

Table 6.3 **Criteria for making urgent decisions in the initial period of a radiological accident**

Protective measures	Averted dose during first 10 days, mGy			
	whole body		Thyroid, lungs, skin	
	Level A	Level B	Level A	Level B
Sheltering	5	50	50	500
Iodine prophylaxis: adults infants	 – –	 – –	 250* 100*	 2500* 1000*
Evacuation	50	500	500	5000

** For thyroid dose only*

Table 6.4 **Criteria for making decisions on resettlement and restriction of consumption of contaminated foodstuffs**

Protective measures	**Averted effective dose, mSv**	
	Level A	**Level B**
Restriction of consumption of contaminated foodstuffs abd potable water	5 during the first year 1 per year in subsequent years	50 during the first year 10 per year in subsequent years
Resettlement	50 during the first year	500 during the first year
	1000 during the whole resettlement period	

Table 6.5 **Criteria for making decisions on restriction of consumption of contaminated foodstuffs during the first year after an accident**

Radionuclides	Specific activity of radionuclide in foodstuffs, kBq/kg	
	Level A	Level B
^{131}I, ^{134}Cs, ^{137}Cs	1	10
^{90}Sr	0.1	1.0
^{238}Pu, ^{239}Pu, ^{241}Am	0.01	0.1

If the dose averted by a protective measure does not exceed the Level A, there is no need to implement protective measures that are associated with disturbances of both normal life activity of the population and economic and social life of the territory.

If the dose averted by a protective measure exceeds the Level A but does not exceed the Level B, the decision is to be made based on the justification and optimization principles with particular situation and local conditions taken into account.

If the dose averted by a protective measure exceeds the Level B, implementation of relevant protective measure is obligatory even though they would involve any associated disturbances of normal life activity of the population, economic and social life of the territory.

2. Methodology for establishment of sizes of protective measure planning zones in case of an accident at a nuclear plant. MT 1.2.5.05.0110-2012, Rosenergoatom Concern OJSC

Numerical criteria necessary for establishment of boundaries of the emergency response zones are given in the Tables A.1 and A.2.

Table A.1 – The criteria for establishment of boundaries of the emergency response zones as specified in NRB -99/2009, NP-032-01

Emergency response zones	Criteria	Value (mGy)
Mandatory population evacuation planning zone	Absorbed dose / whole body / 10 days	500
	Absorbed dose / lungs / 10 days	5000
	Absorbed dose / skin / 10 days	5000
	Absorbed dose / thyroid / 10 days	5000
Protective measure planning zone	Absorbed dose / whole body / 10 days	5
	Absorbed dose / lungs / 10 days	50
	Absorbed dose / skin / 10 days	50
	Absorbed dose / thyroid / 10 days	50

The exposure pathways as indicated in the Table B.1 are considered in calculations of dosimetric values for the initial period of a radiological accident at a nuclear plant.

Table B.1 – The exposure pathways to be considered in calculations of dosimetric values (for the initial period of a radiological accident at a nuclear plant)

Dosimetric values	Exposure pathways		
	plume	deposition	inhalation
Absorbed dose [1)]	+	+	+
RBE–weighted absorbed dose in red bone marrow	+	+	–
RBE–weighted absorbed dose in thyroid	–	–	+
Equivalent dose in thyroid	–	–	+
Effective dose	+	+	+
Notes: 1) Absorbed dose in whole body is calculated for plume and deposition exposure pathways 2) RBE : relative biological efficiency			

Translation of the definition of the critical group)

Definition of a critical group of population

It is a group of individuals from the population (not less than 10 persons) being homogeneous by one ore more attributes such as: sex, age, social or professional environment, residence, food consumption habits, which is exposed to a maximum radiological impact through a given exposure pathway from a given radiation source.

Summary information in accordance with the updated EIA Report dated 2013, regarding Monitoring; Transportation; Decommissioning; and Quality Assurance.)

A. Environmental Monitoring

The information below is given in the Section 11 of the EIA Report

RECOMMENDATIONS ON THE ENVIRONMENTAL MONITORING PROGRAMME ARRANGEMENT

Proposals as to a programme of integrated environmental monitoring of the planned business activity are developed based on environmental impact assessment results (Regulation on Assessment of Environmental Impacts of a Planned Business Activity or Other Activities in the Russian Federation) and Federal Law No. 7-FZ “On Environmental Protection”.

Considering specific features of radiation facilities and requirements of regulatory documents, the environmental monitoring is conducted in the NPP location area (Regulation on Assessment of Environmental Impacts of a Planned Business Activity or Other Activities in the Russian Federation; Guidelines for Investment and Construction Project Environmental Support; NRB-99/2009) in order to:

Obtain baseline data on concentrations of radionuclides in the environment at a level of the global background, analyse regularities and migrations/accumulation of radionuclides in ecosystem components as a result of the investment construction project implementation,

Analyse, compare and rate sources of radionuclides in the environment, compare doses/risks for the population due to contamination of the environment upon implementation of the project, assess compliance of the risk with acceptable levels,

Make a comparative evaluation of risk for population related to contamination of the environment by radioactive and chemical substances in the NPP location area,

Use results of the radiation environmental monitoring of natural habitats and ecosystems for optimization and improvement of new NPP projects,

Work out recommendations on optimized monitoring in areas of location of new generation serial nuclear power units.

Environmental monitoring in radiation facility location areas shall comprise monitoring subsystems [IV-1] for the following factors: (1) effects (radioactive, chemical substances, thermal load) on the environment, and (2) response of land and water ecosystem components to changing habitat parameters.

These proposals to the programme of environmental monitoring in the Baltic NPP location area are based on:

- Requirements of normative documents to environmental impact assessment,
- Hygienic norms, recommendations, and guidelines for environmental risk assessment by economic activity with radioactive substances, and
- Recommendations on environmental monitoring of land and water ecosystems of the Balakovo NPP location area and Leningrad-II NPP site.

Results of complex environmental monitoring in the Leningrad NPP location area, Archival materials on the environment contamination levels in the Kaliningrad Region and cross border states of Lithuania and Poland (see Fig. 3.5.6), physiogeographical and meteorological description of the region, distinctive features and parameters of radionuclide emissions/discharge into the ground level atmosphere and natural waters during the operation of the Baltic NPP.

