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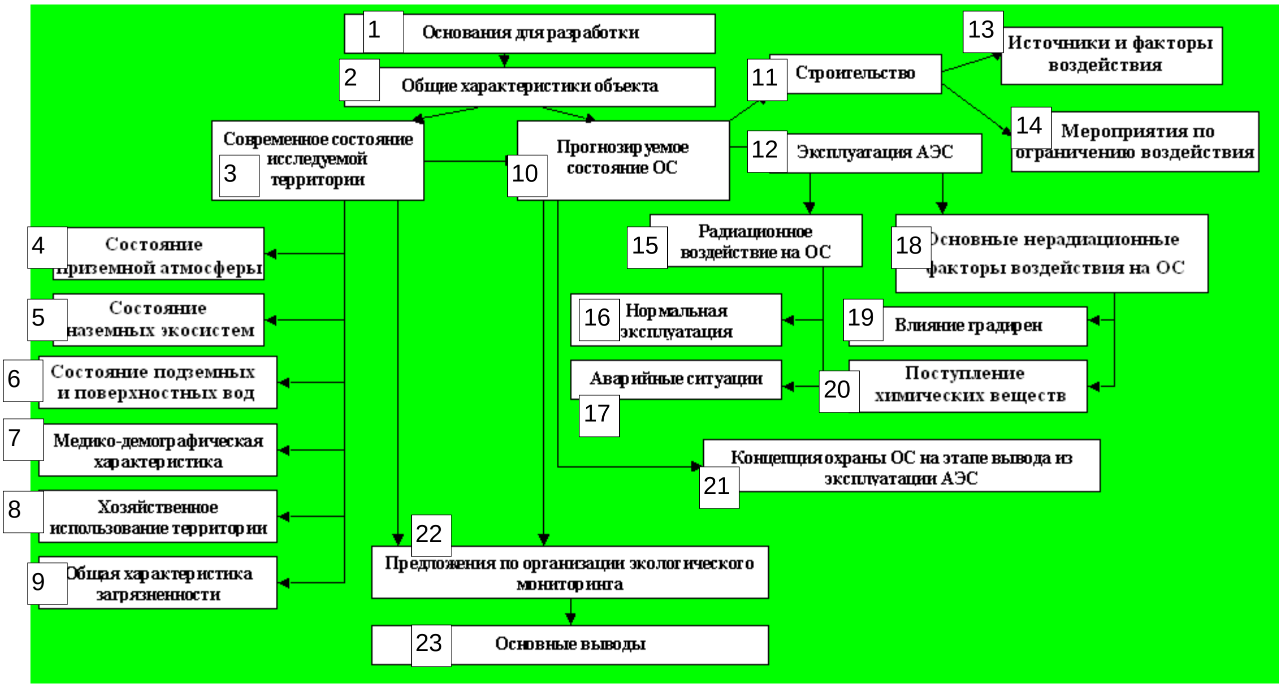
1 ENVIRONMENT PROTECTION REQUIREMENTS

1.1 Environmental concepts of nuclear power engineering

From the very outset of the nuclear power engineering development, presence of potentially dangerous radiation effect on the environment determines increased requirements for the environment monitoring both in the sanitary protective zone and in the observation zone around the Nuclear Power Plant (NPP). On the basis of analysis and review of information on the environment condition and protection around the NPP, behavior of pollutants from the NPP in the environment, and ecosystems responses on the effects, related to the NPP operation, the following environmental concepts of nuclear power engineering were formulated:

- the NPP is a system, including the NPP itself, its supplementary and constructional organizations and enterprises, and a town or village for the NPP personnel, including its service enterprises and utilities;
- the NPP is a source of four effects, affecting the population life quality conditions and natural environment, namely: radiation; chemical; heat; effects related to the area urbanization;
- during normal operation of the NPP, the population and natural environment are absolutely protected against any radiation effects of the NPP, but, in case of any abnormalities in its operation, radiation effects can become the most significant kind of effect;
- during normal operation of the NPP, the most significant factor affecting the ecosystem is a heat emitted by its cooling towers;
- the most significant factors affecting terrestrial ecosystems are the factors related to construction works, area urbanization and, possibly, chemical effects;
- in the area around the NPP, there are groups of population, biogeocenoses, landscapes, landscape couplings, species of plants and animals, that are critical to the NPP effects.

Therefore, great attention should be paid to the matters of environmental safety during the design, construction and operation of the NPP. For a structure of substantiation of the NPP safety, see Figure 1.



