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### Conclusion No.98

of the State Ecological Expertize, Ministry of Natural Resources and Environmental Protection of the Republic of Belarus, on the Belarusian NPP design documentation.

Customer	State Institution “Directorate of Nuclear Power Plant Construction”
EIA Report was prepared by	“Belnienergoprom” Design Scientific and Research Republican Unitary Enterprise
Design organization	“Atomenergoproect” Nizhny Novgorod” Engineering Company OJSC (General Project Developer)
Plant’s installed power	2400 MW (2 x VVER-1200)

Seventy four potential areas for NPP siting were considered in the Republic of Belarus. 20 areas were eliminated from further consideration, as they were affected by prohibiting factors determined by the main criteria and requirements for NPP siting. Thus, 54 areas were evaluated on the presence of unfavorable factors. The analysis was based on the archive data available.

Based on the assessment of hydrological, seismotectonic, environmental, meteorological, radiological, engineering geological factors, land use conditions and additional survey field works, a special expert commission selected three most perspective areas for further detailed analysis in order to reduce the volume of surveys for the areas under consideration:

- Bykhov area (Mogilev Region);
- Shklov-Gorky area (Mogilev Region);
- Ostrovets area (Grodno Region).

In 2006-2008, three sites were identified in these areas:

- Krasnaya Polyana site (Bykhov area);
- Kukshinovo site (Shklov-Gorky area);

– Ostrovets site (Ostrovets area).

On these sites surveys were carried out in order to select the priority site for NPP construction.

The comparative analysis of the characteristics of the selected sites gave the following results:

– at the Krasnaya Polyana and Kukshinovo sites, activation of suffusion-karst processes is possible, which is a complicating factor. The engineering geological and hydrogeological conditions at the Kukshinovo site are complicated (no regularity in occurrence of soils with various composition and properties, confined waters with piezometric level within 1.5 m from the surface are present);

– on the basis of the combination of significant factors, the Ostrovets site was found to be more preferable than the Krasnaya Polyana and Kukshinovo sites.

Taking these findings and IAEA recommendations into account, and having in mind the importance of safety issues, the Ostrovets site was selected as the priority one.

The priority site for Belarusian NPP construction with area of about 103.12 hectares is located in the North-West part of the Republic of Belarus, in the Ostrovets District of the Grodno Region, 15 km north-east from the town of Ostrovets.

The environmental impact assessment (EIA) of the planned Belarusian NPP was carried out within the scope of justification of investments for NPP construction.

The Ostrovets site is 130 km away from the capital of the Republic of Belarus, the city of Minsk.

The Ostrovets site is 25 km away from the border of the nearest foreign country (Republic of Lithuania), and 50 km away from the capital of Lithuania, the city of Vilnius.

The lands adjacent to the site are mainly represented by agricultural lands with inclusion of small areas of coniferous forests.

The river Viliya, a right tributary of the river Neman, flows around the site in 5...8 km to the North. The largest lakes within the Belarusian NPP 30-km zone are Vishnevskoye and Svir' lakes (located at a distance of 20 km and more from the NPP) and the Sarochanskiye lakes (located at a distance of 10 km).

The confined/free ground water level depth is 15...20 m.

The strongest earthquakes in Belarus took place in historical periods when the recording equipment was not yet available (years 1887, 1893, 1896, 1908).

The area under consideration is tangibly affected by seismic impacts from subcrustal earthquakes with their sources in Romania, in the juncture of Eastern Carpathians, Southern Carpathians and Precarpathian Foredeep (the Vrancea Mountains). Strong earthquakes in Vrancea region are relatively frequent. In the second millennium, 35 devastating earthquakes took place here. Only during the previous 60 years, four of these earthquakes – in 1940, 1977, 1986, 1990 – were perceptible in Belarus with the intensity 3...5. For example, the earthquake on 4 March, 1977, M=7.1, resulted in shakes in Belarus, with the intensity 4–5.

As the normative basis for assessment of seismic hazard in the NPP construction area, the Northern Eurasia general zoning map was used (OSR-97-D, 1:10000000, Ulomov et al, 2000). The territory of Belarus is also represented on this

map. The map corresponds to repeatability of seismic effect on average once per 10000 years (i.e. the average annual risk is  $10^{-4}$ ) and probability  $P=0.5\%$  of occurrence and possible exceeding of seismic event within 50 years specified on the map in the MSK-64 scale. The map is intended for the seismic hazard assessment for the areas where sensitive facilities, such as NPPs, radioactive waste grounds, etc. are located. In accordance with this map, the Ostrovets site area falls into the zone for which the estimated intensity is 7. Therefore, the assessment resulting from this map is 7 (MSK-64 scale). This assessment meets the level of maximum design earthquake. In accordance with the existing practice, the design earthquake intensity is assumed to be equal to that for the maximum design earthquake minus one.