Information on land use and parameters of produced agricultural products in the eastern station location area requires solution;

RECOMMENDATIONS FOR THE ENVIRONMENTAL MONITORING PROGRAMME FOR THE BALTIC NPP LOCATION AREA

The main purpose of the programme is establishment of general requirements to an organizational structure and environmental monitoring output data (structure, natural environment objects, nomenclature, and control parameter measurement inaccuracy).

The main requirement to the Baltic NPP environmental monitoring administrative structure is provision of data required for analysis and justification of correspondence of consequences of emissions/discharges of radionuclides from the NPP with the acceptable risk levels, for comparison with the natural and man-induced radiation background risk, environment background chemical contamination risk (NP 032-01, R 2.1.10.1920-04, Regulation on Assessment of Environmental Impacts of a Planned Business Activity or Other Activities in the Russian Federation) [IV-1].

Effective dose value and corresponding risk factors are the main input data for assessment of radiation risk (NRB-99/2009).

As the hydrosphere is the end "reservoir" and natural migration route for atmospheric radionuclide and chemical substance fallout on the surface of the earth, monitoring of chemical substance concentration dynamics in the hydrographic network is required for the area close to the radiation monitoring area (in the Sanitary Protection Area and Observation Area).

ADMINISTRATIVE STRUCTURE OF THE ENVIRONMENTAL MONITORING

In the sanitary protection area (within the plant site boundary) and observation area of the Baltic NPP, there shall be established posts of continuous control of radionuclide and chemical substance concentrations in the environment (air, water, soil), land (including agricultural and forest land) and water ecosystem components. Also, equivalent dose rate and absorbed dose in air shall be measured.

Radionuclide and chemical substance concentrations are monitored at specially equipped control posts. Simultaneous meteorological parameters (wind direction and speed, air temperature, humidity, atmospheric pressure) are measured in a control point within the plant site boundary.

When selecting control post locations it is necessary to consider a need to obtain representative data on levels of environmental contamination in the zone of maximum potential effects on the population and the environment, and in control points.

Measurement results shall be transferred to the information collection and analysis center of JSC Rosenergoatom Concern and Rosatom State Corporation.

It is reasonable to monitor concentrations of radionuclides and chemical substances in land ecosystem components at the points of continuous control of atmospheric air condition.

Projected entry of radionuclides and chemical substances with flushing waters into the Nieman upon commissioning of the Baltic NPP demands a water ecosystem monitoring. Water ecosystem monitoring scope may be justified after 3 years of observations of changes in concentrations/ accumulation of $^{134,137}Cs$ in water ecosystem components, chemical composition and discharge volume of liquid NPP effluents into the surface waters in order to finally develop an observation procedure and a list of monitored parameters. It is reasonable to monitor radionuclide concentrations and water ecosystem (water, bottom deposits, plankton, fish and mollusks) condition in the Nieman (at the intake points and after flushing water discharge), Šešupė, and Instruch rivers within the observation area.

Land ecosystem biological monitoring aimed at assessment of Baltic NPP radionuclide, chemical substance, and heat emissions effects on critical components shall be carried out in the observation area and at a control point outside the NPP emission impact area.

It is necessary to procure representative meteorological information to identify a potential source of radionuclide contamination of the ground level atmosphere, and assess the NPP gas/aerosol emission dispersion and cooling tower effects.

REQUIREMENTS TO THE OUTPUT DATA OF ENVIRONMENTAL MONITORING

Environment object types, volume, place, frequency of sampling, and controlled parameter nomenclature are defined so that:

- To minimize the probability of non-detection of changes in concentrations of radioactive and chemical substances in the environment and ecosystem components when they occur;
- Organizational, technical, and procedural means are sufficient for identification, in the environment objects, of low (background) concentrations of radionuclides and chemical substances at the global background level;
- To carry out a quantitative assessment of Baltic NPP emissions/discharge contribution to changes in environmental setting parameters for the location area;
- To carry out a comparative assessment of risks for the population related to environmental contamination as a result of the Baltic NPP commissioning.

RADIATION MONITORING

Radiation monitoring shall ensure receipt of information necessary for:

- Identification and rating of sources of man-induced radionuclides in the environment (water, air, soil) and ecosystem components (land, water, agricultural);
- Assessment of Baltic NPP gas/aerosol emissions contribution to population exposure;
- Assessment of Baltic NPP effluent discharge contribution to population exposure;

- Identification of areas most affected by the Baltic NPP emissions/discharge into the atmosphere and radionuclides that are main contributors to the population exposure;
- Identification of consistent patterns in long term dynamics of environment and ecosystem contamination during the operation of the Baltic NPP;
- Assessment of population external and internal doses, uncertainties in assessment of exposure and radiation risk.

Collection of information on environmental contamination by radionuclides shall be carried out in the process of current monitoring of atmosphere, hydrosphere, land ecosystem components, including agrarian, woodland and water ecosystems.

The Programme shall be based on the Generic Programme for Environmental Monitoring in the NPP Vicinity by Rosgidromet [IV-1].

According to the Program, analysis of contamination of the environment (air, water, soil) and biota by gamma emitting radionuclides (man-induced and natural) shall be conducted with an accuracy of not greater than 25% in a range from 50 to 2.000 keV.

To reduce uncertainties of dose assessments, the monitoring programme provides for information on specific/volumetric activities of gamma emitting radionuclides, tritium, ^{14}C, ^{90}Sr, plutonium isotopes, as well as natural uranium-thorium radionuclides in components of the environment.

It is necessary to complement the monitoring results by calculations of ^{14}C and ^{3}H emission dispersion, discharged tritium migration, and doses calculated using models verified with regional data. A data bank and application software package shall be used for storage, analysis, and presentation of the information.

Organizational, technical, and procedural means shall be sufficient for identification of radionuclide concentrations in the environment at a low (background) level close to that for the global fallout.

Radiation monitoring objects include:

- The environment (air – aerosol and gaseous constituents, suspended matter, precipitation, surface and ground water, drinking water, soil);
- Components of agricultural and forest ecosystems (perennial grasses, acerous foliage, moss, mushrooms, berries, forest floor, cultivated and virgin soils, milk, cereals, and other local agricultural products);
- Water ecosystem components in rivers and lakes in the area (plankton, algae, bottom deposits, including the ones in floodplains, fish);
- Absorbed dose, equivalent dose rate.