1 Grounds for project
2 General characteristics of an object
3 Current condition of a surveyed territory
4 Surface air condition
5 Terrestrial ecosystems condition
6 Ground and surface waters condition
7 Medical and demographic characteristic
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9 General characteristic of pollution
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13 Impact sources and factors
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19 Cooling towers impact
20 Impact of chemicals
21 Concept of environment protection during the NPP decommissioning
22 Proposals for environmental monitoring organization
23 Main conclusions

Figure 1 – NPP safety substantiation

As can be seen from Figure 1, the main tasks on the stage of the environmental impact assessment include:

- obtaining of any possible information concerning the environment condition in the NPP site and its observation zone;
- determination of groups of population, biogeocenoses, landscapes, landscape couplings, species of plants and animals, that are critical to the NPP effects;
- development of proposals for organization of the environment monitoring system.

1.2 Information about the customer, the designer and the executors of the EIA

In accordance with the Decree of the President of the Republic of Belarus, dated November 12, 2007, No. 565 “On some measures for construction of a nuclear power plant” the following institutions have been established in the Republic of Belarus:

1 the state company “the Directorate of Nuclear Power Plant Construction” for carrying out the customer’s functions of fulfilling the complex of preparative and design and survey works of nuclear power plant construction (hereinafter referred to as NPP).

2 the Department of Nuclear and Radiation Safety for performance of the state supervision in the field of the nuclear and radiation safety provision in the Ministry of Emergency Situations.

The Design Scientific-Research Republican Unitary Enterprise “Belnipienergoprom” has been determined as the general designer for coordination of the design and estimate documentation for construction of the NPP.

Co-executors of the environmental impact assessment:

the Republican Unitary Enterprise “Central Research Institute for Complex Use of Water Resources” (RUE “CRICUWR”) – the institute of the Ministry of Natural Resources of the Republic of Belarus occupied with the study of surface waters. The study is aimed at estimation of impact on the water environment of the nuclear power plant in the Republic of Belarus. Surface waters are quantitative and qualitative properties. Transborder transfer of radioactive pollution.

the State Enterprise “Republican Centre for Radiation Control and Environmental Monitoring” (SE “RCRCEM”) - the state institution as a part of the Ministry of Natural Resources of the Republic of Belarus occupied with monitoring of environment objects of the Republic of Belarus (chemical and radioactive pollution). The study is aimed at development of a monitoring system in the observation zone of Belarusian NPP, evaluation of the current state of environment objects, launching monitoring in the field of supervision during construction of the Belarusian NPP, evaluation of the surface radioactive pollution in the normal operation mode and in case of an out-of-design accident at the Belarusian NPP, transborder transfer of radioactive pollution by air.

the State Enterprise “Republican Hydro- and Meteorological Centre” – the state institution as a part of the Ministry of Natural Resources of the Republic of Belarus. Its study is aimed at description of the current state of the air environment and climate, assessment of Belarusian NPP impact on the air environment and microclimate.

the State Research Institution “Institute for Nature Exploitation of the National Academy of Sciences of the Republic of Belarus” – a leading research institution of the Republic of Belarus in the field of nature use, environment and hydraulic technologies protection, geological ecology, geography and paleography, climatology, hydrogeochemistry, hydroecology, geodynamics. The study is aimed at specifying the current state of environment (landscapes, flora and fauna). assessment of Belarusian NPP impact on their state. Provision of a forecast of the transborder transfer of chemical and radioactive pollution by underground waters.

The Research and Development Department – the Head Department of Science of the Belarusian State University (the research laboratory of hydroecology of the Belarusian State University) – a leading research institution in the field of hydroecology of the Republic of Belarus. A big working experience in the Naroch nature reserve. Its work is aimed at studying the contemporary state of biological components of water ecological systems and processes of water quality formation. Assessment of impact of the Belarusian

NPP on the state of water ecological systems and water quality.

the Republican Scientific and Practical Centre "Hygiene" of the Health Care Ministry of the Republic of Belarus – it executes a register of dose loadings for the population. The work is aimed at description of the contemporary state of the population in the area of the Belarusian NPP location, assessment of the radiological impact of the Belarusian NPP on the population of the Republic of Belarus (the normal operation mode and out-of-design accidents), assessment of the risk of impact of atmospheric air pollution by the NPP using various fuels on health of the population.

the Republican Research Unitary Enterprise "Radiology Institute" – a leading research institution of the Republic of Belarus in the field of agricultural radiology. The work is aimed at description of the current state of agriculture in the area of the Belarusian NPP, assessment of radiation impact on agricultural ecological systems as the result of the planned activities, provision of recommendations for agricultural production in case of radioactive pollution of environment during out-of-design accidents.

the Research Institute "of Fire Safety and Problems of Emergency Situations" – a specialized institution for assessment of emergency situations risks and problems of these situations. The work is aimed at assessment of impact of emergency situations on the NPP, planning the measures of liquidation of emergency situations at the Belarusian NPP.