High air humidity is observed in this area throughout a year. The average annual relative air humidity is 81%. In winter, the relative air humidity is 88%. The minimal air humidity is observed in May, with the average monthly relative air humidity of 69%. The partial water vapor pressure is minimal in January-February (3.9 hPa) and maximal in July (14.1 hPa).

The area for the process water intake facilities used to feed the process water supply system is located 7 km north from the NPP site at the Viliya river near the Malye Sviryanki settlement. The area for the second-lifting facilities is 0.25 km north from the Matskely settlement.

The water intake facilities for the utility and drinking water supply system will be located 6 km south-east from the NPP near the Gaigoli settlement. The water intake facilities comprise of 4 water intake sites and a water treatment site for purification of utility and drinking water.

The NPP site is divided into the primary industrial zone (the nuclear island) and a zone of auxiliary buildings and facilities.

The primary industrial zone consists of two block modules (reactor units) designed as a single object for construction purposes, each of which includes:

- the reactor building;
- the truck lock ramp;
- the steam chamber;
- the safety building;
- the auxiliary building;
- the control building;
- the storage for fresh fuel and solid radioactive waste (at the first reactor unit) and the storage for transportation and process equipment and for solid radioactive waste (at the second reactor unit);
- the nuclear service building with the utility rooms for the controlled-access zone;
- the turbine building;
- the normal-operation electric power supply building;
- the heating system building (at the first reactor unit);
- the water treatment building with the tanks for chemical treatment of water used for the plant itself.

The separate buildings and structures for each reactor unit:

- the ventilation stack;

- the unit's diesel power plant and the intermediate diesel fuel storage;
- the standby diesel power plant building (for the emergency electric power supply system) with the intermediate diesel fuel storage;
- the unit transformers' facility;
- the pumping plant for automatic fire suppression by water, with water tanks for automatic fire suppression.

East from the reactor units, there are spray ponds used in the cooling system for essential services (two for each reactor unit) and two standby reservoirs.

The essential services' pumping plants with the switching chambers will be provided between the reactor units and the spray ponds.

The facilities near the first reactor unit are as follows: the pre-start flushing water treatment building (with the tank farm), the heated parking for special trucks (with the storage for free containers) and the utility building for the free-access zone. These facilities serve both reactor units.

West from the reactor units, near the turbine building (as near as possible), there are chimney-type evaporative cooling towers with the pumping plants serving the systems in the turbine building.

The plant's auxiliary buildings and facilities are in the northern part of the site. The facilities as follows will be provided there:

- the building for the plant administration, laboratories and utilities;
- the protected emergency control center;
- the canteen;
- the free-access zone's workshops and the material storage;
- the integrated gas supply building;
- the storage for gas bottles;
- the integrated pumping plant providing fire water supply, utilities and drinking water;
- the starting and standby boiler plant;
- the gas distribution plant;
- the oil and diesel fuel facilities including the reception facility for the oil and diesel fuel pumping plant and the open-access storage for oil and diesel fuel;
- facilities for treatment of process waste water, runoff rain water, water contaminated with petroleum products and sanitary waste water from the free-access and controlled-access zones.

The power output facilities are in line with the facilities of the cooling system for the equipment in the turbine building, west from the reactor units.

The power output facilities include the building for the integrated gas-insulated distribution unit (330 kV), the relay panel building, the plant-service distribution unit building (10 kV) providing the emergency power supply and the plant-service power supply, the facility for standby transformers and plant-service transformers, the open-air 330-kV lines' equipment.

The nuclear fuel for the NPP is uranium dioxide in tablets. The tablets are used to make the fuel elements; the fuel elements are integrated into the fuel assemblies. The fuel assemblies for the Belarusian NPP are similar to those for VVER-1000

reactor in terms of their geometry, but some improvements are made in their design. The average fuel enrichment is 1.30...4.92%.

The special railway trains will be used to deliver fresh nuclear fuel in the manufacturer's transportation containers to the NPP.

The NPP will be comprised of two reactor units, with the VVER-1200 reactor and the turbine unit for each reactor unit. The double-circuit heat system will be used. The expected service life for the NPP primary equipment is 60 years.

The first circuit consists of the reactor, four main circulation loops, steam pressurizer, and auxiliary equipment. Each circulation loop includes the steam generator, the main circulation pump unit, and the main circulation pipeline.