The list of radionuclides in the environment analysed is determined by their nomenclature in NPP emissions/discharges during normal operation and operational occurrences (^{14}C, ^{3}H, IRG, $^{137,134}Cs$, ^{60}Co, ^{54}Mn, ^{131}I, $^{89,90}Sr$, etc.), by those available in the deposition links of ecosystems after the Chernobyl NPP accident (^{137}Cs, $^{239,240}Pu$), those expected as part of radionuclide emissions/discharges from the NPP in the event of potential accidents (^{131}I, etc.), those forming the natural radiation background (^{40}K, ^{210}Pb, ^{232}Th), and by requirements of a radiation monitoring procedure developed in compliance with the Procedural Guidelines MR 2.6.1.27-2003, Radiation Monitoring Arrangement and Implementation.

The Automatic radiation situation monitoring system (ASKRO) technical means are used for radiation monitoring. In compliance with requirements of Russian standards and regulations in the nuclear power industry, environmental monitoring in a nuclear power plant location area is performed within the observation area (OA).

For the purpose of development of radiation protection and monitoring design solutions, the Baltic NPP design addresses:

- IAEA recommendations and safety standards,
- Requirements of the European operators for new generation nuclear power plants with light water reactors (LWR) (European Utility Requirements (EUR), Revision C).

CHEMICAL MONITORING

Tasks of chemical monitoring in the Baltic NPP location area are as follows:

- Determination of levels and dynamics of chemical substance contamination of air, water, land and water ecosystem components,
- Determination of Baltic NPP emissions/discharge contribution to chemical contamination of the environment.

In the Baltic NPP location area, sources of environmental contamination by chemical substances may include boiler houses, other industrial enterprises, communal waste waters, motor vehicles, surface fertilizer wash-off from agricultural land into the river catchment basin, transboundary transport of natural radionuclides together with wastes from the thermal plants using conventional fuels (coal, residue oil, gas).

Chemical monitoring objects include: ground level air, surface and ground water, land and water ecosystem components, and local foodstuffs.

The list of monitored chemical substances includes:

- Oil products and heavy metals;
- Polycyclic aromatic hydrocarbons and heterocyclic compounds; polychlorinated dioxins and biphenyls;
- Inorganic contaminants (sulfur and nitric oxides);
- Surfactants;
- Nitrogen and phosphorus,
- Chlorides, sulfates, soil salinity.

Generally, the list of monitored chemical substances is based on the data provided by enterprises on emissions/discharges to the environment.

Surface water chemical monitoring involves receipt of the following information on hydrochemical conditions and quality of natural waters: pH, chlorides, sulfates, salinity, suspended matter, nitrogen and phosphorus forms, oxygen, carbon, biological and chemical oxygen consumption. To determine concentrations of the above contaminants in water bodies, the samples are taken in discharge and intake waters of the catchment basin rivers. Air and land sampling points shall be defined at continuous monitoring station locations according to wind rose and landscape.

The points and frequency of atmospheric component sampling are the same as for radiation monitoring system; in particular a sample aliquot is taken to analyse concentrations of heavy metals.

Natural environment samples are analysed using general methods in a stationary analytical laboratory.

Analytical equipment shall provide required sensitivity to chemical substance concentrations at a natural level in objects of nature.

It is reasonable to monitor ingress of chemical substances with effluents by means of control posts equipped with automatic effluent control systems.

BIOLOGICAL MONITORING

Biological monitoring shall be aimed at control (over structural and functional parameter dynamics) of condition of biological systems at different organization levels such as communities of individual species regarded as indicators, and biocoenosis.

Biological monitoring purpose is assessment and prognosis of changes in land and water ecosystem components. Relying on baseline data of radiation and chemical monitoring, the biological monitoring allows assessment of biota response to anthropogenic loads.

Complex field survey of land ecosystems serves as a basis for their monitoring, including determination of current and dynamic levels of agrocoenosis, top soil, vegetation (phytocoenoses), fauna; determination and analysis of concentrations of radionuclides, heavy metals, and other potential contaminants in land ecosystem components.

Research is conducted at selected permanent sampling areas and control sections for three years in order to finally develop monitoring regulations and a list of determined parameters.

In the first 3 years, observations of hydro-biological parameters of water bodies shall be arranged and carried out at the established hydrochemical observation points. There shall be also arranged observations of bottom deposit and floodplain soil conditions.

Hydrobiological observations are performed at permanent stations. Hydrobiological survey shall take place three times per a year. Moreover, during each survey session 4–6 measures are taken on daily basis or on alternate days. Hydrobiological survey includes: study of hydrobiocoenosis (phyto-, zoo-, bacterial plankton, benthos, periphyton, macrophytes, ichthyofauna) quantitative behavior; study of hydrobiont migration behavior; determination of sanitary condition of a water body.

Bottom deposits shall be sampled layer by layer to assess current composition of radionuclides and chemical substances in bottom deposits, and its changes. Man-induced and natural radionuclides, and heavy metals are determined in such samples. Suspended matter and bottom deposit sampling takes place once every 2–3 years.

To describe a mechanical composition in the bottom deposits, both in the surface layer and by profile, the following parameters are measured; size distribution, frame bulk weight, natural humidity, density, and thickness of individual layers of bottom deposits. To assess the rate of sedimentation and rate of accumulation in water, the suspended matter concentrations are determined under various hydrometeorological conditions, as well as their distribution by water profile and aquatory, and their annual and seasonal variability.

Final development of the observation procedure and list of determined parameters of natural environment setting, and land and water ecosystem components shall be accomplished within three years upon plant commissioning based on observation results.

Apart from the previously mentioned environmental monitoring activities for land and water ecosystems in the Baltic NPP location area, certain observations of levels and dynamics of radionuclides and chemical substances shall be provided for subterranean waters.