1.3 Basic normative documents

List of the main regulatory documents of the Republic of Belarus in the sphere of eclological, radiological and nuclear safety is in the References.

To provide human safety in any conditions of ionizing radiation, artificial or natural, the Radiation Safety Standard (NRB-2000, GN2.6.1.8-127-2000) is approved in the Republic of Belarus, brought into force by the Decision of the Chief State Medical Officer of the Republic of Belarus (January 25, 2000, No.5).

The requirements for protection of humans against harmful radiation impact under any conditions of exposure to radiation from any radiation sources (hereinafter referred to as radiation sources), covered by the scope of NRB-2000, are established in "Basic sanitary rules of providing radiation safety" (OSP-2002), approved and brought into force by the Decision of the Chief State Medical Officer of the Republic of Belarus (February 22, 2002, No.6).

General provisions for providing safety of Nuclear Power Plants are specified in the Technical Code of Practice TCP 170-2009 (02300).

The requirements for providing nuclear safety of reactor installations on Nuclear Power Plants are specified in the Technical Code of Practice TCP 171-2009 (02300).

The requirements for the data, used for environmental impact assessment, including the requirements for these data contents and quality, the procedures of arrangement and organization of public hearings, and other recommendations are specified in the normative documents listed below:

- Instructions on the procedure of environmental impact assessment of planned economic or other activities in the Republic of Belarus, brought into force by the Decision of the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus, June 17, 2005 г, No.30;
- Technical Code of Practice TCP 099-2007 "Location of atomic stations. Guide for preparation and contents of environmental safety substantiation for atomic stations», approved by the Ministry of Natural Resources and Environmental Protection and the Ministry of Emergency Situations of the Republic of Belarus, October 10, 2007, No.6-T/88;

- Regulation on the procedure of consideration of matters, concerning using of atomic energy, with participation of public associations, other organizations and citizens, approved by the Decision of the Council of Ministers of the Republic of Belarus, May 04, 2009, No. 571;

- Regulation on the National system of environment monitoring in the Republic of Belarus, approved by the Decision of the Council of Ministers of the Republic of Belarus, July 14, 2003, No.949;

- Regulation on the procedure and using of data of radiation monitoring within the National system of environment monitoring in the Republic of Belarus, approved by the Decision of the Council of Ministers of the Republic of Belarus, May 17, 2004, No.576;

- Regulation on the procedure and using of data of atmospheric air monitoring within the National system of environment monitoring in the Republic of Belarus, approved by the Decision of the Council of Ministers of the Republic of Belarus, April 28, 2004, No.482;

- Regulation on the procedure and using of data of surface waters monitoring within the National system of environment monitoring in the Republic of Belarus, approved by the Decision of the Council of Ministers of the Republic of Belarus, April 28, 2004, No.482;

- Regulation on the procedure and using of data of ground waters monitoring within the National system of environment monitoring in the Republic of Belarus, approved by the Decision of the Council of Ministers of the Republic of Belarus, April 28, 2004, No.482.

2 DESIGN DECISION OUTLINE

2.1 Design decision implementation purposes

The primary purpose of the design decision is to satisfy the increasing power demands of the national economy of Belarus. Commissioning of nuclear power source, 2300 – 2400 MW, will provide reliable development of fuel and energy system of Belarus and make it possible to achieve the following purposes:

- exclusion of considerable quantities of organic fuel from the power production cycle;
- diversification of power sources;
- improvement of ecological conditions in the Republic of Belarus, because, with a nuclear power source, the electric power production will require much lesser chemical burden on the environment;
- improvement of investment opportunities in the NPP region;
- development of new equipment and technologies;
- improvement of social and economic opportunities of the NPP region.

2.2 NPP site alternatives

Initially, 74 potential locations were selected in the Republic of Belarus. 20 locations were excluded from further considerations, since they fell within the scope of prohibitory factors, set by the basic criteria and requirements for the selection of nuclear power plant locations. Thus, 54 locations were analyzed against adverse effects based on the fund and archive materials.

An expert commission was set up to reduce the volume of exploration work, which, following the analysis of hydrological, seismotectonic, environmental, aerometeorological, radiological and geotechnical data, land use conditions and additional reconnaissance field work, determined three most promising locations for detailed evaluation:

– Bykhov, (Mogilyov region);
– Shklov-Gorki (Mogilyov region);
– Ostrovets (Grodno region).