The first-circuit coolant, heated while passing through the active zone of the reactor, comes to the steam generators, and heat is transferred from the heated coolant to the second-circuit water through the walls of the piping system. The second circuit consists of the steam-producing part of steam generators, main steam pipelines, one turbine unit, auxiliary equipment and service systems, deaeration equipment and the equipment for feed water warming and delivery to the steam generators.

The turbine unit includes the steam turbine and the generator mounted on a single base.

The circulating water supply system will be used at the NPP:

- the primary cooling water system (PA) that supplies cooling water and transfers heat to the chimney-type evaporative cooling towers from the turbine condensers;

- the auxiliary cooling water system (PC) that transfers heat to the cooling towers from the intermediate cooling circuit used for nonessential services and from the chilling machines' condensers;

- the cooling system for essential services (PE) that removes heat to the spray ponds from the systems located in the safety buildings.

To reduce negative environmental impact of cooling towers and to reduce the carryover of droplets through the tower top, water catchers will be used.

During normal operation, the total water flow rate in the PA system (i.e. through the cooling towers) for two reactor units amounts to 300000 m<sup>3</sup>/hour. The design of water catchers accepted for the cooling towers is capable to reduce the carryover of droplets to 0.002% of the total flow rate at the cooling tower. The annual average water loss resulting from evaporation and carryover in the cooling towers will not exceed 4630 m<sup>3</sup>/hour (for two reactor units).

The annual average total amount of regular fresh water replenishment will not exceed 2.54 m<sup>3</sup>/second (for two reactor units).

The river Viliya is assumed to be the primary source to replenish the consumptive water use.

The forecast of water intake for the NPP from Viliya demonstrates that, for two reactor units:

- in case of water flow in the river approximately equal to its mean annual flow estimated for many years, water intake will not be greater than 2.2% of the water flow in the river;

– in case of a year with low water, and water flow rates in Viliya approximately equal to the minimum average monthly rates in summer, autumn and winter low-water periods, the consumptive water intake will not be greater than 6% of the river flow rate.

Under abovementioned hydrological conditions, after water intake from Viliya for the NPP operation processes the water flow rate in Viliya will not be less than 24.12 m<sup>3</sup>/second, i.e. it will remain higher than the minimum flow rate necessary for the aquatic ecological system of the river.

The estimated water consumption for the NPP utilities and drinking purposes (including hot water supply) is 1315 m<sup>3</sup>/day.

The estimated water consumption for the NPP processes (not including the replenishment water for the circulating water supply systems) is about 876.4 m<sup>3</sup>/day (the process water).

For the purposes of rational use of water resources, waste water originating from the NPP site is predominantly reused. The reused water includes treated waste water as follows:

- sanitary waste water from the free-access zone;
- process waste water and runoff rain water;
- process waste water contaminated with petroleum products;
- non-radioactive sanitary waste water from the sewage of the controlled-access zone.

Cleaned waste water is used as replenishment water for the circulating process water supply system.

Due to reuse of the cleaned water, water consumption from external sources is reduced by 2270 m<sup>3</sup>/day (not including runoff rain water use).

In accordance with the project, container-type modular water treatment facilities will be used to purify the sanitary waste water from the free-access zone. These facilities will provide mechanical and biological treatment as well as disinfection.

The project also provides for the system of facilities to treat process waste water, runoff rain water and waste water contaminated with petroleum products.

Technical solutions and organizational arrangements are applied for treatment of sanitary waste water to prevent radionuclides from penetration into the environment with treated sanitary waste water.

The controlled-access zone's sanitary sewerage system receives sanitary waste water from water closets and shower rooms. Waste water from the special laundry and sanitary checkpoints is delivered to the special sewerage system tanks. After radiation measurements, this water is discharged to the controlled-access zone's sanitary water treatment facilities. However, if the level of activity found in waste water exceeds the permissible level, water is removed for special treatment.

The sanitary waste water treatment procedure proposed for the controlled-access zone is similar to the sanitary waste water treatment procedure for the free-access zone.

To ensure the environment protection, the detection unit will be used to check the volumetric activity of waste water downstream the water treatment facilities, both

for the controlled-access and the free-access zone, in the line used to deliver the treated water to the circulating process water supply system.