Table 11.8.1 –Recommendations to the scope of environmental monitoring programme in the Baltic NPP location area

Object under observation	**Permanent observation point**	**Monitored parameters**
Air environment		
Ground air	Filter ventilation units are installed: sanitary protection zone; Malomozhajskoe (southeast; 4.0 km), Gannovka (southwest; 2.4 km), Lunino (southwest; 5.0 km), Niemen (northwest; 15.0 km), Kalacheevo (northeast; 7.8 km), Krasnoznamensk (east; 20.0 km) Lagernoe	^{3}H, IRG, gamma spectrum ($^{134,137}Cs$, ^{60}Co, ^{54}Mn, ^{131}I, ^{7}Be and others) $^{89,90}Sr$, $^{239,240}Pu$, ^{40}K, natural radionuclides, suspended material, sulfuric acid, sulfur dioxide, carbonic oxide, nitrogen dioxide and oxide, sodium chloride, magnesium chloride, benzene, kerosene, benzpyrene, hydrogen sulphide, phenol, carbon bisulphide, mercaptan, vanadium, nickel oxide, arsenic, hydrargirum, cadmium, chrome, lead, pesticides
Atmospheric fallout	Sanitary protection zone; Malomozhajskoe (southeast; 4.0 km), Gannovka (southwest; 2.4 km), Lunino (southwest; 5.0 km), Niemen (northwest; 15.0 km), Kalacheevo (northeast; 7.8 km), Krasnoznamensk (east; 20.0 km)	^{3}H, gamma spectrum ($^{134,137}Cs$, ^{60}Co, ^{54}Mn, ^{131}I, ^{7}Be and others) ^{40}K, natural radionuclides, sulfuric acid, sulfur dioxide, carbonic oxide, nitrogen dioxide and oxide, sodium chloride, magnesium chloride, benzpyrene, hydrogen sulphide, phenol, carbon bisulphide, mercaptan, vanadium, nickel oxide, hydrargirum, cadmium, arsenic, chrome, lead.
Absorbed dose, equivalent dose rate	Sanitary protection zone; Malomozhajskoe (southeast; 4.0 km), Gannovka (southwest; 2.4 km), Lunino (southwest; 5.0 km), Niemen (northwest; 15.0 km), Kalacheevo (northeast; 7.8 km), Krasnoznamensk (east; 20.0 km) Lagernoe	
Components of terrestrial ecosystems		
Perennial herbs	Malomozhajskoe (southeast; 4.0km), Gannovka (southwest; 2.4 km), Lunino (southwest; 5.0 km), Niemen (northwest; 15.0 km), Kalacheevo (northeast; 7.8 km), Krasnoznamensk (east; 20.0 km), Uzlovoe, Ujanovo,Pokrovskoe, Zhilino, Niemenskoe, Iskra, Rakitino Lagernoe	^{14}C, ^{3}H, gamma spectrum ($^{134,137}Cs$, ^{60}Co, ^{54}Mn, ^{131}I and others) ^{90}Sr, ^{40}K, natural radionuclides. Cadmium, hydrargirum, arsenic, chrome, lead, pesticides
Soil (virgin)	Sanitary protection zone; Malomozhajskoe (southeast; 4.0 km), Gannovka (southwest; 2.4 km), Lunino (southwest; 5.0 km), Niemen (northwest; 15.0 km), Kalacheevo (northeast; 7.8 km), Krasnoznamensk (east; 20.0 km), Uzlovoe, Ujanovo, Pokrovskoe, Zhilino, Niemenskoe, Iskra. Rakitino, Lagernoe	Gamma spectrum ($^{134,137}Cs$, ^{60}Co, ^{54}Mn and others) $^{239,240}Pu$, ^{40}K, natural radionuclides, pH, 3.4 benzpyrene, sanitary number (Ratio between protein nitrogen and total organic nitrogen), ammonium nitrogen, nitrate nitrogen, chlorides, pesticides (residual quantity), petroleum and petroleum product, volatile phenols, sulfurous compounds, detergents, arsenic, cadmium, mercury, chrome, lead, polychlorinated biphenyls, cyanides, macrochemical fertilizers, micro chemical fertilizers, lactose-positive Bacillus coli (coliform index), enterococcuses (fecal streptococcus) (index), pathogenic microorganisms (index), helminth larvaes and eggs (viable), cysts of intestinal pathogenic protozoa, larvaes and chrysalides of synanthropic flies
River water	Niemen river (76.5 km from river outlet, 14.5 upstream from Sovetsk, 0.5 km upstream from Nieman), Sheshupe river (at the point of level	^{3}H, gamma spectrum (^{137}Cs), ^{90}Sr, natural radionuclides, temperature at the moment of sampling, scent at 20°C qualitative and quantitative, scent at 60 °C qualitative and quantitative, smack at 20 °C qualitative