Three sites were chosen at these three locations in 2006-2008:

– Krasnaya Polyana site (Bykhov location);
– Kukshinovo site (Shklov-Gorki location);
– Ostrovets site (Ostrovets location).

Research work was conducted at the indicated sites to choose the priority site for the nuclear power plant construction.

For the survey results, used for sites comparison, see Tables 1 – 3.

Table 1 – Characteristics for NPP sites comparison

Characteristic	Sites to be compared		
	Kukshınovo	Krasnaya Polyana	Ostrovets
Seismotectonic conditions			
Area of extended sites on stable blocks, km^2	4.0	2.0	4.5
Distance to the nearest area of possible earthquake source (PES), km (in accordance with IAEA recommendations, at least 5 km)	12 km (to Orsha PES)	24 km (to Mogilev PES)	39 km (to Oshmyany PES)
Soil category, in accordance with seismic properties	II	II	II
Rated earthquake magnitude	5	5	6
Maximum design earthquake magnitude	6	6	7
Geological and hydrogeological conditions			
Composition of bed rocks under Quaternary sediments	Dolomite, limestone, clay, silt, siltstone	Chalk, marl, clay	Silt, marl, dolomite
Quaternary sediments thickness, m	68-72	45-55	72-103
Quaternary sediments composition	Primarily moraine, lacustrine and ice-borne loams; moraine sands	Primarily inter-moraine sands; moraine loams and loamy sands	Primarily moraine, loamy sands and loams; moraine sands
Surface occurrence of weak loess-type and lacustrine or boggy soils, 5 m or thicker	No	No	No
First inter-moraine water-bearing horizon	Artesian	Free	Intermediate
Depth of occurrence of the first water-bearing horizon, m	1,8	10	15
Ground waters protection against pollution from surface (upper confining layer)	Good	Satisfactory	Good
Hydrological conditions for water supply			
Natural source of process water supply	Dnieper river	Dnieper river	Viliya river

Table 1 (continued)

Characteristic	Sites to be compared		
	Kukshınovo	Krasnaya Polyana	Ostrovets
NPP process water supply (makeup) (2.54 m^3/s required)	12.58 m^3/s	18,18 m^3/s	17,3 m^3/s
Weather conditions			
Conform to the standard requirements on all sites considered			
Anthropogenic effects			
Steam and moisture emissions of cooling towers:			
in summer	Increasing of relative humidity by 0.2% over the background level. No influence on the processes of dew, haze or fog formation		
in winter	Increasing of relative humidity by 1% over the background level. No influence on the processes related to humidity variations. No increasing of electric power lines icing		
Radiation conditions on the site, resulting from steam and moisture emissions	Small increasing of radioactive aerosols concentration within 1.5 km from an emission source		
Effect of emissions of other industrial plants on the site area (30 km)	No	No	No
Effect of emergencies outside the site			
Radioactive aerosols transfer in case of forest or peatbog fires	Small	Small; radiation monitoring is necessary	Small
Smoking from emergencies and fires on gas pipelines	Small	No	Small
Smoking from emergencies and fires on oil pipelines	Possible	No	No
Radioactive pollution			
Natural soil pollution by radioactive nuclides at the time of the NPP commissioning, Ci/km^2 (standard pollution: 5 Ci/km^2 max)			
	0.17 max	4.99	0.28
Demographic characteristics			
Population density, per km^2 (100 max permissible)	34	20	24

Table 2 – Characteristics of construction conditions on competitive sites

Data on construction conditions	Sites to be compared		
	Kukshınovo	Krasnaya Polyana	Ostrovets
1 Population density and distribution within 25 km - population density, per km^2 - settlements (direction, distance, population[1)]	 34 - Mogilev, SW, 50 km, 365 000; - Gorki, SE, 15 km, 33900; - Shklov, SW, 28 km, 15000; - Orsha, NW, 25 km, 130500.	 20 - Mogilev, NW, 35 km, 365 000; - Bykhov, SW, 30 km, 16700; - Chausy, NE, 25 km, 10600; - Slavgorod, SE, 25 km, 8300; - Godylevo, E, 25 km, 1000.	 24 - Ostrovets, SW,19 km., 8000; - Svir, 22 km., NE, 1500; - Vilnius, 40 km, W, 542000.
2 Main facilities foundation conditions	Because of high level of confined ground waters and weak soils, constructional dewatering, substantial waterproofing, substitution of soils with low strength characteristics is required. Suffosion and karst processes activation is possible in cavernous and karst dolomites.	Suffosion and karst processes are possible in marls and chalks under quaternary sands.	Construction of main facilities is possible on the natural ground (the most economical choice). Dry construction area.