During the NPP operation and decommissioning, the NPP location area will be affected by the following impacts:

- thermal impact resulting from operation of systems used to cool the NPP process equipment (such as spray ponds, cooling towers, warm water discharge etc.);
- chemical impact resulting from use of chemicals in the NPP operation processes, operation of water treatment systems, water conditioning systems, cooling system blowing etc.;
- radioactive impact;
- electromagnetic impact that can originate from electric power transmission lines and high-voltage equipment within the NPP site;
- noise (acoustic) impact.

The analysis of operating experience of NPPs with VVER reactors demonstrates that electromagnetic and acoustic impact affects the NPP site area only. Beyond the NPP site, the noise originating from the NPP units and mechanisms does not exceed 50 dBA; such noise level meets the standards.

The thermal impact on the environment results from use of evaporative cooling tower and spray ponds in the circulation water calculation system.

The thermal atmospheric impact on the environment resulting from a single VVER 1200 reactor unit is about 2000 Gcal/hour. The total overheat of the steam-water mixture is about 30°C (as compared with the ambient atmosphere). Water and droplet carryover from the cooling tower nozzle results in precipitations at the leeward side. The additional amount of precipitations falling on the soil, as a result of discharges from cooling towers, is about 0.3 mm/year or less than 0.05% of the natural level of precipitations. Intensity of precipitations and the area affected by them depends on the wind speed and direction. When the wind is weak or moderate, the intensity of precipitations near the cooling tower becomes maximum but sharply drops at a distance. At 1...3 km, only weak precipitations or their traces are observed, and there is practically no thermal impact.

The calculations were carried out for two VVER-1000 reactor units (similar to those used at the NPP) for summer and winter climatic characteristics.

In summer, the estimated maximum additional water vapor content resulting from the cooling towers' discharges is about 135.7 mg/m<sup>3</sup>; it is about 22 times less than the background vapor content, and it cannot influence any moisture-related atmospheric processes (such as dew, fog or mist).

In winter, the maximum water vapor concentration is 120.71 7 mg/m<sup>3</sup>; it cannot significantly influence any moisture-related processes, such as aerial conductor icing. Under real conditions, maximum water vapor concentration in winter will be much less because the evaporated water rate is about 3 times less than in summer mode.

The cooling tower's flare impacts the distribution of gas and aerosol releases from the NPP resulting in their more intensive vertical dispersion when they are distributed near the flare. However, at 5 km from the cooling tower, there is

practically no flare-related effects; for longer distances, reduction of gas and aerosol release impact on the off-site territory is observed.

There is no transboundary impact of cooling towers affecting the territories of other countries.

The NPP's chemical environmental impact consists of atmospheric releases from the starting and standby boiler plant, diesel generator plants, vehicles, gas electric welding works, exhausts from chemical laboratories etc.

The primary fuel for the boiler plant is natural gas. Diesel fuel will be used as emergency fuel.

For diesel fuel storage, three vertical ground tanks will be built, 300 m<sup>3</sup> volume each (one tank will be used as a standby unit).

In the time adjustment procedures, the boiler plant will operate 24 hours a day.

In accordance with the boiler plant design, four LOOS 825 L steam boilers (manufactured by LOOS International, Germany) will be installed; providing 40 tons of steam per hour.

The designed boiler plant's total maximum heat generation capacity is 104.376 kW (89.763 Gcal/hour). In accordance with the design, the emissions from the boiler plant will be within the limits stipulated by the Belarusian national standard, STB 1626.1-2006 *Boilers plants. Plants working on gas, liquid and solid fuel*.

The consumption of the primary fuel at the boiler plant is as follows:

- maximum hourly consumption: 12444 m<sup>3</sup>/hour;
- annual consumption: 46332.72 thousand m<sup>3</sup>/year.

The pollutants originating from natural gas burning in the boiler plant are as follows: nitrogen dioxide, nitrogen oxide, carbon oxide, benzpyrene.

When the boiler plant consumes the emergency (diesel) fuel, more pollutants are formed: black carbon (soot) and sulfur dioxide.

To remove the combustion gas, each boiler is provided with an individual chimney. The chimneys' opening diameter is 1.1 m. The height of chimneys is 45 m from the ground level.

As per the design, the total atmospheric emission from all designed stationary facilities will not exceed 93.77 tons/year (including the emissions from the boiler station during the commissioning and adjustment procedures).

The standardized atmospheric pollution calculation software, Ecolog PRO (v.3.0), designed by Integral Company (Russian Federation), was used to calculate the surface concentrations of pollutants in the atmospheric air.

Calculation demonstrates that the surface concentrations of pollutants at the site boundary will not exceed 0.1 of the maximum permissible concentrations.

For the Belarusian NPP, the boundary of the sanitary protective zone coincides with the NPP site fence. The observation zone is 10...13 km.