Object under observation	**Permanent observation point**	**Monitored parameters**
	gauge station at Sheshupe river in Dolgoe), Instruch river (51 km from river outlet, 0.2 km upstream from Uljanovo and downstream from Uljanovka river)	and quantitative, color of water in degrees, opacity, pH, suspended materials, iron, manganese, arsenic, mercury, cadmium, chrome, lead, total hardness, sulphates, dry residual, free carbon dioxide, fluorine, chlorides, alkalinity, ethanolamine, surface anion active substances – totally, biochemical oxygen demand (BOD), chemical oxygen demand (COD), permanganate oxidation susceptibility, saline ammonium, nitrites, nitrates, quantity of saprophytic bacteriums, quantity of lactose-positive Bacillus coli, causative agents of enteric infections (salmonella, Shigella, enteroviruses), quantity of coliphages, quantity of enterococcuses, phytoplankton
Forest ecosystem components		
Berries	In places of massive berrying	Gamma spectrum (^{137}Cs, ^{60}Co, ^{54} Mn, ^{131}I), ^{40}K, natural radionuclides, heavy metals (cadmium, mercury, chrome, lead), arsenic
Mushrooms	In places of massive gathering	Gamma spectrum (^{137}Cs, ^{60}Co), ^{40}K, heavy metals (cadmium, mercury, chrome, lead), arsenic
Moss	From leeward side and windward side	Gamma spectrum (^{137}Cs, ^{60}Co, ^{54}Mn, ^{131}I and others), ^{40}K, heavy metals (cadmium, mercury, chrome,lead)
Forest floor	From leeward side and windward side	Gamma spectrum (^{137}Cs, ^{60}Co, ^{54}Mn), ^{40}K, natural radionuclides, heavy metals (cadmium, mercury, chrome, lead)
Acerose leaf	From leeward side and windward side	Gamma spectrum (^{137}Cs, ^{60}Co, ^{54}Mn), ^{40}K, heavy metals (cadmium, mercury, chrome, lead), pesticide
Components of agrarian ecosystems		
Soil (arable)	Agricultural land	Gamma spectrum (^{137}Cs, ^{60}Co, ^{54}Mn and others), ^{90}Sr, ^{239,240}Pu, ^{40}K, natural radionuclides, 3,4-benzpyrene, sanitary number (ratio between protein nitrogen and total organic nitrogen), ammonium nitrogen, nitrate nitrogen, chlorides, pesticides (residual amount), heavy metals (cadmium, mercury, chrome, lead), petroleum and petroleum product, volatile phenols, sulfurous compounds, detergents, carcinogens, arsenic, polychlorinated biphenyls, cyanides, macrochemical fertilizers, micro chemical fertilizers, lactose-positive Bacillus coli (coliform index), enterococcuses (fecal streptococcus) (index), pathogenic microorganisms (index), helminth larvaes and eggs (viable), cysts of intestinal pathogenic protozoa, larvaes and chrysalides of synanthropic flies
Milk and pasture herbage, crops, potatoes, meat, eggs, fish, vegetables, fruits, berries, roots	Farming land	^{14} Cs, ^{3} H (milk and pasture herbage, crops, potatoes). Gamma spectrum (^{137}Cs, ^{60}Co, ^{54}Mn, ^{131}I and others), ^{90}Sr, ^{40}K, lead, cadmium, zinc, copper, nickel, arsenic, mercury, pesticides
Water ecosystem components		
Discharge, storm and intake water of enterprises	In places of water intake and water discharge into the Niemen river	^{3}H, gamma spectrum (^{137,134}Cs, ^{60} Co, ^{54}Mn and others), ^{90}Sr, ^{40}K, natural radionuclides, temperature at the moment of sampling, scent at 20 °C qualitative and quantitative, scent at 60 °C qualitative and quantitative, smack at 20 °C qualitative and quantitative, color of water in degrees, opacity, pH, suspended materials, iron, manganese, total hardness, sulphates, dry residual, free carbon dioxide, fluorine, chlorides, alkalinity, ethanolamine, surface anion active substances –

Object under observation	Permanent observation point	Monitored parameters
		summary, biochemical oxygen demand (BOD), chemical oxygen demand (COD), permanganate oxidation susceptibility, saline ammonium, nitrites, nitrates, quantity of saprophytic bacteriums, quantity of lactose-positive Bacillus coli, causative agents of enteric infections (salmonella, Shigella, enteroviruses), quantity of coliphages, quantity of enterococcuses, general colimorphic bacteriums, thermocolimorphic bacteriums
Higher aquatic vegetation	Niemen river (76.5 km from river outlet, 14.5 upstream from Sovetsk, 0.5 km upstream from Niemen), in places of water intake and water discharge into the Niemen river	Gamma spectrum (^{137,134}Cs, ^{60}Co, ^{54}Mn, ^{131}I and others), ^{40} K, lead, cadmium, zinc, copper, nickel, arsenic, mercury
Bottom sediments	Niemen river (76.5 km from river outlet, 14.5 upstream from Sovetsk, 0.5 km upstream from Niemen), in place of discharge and up to the control point 500 m downstream	Gamma spectrum (^{134,137}Cs, ^{60}Co, ^{54}Mn and others) ^{90}Sr, ^{239,240}Pu, ^{40}K, lead, cadmium, zinc, copper, nickel, arsenic, mercury, petroleum products, organochlorine pesticides, polycyclic aromatic hydrocabons
Fish (predatory fish and plankton feeders)	Niemen river, Sheshupe river, Instruch river (before and after warm water discharge)	^{3}H, gamma spectrum (^{137,134}Cs, ^{60}Co, ^{54}Mn and others), ^{89,90}Sr, ^{40}K, natural radionuclides, lead, cadmium, zinc, copper, nickel, arsenic, methyl mercury
Phyto- and zooplankton	Niemen river, Sheshupe river, Instruch river (before and after warm water discharge)	Gamma spectrum (^{134,137} Cs, ^{60} Co, ^{54} Mn, ^{131}I and others) ^{40} K, lead, cadmium, zinc, copper, nickel, arsenic, mercury, methyl mercury, total number of cells (phytoplankton), total number of organisms (zooplankton), total number of types, total biomass, number of main groups, biomass of main groups, number of types in group
Ground waters	Sanitary protection zone and observation zone (to be specified on the basis of monitoring in sanitary protection zone)	^{3}H, gamma spectrum (^{134,137}Cs, ^{60}Co, ^{54}Mn, ^{131}I and others) ^{90} Sr, ^{239,240} Pu, ^{40}K, natural radionuclides, temperature at the moment of sampling, scent at 20 °C qualitative and quantitative, scent at 60 °C qualitative and quantitative, color of water degrees, opacity, pH, ethanolamine, heavy metals (cadmium, mercury, chrome, lead), petroleum and petroleum product, beryllium, boron, iron, manganese, copper, molybdenum, arsenic, nitrates, total hardness, permanganate oxidation susceptibility, chemical oxygen demand (COD), lead, selenium, hydrogen sulphide, strontium, sulphates, dry residual, free carbon dioxide, fluorine, chlorides, zinc, nitrates, quantity of saprophytic bacteriums, quantity of coliform bacteriums
Drinking waters	Malomozhajskoe (southeast; 4.0 km), Gannovka (southwest; 2.4 km), Lunino (southwest; 5.0 km), Niemen (northwest; 15.0 km) Kalacheevo (northeast; 7.8 km), Krasnoznamensk (east; 20.0 km), Uzlovoe, Ujanovo, Pokrovskoe, Zhilino, Niemenskoe, Iskra, Rakitino, Lagernoe	^{3}H, gamma spectrum (^{137}Cs) ^{90} Sr, natural radionuclides, mercury, benzpyrene, linden, 3, 4, 7, 8-dioxin, dichlorethylene, ethyl mercury, gallium, lead tetraethyl, tetraethyl tin, trichlorbiphenyl, aluminum, barium, cadmium, nitrites, cyanides, arsenic

B. SNF and RW transportation

Both spent nuclear fuel (SNF) upon storage in spent fuel pools and radioactive waste (RW) are removed from Baltic NPP by a special container carriage train dedicated for SNF and RW shipping from a NPP site, with subsequent container reloading into a specialized sea vessel in the Kaliningrad seaport for delivering to St. Petersburg seaport and then by railway transport to a nuclear fuel recycling plant.