Table 2 (continued)

Data on construction conditions	Sites to be compared		
	Kukshınovo	Krasnaya Polyana	Ostrovets
3 Climatic and aeroclimatic conditions	Squalls and whirlwinds are possible	Squalls and whirlwinds are possible	Squalls and whirlwinds are possible
4 Relief (average surface slope) within the main site	15 %	14 %	14 %
5 Radioactive pollution of the site	The site is free of radioactive pollution	The site is within an area of partial radioactive pollution resulting from Chernobyl NPP accident (within the periodic radiation monitoring zone)	The site is free of radioactive pollution
6 Water supply required for facilities to be constructed	2.54 m^3/s	2.54 m^3/s	2.54 m^3/s
7 Conduits for process makeup water supply (length, diameter)	39 km Two lines, ∅1200 mm	36 km Two lines, ∅1200 mm	6 km Two lines, ∅1200 mm
8 Process water supply system	Circulating water supply system with cooling towers	Circulating water supply system with cooling towers	Circulating water supply system with cooling towers
9 Access railway, km	4	27	32
10 Outside highways, km	4	3	4

Table 3 – Analysis of sites conformance to the requirements of normative documents

Factors considered for the site selection	Sites to be compared					
	Kukshınovo		Krasnaya Polyana		Ostrovets	
	Characteristic	Conclusions	Characteristic	Conclusions	Characteristic	Conclusions
Prohibiting factors (NPP construction is prohibited in accordance with TCP 097-2007)						
The site is located directly on tectonically active fractures	No active fractures	Conforms	No active fractures	Conforms	No active fractures	Conforms
The site seismicity exceeds 9 (maximum design earthquake magnitude, MSK-64 scale)	Rated earthquake magnitude: 5 Maximum design earthquake magnitude: 6	Conforms	Rated earthquake magnitude: 5 Maximum design earthquake magnitude: 6	Conforms	Rated earthquake magnitude: 6 Maximum design earthquake magnitude: 7	Conforms
The NPP site is over water supply sources with asserted ground water reserves, being in use or planned to be used for drinking water supply, and it's impossible to prove that these water supply sources cannot be polluted by radioactive substances	No water supply sources	Conforms	No water supply sources	Conforms	No water supply sources	Conforms
There are no water resources in the site area, sufficient to provide 97% compensation of losses in the NPP cooling systems, and there are no reliable sources for compensation of water losses in the reactor plant cooling systems, that are important for the NPP	150 000 - 200 000 m^3/day water supply is provided, taking environmental limitations into consideration	Conforms	150 000 - 200 000 m^3/day water supply is provided, taking environmental limitations into consideration	Conforms	150 000 - 200 000 m^3/day water supply is provided, taking environmental limitations into consideration	Conforms

safety. Water requirements: 22 000 m^3/day						

Table 3 (continued)

Factors considered for the site selection	Sites to be compared					
	Kukshınovo		Krasnaya Polyana		Ostrovets	
	Characteristic	Conclusions	Characteristic	Characteristic	Conclusions	Characteristic
Active karst is found, or activation of suffosion and karst processes is possible in the site area	No active karst. Suffosion and karst processes activation is possible in cavernous and karst dolomites.	Conforms Complicating factor	No active karst. Suffosion and karst processes activation is possible in marls and chalks under quaternary sands.	Conforms Complicating factor	No active karst. Suffosion and karst processes activation is impossible	Conforms
In the site area, development of active landslides or other dangerous slope processes (landfalls, mud torrents) is possible	No dangerous processes	Conforms	No dangerous processes	Conforms	No dangerous processes	Conforms
Catastrophic flashes or floods are possible in the site area with 10000 years intervals, taking into consideration ice blockages, wind-induced water emissions, tidal phenomena	No danger	Conforms	No danger	Conforms	No danger	Conforms
The site area can be flooded in case of water inrush from upstream reservoirs	No danger	Conforms	No danger	Conforms	No danger	Conforms

Table 3 (continued)

Factors considered for the site selection	Sites to be compared					
	Kukshınovo		Krasnaya Polyana		Ostrovets	
	Characteristic	Conclusions	Characteristic	Characteristic	Conclusions	Characteristic
The territory where the NPP construction is prohibited in accordance with nature conservation regulations	No prohibitions	Conforms	No prohibitions	Conforms	No prohibitions	Conforms
The territory with population density 100 1/km^2 or more (including the NPP builders and personnel)	Population density is 34 1/km²	Conforms	Population density is 20 1/km²	Conforms	Population density is 24 1/km²	Conforms
Adverse factors						
The territory, where contemporary differentiated Earth crust movements are found (vertical, more than 10 mm/year; horizontal, more than 50 mm/year)	Vertical, less than 10 mm/year; horizontal, less than 50 mm/year	Conforms	Vertical, less than 10 mm/year; horizontal, less than 50 mm/year	Conforms	Vertical, less than 10 mm/year; horizontal, less than 50 mm/year	Conforms
Territories with saline soils, where the processes of salinization or leaching exist	No territories with saline soils and processes of salinization or leaching	Conforms	No territories with saline soils and processes of salinization or leaching	Conforms	No territories with saline soils and processes of salinization or leaching	Conforms