The atmospheric emissions of pollutants will not result in any transboundary impact on the territories of Lithuania, Poland, Latvia or other countries.

The primary sources of radioactive substances at the NPP are as follows: Uranium-235 fission products originating from neutron irradiation of the fuel in the reactor core; structural materials' activation by neutrons; traces of the first-circuit coolant and air in the space near the reactor.



Emission of radioactive gases and aerosols throughout the NPP and their penetration into the environment is confined by persistent implementation of the in-depth defense principle based on the system of barriers. The confining barriers are as follows: fuel matrix; fuel elements' shells; primary coolant circuit; sealed primary coolant circuit's enclosure.

While in operation, the NPP produces liquid, solid and gaseous radioactive wastes.

During the radioactive wastes' collection, conditioning and storage, safety of personnel, population and environment is provided by special measures and technologies, with the system of barriers placed on the path of possible penetration of radioactive substances into the environment. This system of barriers includes physical and chemical form of conditioned radioactive wastes, impenetrable enclosures of rooms and storages, and the walls of the equipment, containers and pipelines that contain radioactive wastes.

The solid and solidified radioactive waste storage will be constructed for temporary keeping of conditioned radioactive wastes at the NPP.

Within the scope of the spent nuclear fuel management, the fuel will be temporarily stored in the spent fuel pool in the course of ten years and then evacuated by the special train, in special containers, to the reprocessing plant.

The radiation monitoring system is implemented to collect and process the information describing the parameters of the NPP and the environment in terms of radiation conditions for all NPP operation modes including design basis accidents and beyond design basis accidents as well as the NPP condition at the time of decommissioning.

Liquid radioactive wastes include salt concentrate (bottom liquid), sludge and pulp of spent filtering materials from the processes where the liquid radioactive substances (drain water) are treated and from the special water treatment facilities operation. The project provides technologies and technical solutions minimizing the amounts of liquid radioactive wastes and, as a result, reducing the amounts of radioactive wastes sent for final burial.

The project provides for the measures as follows:

- waste radioactive aqueous substances are collected and treated separately;
- reagent-free technologies are applied as far as possible;
- low-waste single-bath decontamination process is applied involving an intermediate transformation of the solution, resulting in lower concentrations of chemical components and reduction of amounts of liquid radioactive wastes due to the lesser number of treatment cycles and stages;
- special facilities and mobile modules are used, making unnecessary to construct pipelines for vapor and decontaminating solutions throughout the NPP;
- ion-selective inorganic sorbents that effectively remove  $^{137}\text{Cs}$ ,  $^{60}\text{Co}$  isotopes and other polyvalent metal radionuclides are used to treat potentially inactive and low-active waste waters, and treated salty waters are subsequently removed from the controlled-access zone.

Drain water treatment procedure is based on the evaporation method providing high water decontamination factor in combination with the minimum resulting

amount of radioactive salt concentrates. Ion-exchange filters are used to pre-treat the condensate from the drain water treatment process; then, the pre-treated condensate is collected in the controlled tanks. Samples are taken for radiochemical and chemical tests. If the quality characteristics meet the standards, treated condensate is removed from the NPP process cycle or reused.

The salt concentrate (bottom liquid) remaining from drain water evaporation is sent for further treatment.

The facilities for treatment of liquid radioactive substances are the sources of liquid radioactive wastes:

- salt concentrate (bottom liquid) from the evaporator used in the drain water treatment system;
- pulp of spent sorbents from ion-exchange filters used in the facilities for special water treatment;
- pulp of fine-dispersed resins from precoat filters;
- sludge.

Liquid radioactive waste solidification system will concentrate the bottom liquid, mix it with cement and place the cemented compound into concrete non-returnable protective containers (NZK-150-1,5P).

The solidification unit is used to dewater spent ion-exchange resins; then, dewatered resins are placed into NZK-150-1,5P containers (mixing with cement is not used).

The intermediate storage system is used to keep liquid radioactive waste for at least three months before conditioning to reduce radioactivity due to the decay of short-lived radionuclides.

The structures and structural materials used in containers are mechanically strong and resistant against corrosion (both internal and external) to a degree sufficient to preserve the form of radioactive wastes while they are stored at the NPP during the specified period. The containers' design prevents release of radionuclides into the environment in concentrations exceeding the levels permissible in accordance with the established standards.

Solid radioactive wastes are produced at the NPP during normal operation of reactor units, in the systems for recycling and treatment of liquid and gaseous wastes (e.g. solidified wastes, filters, sorbents, ion-exchange resins etc.), during repair procedures (process equipment, instrumentation and sensors, tools, protective clothing etc.) and in case of emergencies.