C. Decommissioning

DECOMMISSIONING OF THE FACILITY CONCEPTUAL APPROACH TO THE DECOMMISSIONING ISSUE

Power unit decommission is a complex task comprising a wide range of issues from termination of NPP operations to its complete liquidation and restoration of an initial conditions of the site making it available for use in other purposes. This means removal of operational radwaste from the NPP site.

At this, there shall be minimum consequences for the environment in the NPP placement region both during the decommissioning process and afterwards.

Radioactive waste including solid ones (SRW) are generated under normal operation condition in the plant process systems dedicated to treatment and purification of liquid and gaseous waste (solidified waste, filters, sorbents, ion exchange resins, etc.) in the maintenance periods (process equipment, I&C sensors, tools, protective clothing, etc.), and in emergency situations.

Radioactive fission and activation products are generated during nuclear power unit operation, while 99.9% of fission products accumulated in nuclear fuel remain within a spent fuel assembly (FA). After a period of temporary storage at NPP spent nuclear fuel is dispatched for reprocessing.

As per the definition from “General provisions for ensuring safety of nuclear power plants” (OPB-88/97), decommissioning of a power unit is a process of implementation of an activity set after nuclear fuel removal, which excludes any possibility of use of that nuclear fuel as a source of energy and ensures safety of personnel and the environment. Nuclear decommissioning of a power unit is regulated by the following normative documents:

- RD EO 0013-93, Basic provisions for decommissioning of nuclear power units with expired design life;
- NP-012-99, Safety rules for decommissioning of a nuclear power unit;
- RB-13-2000, Requirements to the content of a nuclear power unit decommissioning programme.

Termination of a power unit operation will be effected upon expiration of design service life of its major components (60 years) provided that a plant life extension decision would not be made.

According to OPB-88/97, power unit decommissioning shall be preceded by its comprehensive examination by a special commission, and a final decision shall be taken based on results of such examination.

To perform power unit decommissioning it is necessary to develop well in advance and to coordinate with authorized agencies a power unit decommissioning project.

Such a project shall be developed approximately 5 years ahead of power unit operating life expiration taking into account results of a preliminary examination of its condition and decommissioning experience gained with similar power units. It shall be the principal document providing a base for implementation all major phases of the power unit decommissioning process.

Prior to start of the said project development, the following research and development works shall be completed:

- Feasibility study of alternative decommissioning options aimed at selection of an optimum one, with technical justification of the adopted option;
- Examination and classification of equipment and premises;
- Analysis of radiation conditions, radionuclide composition of coolant and contaminated equipment;
- Calculation and experimental determination of equipment activity levels;
- Evaluation of the total amount of decommissioning waste and its categorization;
- Drafting of normative documentation regulating design activities for decommissioning;
- Development of methods for radiological and ecological condition control in the processes of equipment decontamination and dismantling;
- Development of radiation protection and dosimetric monitoring system for the decommissioning process ;
- Radiological studies, development of methods and mathematical models for assessment of collective doses of personnel in the decommissioning process, calculation of expected dose loads associated with the main technological operations;
- Examination and development of methods of establishing working areas, sealing premises and compartments for dismantling of heavy contaminated and activated structures;
- Development of methods for handling radioactive waste generated in the decommissioning process, and development of an integrated process system for treatment, removal, storage and disposal of radioactive waste, and for declassification of low level waste to the unrestricted category;
- Development of technological means to equip the process operations on decontamination, fragmentation, remelting and compaction of metallic and nonmetallic radioactive waste;
- Development of organizational and technical principles, lists of special equipment and special tools for dismantling of highly activated structures, systems and large components (reactor pressure vessel, reactor internals, steam generator, etc.), including remote controlled complexes;
- Development of a dismantling process for reactor equipment and reactor building compartments with operation breakdown;
- Drafting of a plan of protective measures for personnel and population in an emergency during the decommissioning process, and a set of procedures instructing the decommissioning personnel on how to act in an emergency.

In development of a nuclear power unit decommissioning project, the existing standard systems, equipment, handling and transport means, and protective, sanitary and hygiene barriers shall be used to a maximum possible extent. These include:

- Systems for power supply, heating, water supply, drainage, radiation control, sanitary barriers, systems for inlet and exhaust ventilation with purification filters, transport means and hoisting equipment;
- Standard handling equipment providing for all operations with nuclear fuel and radioactive assemblies in the reactor plant;
- Decontamination baths for reactor equipments, and systems for preparation of decontaminating solutions;
- Standard systems for collection, concentration, solidification and disposal of liquid and solid radioactive waste, and systems for removal and disposal of aerosol filters used in ventilation systems ;
- Two way radio searching and telephone communication means;
- Information on operational impacts on systems and equipment, which is recorded and stored in the NPP archive.

For decommissioning works after expiration of nuclear power unit assigned operating life to be carry out with minimum labour costs, the project should comprise the following technical solutions that are focused also on reduction of personnel doses:

- To establish shortest routes for radioactive equipments and waste flows;
- To arrange closed pathways for transportation of contaminated equipment and assemblies by means of floor vehicles;
- To apply protective containers and equipment for radioactive waste collection, separation, transportation and treatment;
- To provide for systems and equipment for radiation monitoring on-site and within the sanitary protection zone around the NPP;
- Layouts of all buildings and structures shall allow placement of all principal and auxiliary equipment, valves and pipelines for disassembling works in operation zones of hoist facilities providing for lifting and movement of the equipment (assembly or its parts) from place of its installation to ground vehicles with a minimum number of reloads;
- To provide for ventilation and recirculation air conditioning systems for maintenance and operation regimes;
- To provide for plant two way radio searching and telephone communication network;
- To foresee locations for containers for collection and removal of radioactive waste ;
- To provide for a facility for preparation of decontaminating solutions and an area for decontamination of special vehicles and protective containers as well as portable means and rigs for decontamination;
- Information on operational impacts on systems and equipment shall be recorded in a timely manner, documented and stored in the NPP archive;
- To provide for establishment of working areas.

According to RD EO 0013-93 the main options of nuclear power unit decommissioning shall be:

- Nuclear power unit liquidation;
- Nuclear power unit entombment.