Table 3 (continued)

Factors considered for the site selection	Sites to be compared					
	Kukshınovo		Krasnaya Polyana		Ostrovets	
	Characteristic	Conclusions	Characteristic	Characteristic	Conclusions	Characteristic
Territories with abandoned mines or other similar works	No	Conforms	No	Conforms	No	Conforms
There are floodplain terraces of rivers or water body coasts in the territory, with a shear line or an abrasive terrace edge movement exceeding 1 m/year.	No	Conforms	No	Conforms	No	Conforms
Slopes, 15º or more	No	Conforms	No	Conforms	No	Conforms
Chemical or biological pollution of water in the supply source exceeds permissible levels	Chemical and biological pollution of water in the supply source is within permissible levels	Conforms	Chemical and biological pollution of water in the supply source is within permissible levels	Conforms	Chemical and biological pollution of water in the supply source is within permissible levels	Conforms

Table 3 (continued)

Factors considered for the site selection	Sites to be compared					
	Kukshınovo		Krasnaya Polyana		Ostrovets	
	Characteristic	Conclusions	Characteristic	Characteristic	Conclusions	Characteristic
Supply area of main water-bearing horizons	In accordance with available information, the site territory is not a supply area for main water-bearing horizons. Final assessment is possible during the following survey stages.	Conforms	In accordance with available information, the site territory is not a supply area for main water-bearing horizons. Final assessment is possible during the following survey stages.	Conforms	In accordance with available information, the site territory is not a supply area for main water-bearing horizons. Final assessment is possible during the following survey stages.	Conforms
The site with ground waters at a depth less than 3 m from the leveling surface in soils 10 m or thicker, with a filtration coefficient 10 m/day or more, or in highly fractured or coarsely-fragmental soils with low sorption capacity	Ground waters are at a depth less than 3 m from the leveling surface	Does not conform. Dewatering is required.	Ground waters are at a depth 10 m or more from the leveling surface	Conforms	Ground waters are at a depth 10 m or more from the leveling surface	Conforms

Table 3 (continued)

Factors considered for the site selection	Sites to be compared					
	Kukshınovo		Krasnaya Polyana		Ostrovets	
	Characteristic	Conclusions	Characteristic	Conclusions	Characteristic	Conclusions
Structurally and dynamically unstable soils are common in the site area (frozen or permanently frozen soils, loess subsiding and swelling soils, saline and peaty soils, loose sands, soils with a modulus of deformation less than 20 MPa etc.)	Practically no dynamically unstable soils. Surface lacustrine and boggy peaty soils will be removed; boggy and lacustrine peaty soils in the lower part of the quaternary sediment profile, thicker than 10 m, are occurring everywhere at 40-50 m depth	Conforms	Practically no dynamically unstable soils. Loess-type, lacustrine and boggy peaty soils, appearing at the surface in some areas, will be removed during leveling	Conforms	No dynamically unstable soils.	Conforms

Table 3 (continued)

Factors considered for the site selection	Sites to be compared					
	Kukshınovo		Krasnaya Polyana		Ostrovets	
	Characteristic	Conclusions	Characteristic	Conclusions	Characteristic	Conclusions
Hurricanes and whirlwinds are possible in the territory	Squalls and whirlwinds are possible	Does not conform. Risk of whirlwinds must be considered during the NPP design	Squalls and whirlwinds are possible	Does not conform. Risk of whirlwinds must be considered during the NPP design	Squalls and whirlwinds are possible	Does not conform. Risk of whirlwinds must be considered during the NPP design
Unacceptable changes in a behavior, temperature or composition of ground waters or surface waters are possible in the territory, resulting from planned industrial development, construction of waterworks or utilities, development of agricultural irrigation	There are no forecasts of changes in a behavior, temperature or composition of ground waters or surface waters	Conforms	There are no forecasts of changes in a behavior, temperature or composition of ground waters or surface waters	Conforms	There are no forecasts of changes in a behavior, temperature or composition of ground waters or surface waters	Conforms