For the normal NPP operation, including the preventive repair, fourteen (14) NZK-150-1,5P non-returnable protective containers with cemented salt concentrates and eight (8) NZK-150-1,5P containers with dewatered spent radioactive sorbents are expected to be delivered to the solid radioactive waste storage. The maximum expected number of NZK containers with solidified radioactive wastes is 38 containers a year (taking into consideration that the normal operation may be violated and the emergency repair works may be carried out at the power unit).

Solid radioactive wastes are classified into three categories, depending on the radioactive pollution level: low-active, moderately active and highly active.

The percentages of these categories are as follows: low-active, 88%; moderately active, 11%; highly active, about 1%.

Separate management procedures will be applied to the radioactive wastes of different categories. For each category, the management procedure is specified, including their collection, temporary storage, packing, transportation, conditioning (if possible) and storage. Also, appropriate rooms and equipment for radioactive waste management are provided, and the radiation monitoring scopes and procedures are specified.

Solid radioactive wastes are collected and classified at the place of their origin; in accordance with their activity level and required management methods, they are placed into the collection containers. These containers are delivered to the storage buildings. The set of equipment for solid radioactive waste treatment will be provided to reduce the volume of solid radioactive waste; this equipment will include the crushing and compacting machines. The solid radioactive waste treatment equipment will be appropriate to receive the wastes, crush them, place into barrels, compact them into barrels, seal the barrels (including appropriate documenting) and submit the barrels for storage.

Within the EIA scope, an alternative was considered to keep solid radioactive wastes within the NPP site during 50 years. However, within the scope of the project documentation, the decisions were made to keep solidified liquid radioactive wastes and solid radioactive wastes at the NPP during 10 years. Highly active wastes will remain at the NPP throughout its service life.

The gaseous radioactive wastes at the NPP are as follows: process-related gas blow-offs from the equipment and tanks containing the first-circuit coolant, gas blow-offs from the tanks in auxiliary systems, and air from ventilating systems serving the controlled-access zones. When the NPP is operated in normal mode, the most significant sources of radioactive substances contaminating air in the NPP rooms are irregular leakages of the first-circuit coolant from the equipment elements that are not tight.

The systems are provided to treat gas blow-offs from the equipment and tanks, exhaust air from the containment and air in the controlled-access zone rooms. Two 100-m ventilation stacks are used to release air downstream from the treatment systems.

See table below for the annual design emission (Bq/year) of the primary radionuclides, compared with the permissible emission, and the design emission index.

Nuclide or group of nuclides	Belarusian NPP (two units)	Permissible emission for NPP with VVER in accordance with the Sanitary Rules for NPP Design and Operation (SP AS-03)	Design emission index <sup>1)</sup> , %
$\Sigma$ Inert radioactive gases	$9.2 \cdot 10^{13}$	$6.9 \cdot 10^{14}$	13
$^{131}\text{I}$ (gaseous + aerosol form)	$1.5 \cdot 10^8$	$1.8 \cdot 10^{10}$	0.8
$^{60}\text{Co}$	$6.2 \cdot 10^4$	$7.4 \cdot 10^9$	$8.4 \cdot 10^{-4}$
$^{134}\text{Cs}$	$4.0 \cdot 10^7$	$9.0 \cdot 10^8$	4.4
$^{137}\text{Cs}$	$6.1 \cdot 10^7$	$2.0 \cdot 10^9$	3.1
Note: <sup>1)</sup> – The design emission as a percentage from the permissible emission			

For the purpose of environment protection in case of heavy beyond design basis accidents, the project provides additional technical solutions, such as:

- pressure release systems in the first circuit preventing the core destruction at early stages of an accident;
- passive heat removal systems for removal of residual heat in case of an accident involving complete long-time power failure, with the first and second circuits remaining tight;
- the double containment keeping the radioactive substances more effectively in case of an accident involving the core damage;
- the melt localization unit preventing the melt from contact with the concrete and ensuring the quick melt cooling;
- the system for passive heat removal from the containment used to keep the containment non-tightness at the design level both at the early stage and at later stages of an accident;
- the ignition system suppressing the explosive hydrogen concentrations to keep the containment undamaged;
- “iodine problem” solution during the first day of a heavy accident by keeping  $\text{pH} > 7$  in the containment; for this purpose, the tank with 30% NaOH or KOH solution is flushed into the emergency sump.