Nuclear power unit liquidation means its complete dismantling, conditioning of all RW and non-radioactive waste, transportation of conditioned RW to a regional repository, while non-radioactive waste are utilized.

Nuclear power unit entombment implies dismantling and removal of conventionally clean, low contaminated and low activated equipment and pipelines of process circuits and systems of the power unit as well as civil structures. Conventionally clean equipment, metal and structure remnants are then utilized, while radioactive waste is conditioned and stored in the former controlled access area which is equipped with strengthened radionuclide barriers.

Both options, liquidation and entombment necessarily require to perform dismantling of radionuclide contaminated equipment, RW conditioning and storage. It is appropriate to store (on temporary or permanent basis) conditioned RW within the nuclear power unit remnants which shall be strengthened with safety barriers (so called RW storage modules). The studies performed for Baltic NPP have demonstrated that the entombment option would be preferable as compared to the liquidation one (Section 18 of PSAR of Baltic NPP).

The considered power unit decommissioning option foresees termination of power unit operation with complete dismantling of the power unit equipment and systems, demolishing the buildings and structures which will not be used in future. The power unit shall be transferred to a nuclear safe state, and all spent nuclear fuel shall be removed from the NPP site. The power unit systems and equipment used in the dismantling process shall be decontaminated and return to operable state or replaced with new ones.

ENVIRONMENTAL SAFETY OF NUCLEAR POWER UNIT UNDER DECOMMISSIONING

Nuclear power unit conservation is attained by sealing of airlock, doors and hatches in all power unit premises, through which radioactive substances may spread beyond the controlled area, as well as by exclusion of unauthorized access of personnel to that premises.

Environmental safety of nuclear power unit under decommissioning is ensured by the following measures:

- Reactor shutdown, termination of nuclear chain reaction and transfer from power operation to residual heat removal from reactor and spent fuel assemblies located in the in-reactor storage pool. Heat removal from reactor and spent fuel assemblies is provided by operation of system for normal and emergency cooldown, which is designed based on the principle of passive operation;
- Download of spent nuclear fuel from reactor;
- Transportation of spent nuclear fuel after storage period (aged SNF) for reprocessing.

Upon removal of aged SNF from nuclear power unit any nuclear hazards are completely eliminated, while radiation safety is ensured by strict observation of requirements of regulatory documentation in force at the moment of nuclear power unit decommissioning, and using standard systems for special (radioactive) ventilation and drainage.

Decommissioning of buildings and structures can comprise the following phases:

- Equipment dismantling and decontamination as necessary, dispatching either for conditioning and storage or for further use in the national economy;
- Civil structures dismantling and dispatching either for conditioning and storage or for further use in the national economy.

- Dismantling of special (radioactive) ventilation and drainage systems shall be performed progressively as the main process equipment is withdrawn from service.
- Within decommissioning activities the objectives of radiation control are:
- Provision and processing of data on radiation situation at the power unit under decommissioning, and radiological monitoring of the environment in the region of NPP placement.
- Keeping records of dedicated working areas, zones and locations, and working technologies applied;
- Coverage of all parameters and physical values subject to control.

The radiation control system structure in the decommissioning phase remains the same as for the operational phase (details are given in the EIA report Section 11). In the same time, scope and periodicity of the control would be changing to correspond with conditions of the power unit being transferred to a storage module.

The most important safety indicators for decommissioning works performance under an effective radiation control are the planning of individual doses and dose costs of personnel, minimum possible number of radiation workers involved, adjustment of process arrangement based on results of analysis of personnel exposures.

From the viewpoint of labour and radiation safety, relevant dust suppression systems shall be foreseen in designing of any technological process at the decommissioning phase.

DECOMMISSIONING WASTE

GENERAL

The materials given below in this section are fully available in the Section 18 of PSAR of Baltic NPP. Since a number of documents (tecspecs, programmes, operating procedures) have not developed to the moment, some information on issues related to the said documents may be of a preliminary nature and will be amended as they are developed.

The reference unit for studying of decommissioning aspects for Baltic nuclear power units (AES-2006) is Unit 1 of Kalinin NPP. In both cases installed capacity is approximately the same, and, moreover, both power units have no high temperature coolant purification system.

A great amount of radioactive waste is expected to be accumulated over the operating life of Baltic NPP power reactor. Generation of waste is associated with normal process of replacement of assemblies and parts as well as with performance of scheduled maintenance and repair activities. Strictly speaking, after the ultimate reactor shutdown all the equipment inside the containment should be treated as RW of various classes as well.

The sources off ionizing radiation at the power unit under decommissioning are radioactive fission products and radionuclides generated in an activation process due to irradiation of structural and construction materials as well as activated products of structural material corrosion. Such radionuclides generated and accumulated over the power unit operating life are contained in process circuits, civil structures, shielding structures of at-reactor space and RW storage facilities.

Long lived radionuclides determine both the induced activity of reactor equipment and civil structures and the content of fission products in liquid RW generated in the power unit decommissioning process.

The total activity value one year after the reactor shutdown is in the range from 1×10^{18} to 1×10^{19} Bq for foreign NPPs. In the overall issue of nuclear power unit decommissioning, construction materials and shielding structures play an important role since their dismantling, treatment and transportation give more than 50% of RW volume (equal to tens and hundreds of tons per a NPP as a whole) and more than 20% contribution in dose costs.

Radionuclides are generated in the primary circuit due to both neutron activation of the circuit construction materials and fission products release into the coolant from leaky fuel rods. Activity of equipment in other process circuits is stipulated by coolant leaks (loss of steam generator leaktightness, collection of controlled leakages, etc.) and by performance of process operations (discharge of coolant associated with boron control, power unit shutdown, coolant purification, etc.).

As it follows from operational data for tasks being carried out immediately after reactor shutdown, γ-radiation dose rate in the direct proximity of the equipment is by 70% determined by ^{60}Co, ^{58}Co, ^{59}Fe, ^{54}Mn. A year after the ultimate reactor shutdown the corrosion product activity will be determined virtually by only one isotope of ^{60}Co. The expected level of surface activity of that radionuclide is equal to $\sim 3.7 \times 10^5$ Bq/cm^2. After decontamination this surface activity value would be reduced by ~10 times. Approximately 50 years after the surface activity will reduce to ~37 Bq/cm^2 due to radioactive decay. If activity of measured sample is not less than 37 Bq/cm^2, the ^{60}Co radionuclide can be measured with confidence.