Results of comparative assessment show:
– for all three competitive sites of prohibiting factors (i.e. factors/terms not allowing location of NPP site in accordance requirements of standard documents) the following is unavailable;
– at Krasnaya Polyana and Kukshınovo sites potential opportunity exists of activation of suffusion and karst processes, and this is a complicating factor. Engineering, geological and hydrogeological conditions of the Kukshınovo site are complex (there is no regularity in deposition of soils having various composition and properties, there are pressuring waters with their piezometric level is close to the earth surface by 1.5 m).
– by totality of factors having the essential importance the Ostrovetskaya site is more advantageous as compared with Krasnaya Polyana and Kukshınovo ones.
Taking into account the aforesaid, as well as recommendations of IATA, and taking into account importance of issues of safety provision the Ostrovetskaya site was chosen as top priority one (main).

2.3 Possible methods of implementation of the design decision

Nuclear power engineering is a technology based on utilization of heat energy released as a result of fission of heavy nuclei of uranium and plutonium. The amount of energy, released in a single act of nucleus fission, is about 200 MeV, or $3.2x10^{-11}$ J. In general, 200 MeV is very small amount. However, taking into consideration the particle masses, this energy is extremely high. E.g., to obtain heat energy equal to 1 MW*day (i.e., to generate 1 MW of heat energy, or 0.33 MW of electric energy during a day), only 1.24 g of Uranium-235 is required. The equivalent amount of coal, with 30230 kJ/kg combustion heat, is 2860 kg/day. Thus, the coal/Uranium-235 ratio for obtaining equal energy is 2300000:1.

Heat power, released in a reactor core during a controlled reaction of fission of heavy nuclei, is transferred by a coolant to a heat exchanger, where it is utilized for generation of steam, driving a turbine-type generator for electricity generation (similar to thermal power plants).

The majority of nuclear reactor units in the world are light water reactors (LWR). In these reactors, water is used for maintaining a chain reaction and for transferring heat from a reactor core. Water is used also as a moderator of neutrons. There are two types of these reactors:

- boiling water reactor (BWR);
- pressurized water reactor (PWR).

Also, there are two types of reactors with other moderators:

- pressurized heavy water reactor (HWR);
- high-power channel-type reactor, a reactor with a graphite moderator. This type of reactors is not described here, because there are no plans now to construct these reactors.

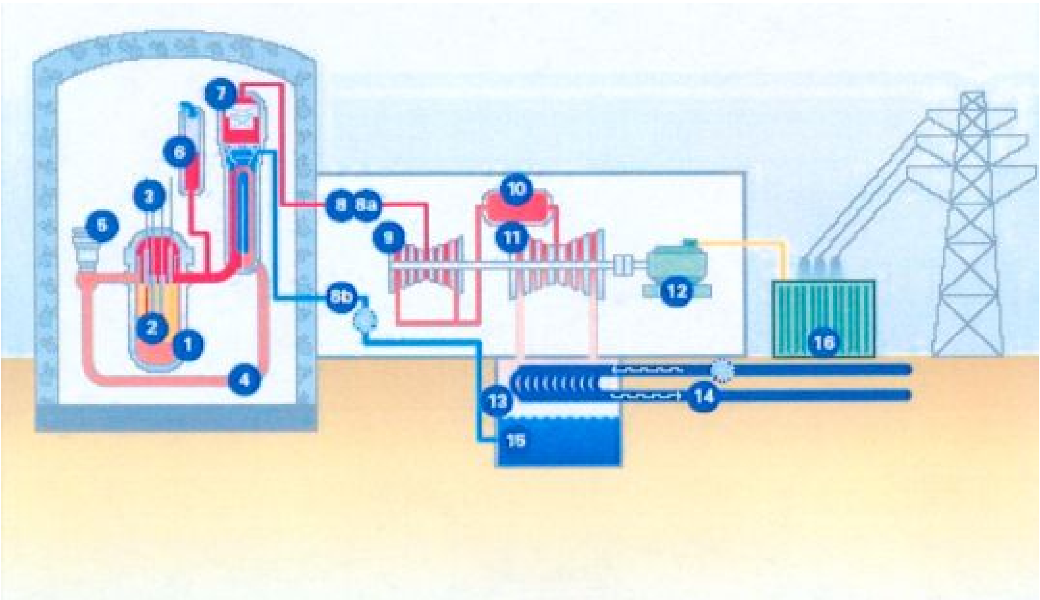
2.3.1 Pressurized water reactor (PWR)

This is the most widespread type of the commercial power reactor in the world. About 60% of the presently operated NPPs use reactors of this type.