During the NPP operation, the permissible emissions and permissible discharges of radioactive substances (meeting the unconditionally permissible risk for population, less than  $10^{-6}$  1/year) will not be exceeded. During the normal operation of the reactor units at the Belarusian NPP (with two VVER-1200 reactors), the limit exposure dose for population at the NPP site boundary and beyond it, in terms of each impacting factor (emissions and discharges), is  $10 \mu\text{Sv}/\text{year}$ .

The radiation exposure for population (the expected design level) beyond the NPP site boundary resulting from all factors of radiation impacts originating from gaseous and aerosol emissions produced by two designed reactor units will be about  $3 \mu\text{Sv}/\text{year}$ , i.e. less than 1% of the annual effective exposure dose primary limit for population ( $1 \text{ mSv}/\text{year}$ ).

The radiation exposure for population resulting from gaseous and aerosol emissions produced by VVER-1200 reactors in case of violation of normal operation

are within the population exposure quotas for normal operation. The expected effective individual exposure dose for persons from population is less than 100  $\mu\text{Sv}/\text{year}$  (this is the dose limit for the AES-2006 NPP project when the normal operation is violated).

With the safety and localization systems operating within their design modes, emergencies at VVER-1200 will not be heavier than the “serious accident” (level 3) as per the INES (see INES User's manual); so, in accordance with the international recommendations and national requirements for this class of accidents, no protective activities for population and environment are required beyond the NPP site boundaries.

In accordance with the calculated estimates, the expected dose for population during the first year after the design basis accident at the reactor unit in the Belarusian NPP will not exceed the limit amounts specified in standards, both at the site boundary and beyond it.

The emergency emissions in case of a heavy beyond design basis accident at VVER-1200 (INES level 5, the residual risk is less than  $10^{-7}$  1/year) will not result in acute radiation impacts on population and will not restrict the use of large land plots and aquatic surfaces for a long period.

In accordance with the project, the mandatory population evacuation zone is 800 m; the protective activities planning zone, 5...7 km; the observation zone, 13 km.

The expected radiation impact levels are not so high to make necessary the intervention levels involving the emergency evacuation and relocation of population. Within the protective activities planning zone, the protective activities for population will include sheltering and/or preventive iodine administering.

The Belarusian NPP will not produce any transboundary radiation impact on the population and environment in Lithuania, Poland, Latvia or other countries.

During the Belarusian NPP operation, impacts on the river Viliya are possible resulting from waste water discharge.

The Water Problems Institute (the institution of the Russian Academy of Sciences) has carried out the research, *The Belarusian NPP Comprising Two Reactor Units. Detailed Determination of the River Viliya Flow Characteristics and the Hydrological Dispersion of Impurities, Assessment of Reliability of the Process Water Supply System for the Belarusian NPP, Thermal Mode Modeling, Elaboration of the Procedures for the River Viliya Flow Management.*

As a result of this research, it was found that, if the waste water is discharged into Viliya, water temperature in the reference cross-section in the warmest month during the summer period (July) will be 1.1°C higher than the initial water temperature in Viliya, and it was estimated to be +23.0°C; in the warmest month during the winter period (October), it will be 0.9°C higher than the initial water temperature in Viliya, and it was estimated to be +7.8°C.

Also, water temperature in the reference cross-section of the river Viliya in August was estimated to be +21.0°C.

In accordance with the Decision of the Ministry of Natural Resources and Environmental Protection and the Ministry of Public Health of the Republic of Belarus No.43/42, 08 may, 2008 (as amended in accordance with the Decision

No.70/139, 24 December, 2009), water temperature in water bodies used for preservation and reproduction of *Salmonidae* and *Acipenseriformes* fish will not be raised by more than 5°C above the natural temperature of a water body, with the resulting temperature not exceeding 20°C in summer and 5°C in winter.

The total rise of water temperature in the reference cross-section of Viliya (500 m downstream from the Belarusian NPP waste water discharge location) in July and October results from background temperatures in the river (21.9°C in July and 6.9°C in October); these background temperatures are higher than those specified in the before-mentioned Decision No.43/42 (20°C in summer, 5°C in winter).

In accordance with the requirement of the Ministry of Natural Resources and Environmental Protection and taking into consideration the concern declared by Lithuania within the scope of discussions with regard to the EIA Report, the measures as follows are provided for in the project documents for the Belarusian NPP construction:

1. For the most unfavorable period (in terms of thermal impacts), the supplementary facility will be used to cool the waste water discharged from the NPP. This facility is an open pool with the nozzles used to spray water over the tank surface for cooling (similar to the technique used in spray ponds). The pool dimensions are 31 x 172 m, the depth is 3 m.