Values of γ-radiation dose rate at the primary circuit equipment undergone decontamination and storage during 50 years would be in the range from 6.1×10^{-5} to 9.3×10^{-3} µSv/s. Estimating the duration of equipment dismantling works as 10 years, one should start these activities not later than 40 years after the ultimate reactor shutdown.

The equipment dismantling process includes the following principal types of work:

- Equipment dismantling (as a whole, with disassembling onto components, with fragmentation, etc.) from its standard location;
- Transportation of the dismantled reactor shop equipment, its components or fragments in containers or without containers between zones within the reactor building;
- Cutting (size lowering) of the dismantled equipment, its components or fragments to a smaller fragments, which sizes are defined by technical parameters of downstream process equipment and operations.

Radioactive waste treatment operations includes intensive decontamination of the equipment, its components or fragments being sent to remelting, compacting, incineration (of flammable RW), solidification (of liquid RW), joint grouting, containerization, temporary storage, transportation, disposal.

Civil structures subject to demolition as part of the decommissioning process are classified by condition and peculiarities of the work process as follows:

- Structures being dismantled by total destruction of their material;
- Structures being dismantled with a partial destruction of their material with the goal of its decomposition onto structural components suitable for a further use;
- Structures being dismantled with total or partial destruction of their material dependent on work performance conditions at the existing enterprises, availability of material destruction means or lifting equipment of a required load capacity.

MATERIALS OF UNRESTRICTED USE (REUSE)

In accordance with para 3.11.1 of OSPORB 99/2010, materials and items with low content of manmade radionuclides can be used in business activities. The criterion for making decision on possible application of radionuclide containing raw materials, processed materials and items in business activities is the expected individual annular effective dose, which shall not exceed 10 µSv for their intended use.

In accordance with para 3.11.2 of OSPORB 99/2010, materials and items coming for use in business activities shall not have inadherent (removable) radioactive contamination on their surfaces.

The most trustworthy data on amounts of materials of unrestricted use will be obtained as result of conduction of a comprehensive engineering radiation examination (KIRO).

The most part of RW generated during the power unit decommissioning are that of low activity. There is some amount of intermediate level RW, mainly from in-vessel internals. A great part of the power unit would not be contaminated at all and would be dismantled by conventional means. Due to decontamination the RW amount would be reduced. The decontamination pursues two goals – to reduce personnel dose costs and to decrease the RW volume. Properly planned technological process of waste decontamination would allow one to convert waste into recyclable materials.

Some equipment parts of the reactor plant can be reused after its decontamination. Such parts include equipment of inspection shafts, fresh fuel container manipulator, container carriage TK-13, and others. Total mass of such reactor plant equipment is estimated to be not less than 1×10^3 tons.

And total amount of equipment and materials for reuse after power unit dismantling is estimated to be 5×10^5 tons.

RW VOLUME

All the RW management operations foreseen for the decommissioning phase shall meet requirements of the normative documents in force at the moment of work performance that regulate RW management and long term storage.

Most part of the decommissioning RW are intermediate level and low level radioactive waste with a negligible level of released heat, which can be packed without a significant biological shielding. In order to reduce the decommissioning RW volume it is appropriate to transfer low level RW into the intermediate level class. Such methods are applied for many years and have been permanently improved. Decontamination being applied with the goal of radiation situation improvement (due to reduction of structural material radioactivity) helps to reduce RW volume in the same time. An intensive decontamination makes it possible to reduce RW volume even more and to transfer formerly contaminated materials into commercial products.

For RW volume (and also labour and dose costs for equipment dismantling and RW treatment) estimation purposes the following assumptions have been adopted. The level of initial radionuclide contamination of surfaces of the primary circuit equipment and pipelines as well as surface contamination of coolant purification, drainage water collection, RW storage and treatment systems is taken to be equal to 4×10^5 Bq/cm^2. The level of initial contamination of surfaces of all other systems is taken to be equal to 4×10^4 Bq/cm^2. Mass activity of the reactor pressure vessel is assumed to be equal to 1.1×10^{10} Bq/kg, and in-vessel internals – 5.5×10^{10} Bq/kg.

Volume and activity of the RW generated in civil structure dismantling is estimated on the basis of the experience with the comprehensive engineering radiation examination (KIRO) of the first units of Novovoronezh NPP. It is adopted that radioactive contaminated thermal insulation volume can be reduced by compacting by a factor of 5.

A preliminary estimation of RW volumes subject to disposal shows that the intermediate and low level waste volume would be 2050 m^3, and high level waste volume – 85 m^3. Operational RW has been excluded from the analysis since the design provides for its removal from the site before the start of the decommissioning activities.

D. Quality assurance

The information below is given in the subsection 2.2.2.2 of the EIA Report

The developers of the design AES-2006 abide by the safety culture principles. All persons and organizations taking part in the development of the design have formed safety culture approaches based on the appropriate selection and training of personnel for safety related positions, establishing and carefully following work instructions, and their periodical renewal taking into consideration work experience. All such personnel shall be aware of the character and extent of the safety significance of their activity.

High quality of the power unit is ensured by:

- Pursuing unified technical policy provided by the safety concept combining normative requirements, WWER design, construction and operation experience, shipboard or other nuclear energy generation plants, IAEA recommendations, experience in sphere of design and operation of new generation enhanced safety plants;
- Developing and implementing a general quality assurance programme for the construction of nuclear power plants;
- Developing and implementing individual quaility assurance (QA) programs;
- Using experience of many years' cooperation among ROSATOM enterprises;
- Establishing the priority of contractors who have certified quality management (QM) systems over their competitors;
- Holding competitive bids among contractors;
- Cooperation with the Federal Environmental, Engineering and Nuclear Supervision Agency of the Ministry of Natural Resources and Ecology of Russia (ROSTEKHNADZOR);
- Employing qualified specialists;
- Implementing solutions proven by operation, tests results, and analyses;
- Organizing independent examinations carried out by outside experts;
- Conducting internal and external quality audits;
- Developing and implementing corrective and preventive measures.

REFERENCES

[IV-1] Guidelines on organization of the environmental control in the area of a nuclear power plant. Edited K.P.Mahonko, Hydrometeozidat, Leningrad, 1990.1.