Due to this after-cooling facility, the discharge water temperature can be reduced, before discharge into Viliya, to 20°C in July and August and to 5°C in October; as a result, it will meet the quality requirements for relevant seasons specified for water bodies used for fishery. In July and October, discharged water temperature will be even lower than the natural water temperature in Viliya.

2. To reduce concentrations of chemicals and other (suspended) substances in the discharged waste water to the levels meeting the maximum permissible concentrations, the design provides for partial removal of waste water from the water conditioning facilities into the sludge disposal sites; this water will be later returned to the water conditioning circuit.

See table below for concentrations of the most significant chemicals in the reference cross-section.

Characteristic	Concentration (mg/dm <sup>3</sup> )		Maximum permissible concentration (mg/dm <sup>3</sup> )
	Summer period	Winter period	
Solid residue (mineralization)	334.9	318.4	1000
Suspended materials	6.7	7.4	0.25 from the background
pH	8.0 – 8.5	8.0 – 8.5	6.5 – 8.5
Calcium	70.98	73.72	180.0
Sodium	80.5	92.5	120.0
Petroleum products	0.01	0.02	0.05
Sulfates	68.6	79.3	100
Chlorides	130.6	148.5	300

The waste water discharge into Viliya is implemented as a dispersing release.

Also, in accordance with the project, the detecting device (UDZhG model) will be used to monitor the volumetric activity of radionuclides in the line for water delivery to Viliya.

The project also specifies the scopes and procedures that will be used to handle the waste materials from construction and non-radioactive waste materials from the NPP operation processes.

Within the scope of the EIA procedure, the EIA Report was discussed with the groups of general public whose rights and legitimate interests can be affected by implementation of the solutions provided in the project.

Mass media were used to inform the general public in the Republic of Belarus about the public discussion:

- nation-wide level: *Sovetskaya Belorussiya* newspaper, No.172, 12 September, 2009; *Respublika* newspaper, No.177, 12 September, 2009;
- regional level: *Grodnenskaya Pravda* newspaper, No.107, 10 September, 2009, No.112, 23 September, 2009;
- district level: *Ostrovetskaya Pravda* newspaper, No. 69, 12 September, 2009, and No.77, 7 October, 2009;
- in Internet, on the web sites of the Ministry of Natural Resources and Environmental Protection, the Ministry of Energy, Grodno Regional Executive Committee, Ostrovets District Executive Committee and the State Institution “Nuclear Power Plant Construction Directorate”.

The EIA Report was discussed at the public meeting in Ostrovets, Grodno Region, on 09 October, 2009.

Within the EIA scope, international procedures were carried out to take possible harmful transboundary effects into consideration.

The timeline of the international procedures carried out within the EIA scope is as follows:

- in August, 2009, the notification describing the planned activities, the EIA procedure, the participation and discussion process and brief EIA information was sent by Belarus to all affected parties (Latvia, Lithuania, Poland, Russia, Ukraine);
- in September, 2009, the EIA documentation (the preliminary EIA Report) was sent by Belarus to all affected parties;
- from October, 2009, to June, 2010, the preliminary EIA Report was discussed with all affected parties;
- in February, 2011, the final EIA Report was sent by Belarus to all affected parties for their comments;
- from February to June, 2011, the final EIA Report was discussed (with Lithuania, until October, 2013).

Russia has not expressed its wish to take part in the EIA procedure. Austria was admitted as an affected party in accordance with its request.

All affected parties were consulted by way of exchange of letters or expert meetings.

In accordance with the desire of affected parties, the EIA Report was discussed at public meetings in Kiev (Ukraine), Vienna (Austria), and, for Lithuanian general public, in Vilnius (March, 2011) and in Ostrovets, Belarus (August, 2013).

Within the EIA scope, alternative energy sources were also considered in view of their possible implementation if the NPP is not built (the so-called “zero alternative”). However, the “zero alternative” (i.e. the decision not to build the NPP) is not acceptable for the Republic of Belarus in terms of environmental and economic security.

In accordance with the EIA Report, the Belarusian NPP operation will not result in any transboundary impacts or significant hazards at large distances.

Presently, the development of the Comprehensive Program of Environmental Monitoring for the NPP Region and Site is in its final stage.

Taking the this information into consideration, the State Ecological Expertise of the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus hereby **endorses** the Belarusian NPP project documentation.

**Until December, 2014, the post-project analysis program is to be approved, taking into account the discussions with the Affected Parties.**

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Department

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