Uranium dioxide (UO_2) with 3-5% enrichment for Uranium-235 is used as a fuel; it is placed in zirconium tubes, 3.5-4 m length. Pressurized water is used as a moderator and, as a coolant, transfers heat from a core in a steam generator; in a secondary cooling circuit, water is heated for steam generation. Steam is used to drive turbine(s) (see Figure 2).

To increase a boiling point and provide more effective transfer of heat, a coolant in a primary cooling circuit is under high pressure (16 MPa). During passing through a core, a coolant removes heat, released during a reaction of fission of Uranium-235 nuclei; a coolant temperature is increased to 300-330ºC. In a steam generator, heat is transferred to a coolant of a secondary cooling circuit, pressurized up to 7.8 MPa. Then, pumps are used to deliver a primary coolant to a core inlet. A secondary coolant is heated in a steam generator, up to 290°C, and is delivered to a turbine generator. The heat efficiency of a NPP with PWRs is about 32-37%.

A reactor and main equipment of a primary cooling circuit are mounted in a containment, designed to provide integrity in case of an internal impact (breakage of a pipeline in a primary cooling circuit, explosion of detonating mixture generated during a reactor operation) or an external impact (earthquake, small aircraft impact, act of terrorism).

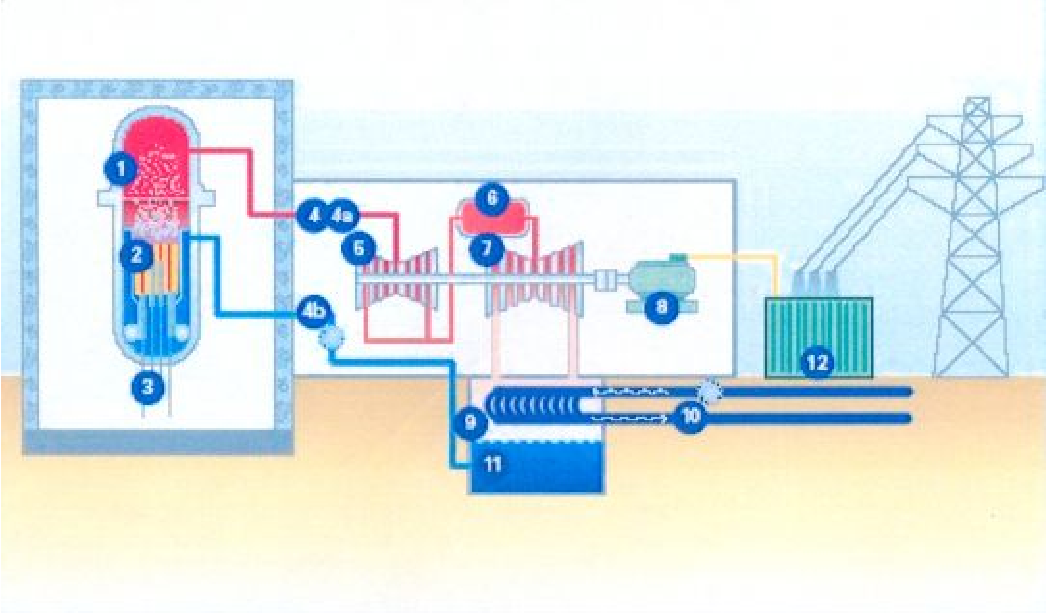


(1) reactor, (2) core, (3) absorbing rod, (4) primary cooling circuit, (5) main circulating pump, (6) pressure compensator, (7) steam generator, (8) secondary cooling circuit, (8a) steam for turbine, (8b) water for steam generators, (9) high-pressure cylinder, (10) steam superheater, (11) low-pressure cylinder, (12) generator, (13) condenser, (14) condenser cooling water circuit, (15) condensate, (16) transformer.

Figure 2 – Main components of NPP with PWR

2.3.2 Boiling water reactor (BWR)

BWR is a single-circuit reactor without a steam generator (see Figure 3), with water circulating through a core, serving as a moderator and a coolant. As a result of heat removal in a core, water is heated up to 300°C, boils and generates steam under about 7.0 MPa. About 10% of water is converted to steam and transferred to steam turbines. After condensation, water is returned to a core by pumps, completing a circulation cycle. Fuel is similar to that in PWR, but its specific volume power (power per unit of core volume) is two times less, with lower temperatures and pressures. It means that, to produce equal quantity of heat, a BWR vessel must be larger than that for a PWR, but, because there is no steam generator, and pressures are lower, a protective containment can be smaller. The significant drawback of this nuclear unit is an existing risk of pollution of a circuit by radioactive fission products in case of failure of a fuel element cladding; also, radioactive pollution of internal surfaces in a cooling circuit by radioactive corrosion products must be taken into consideration during preventive and current maintenance. With lower pressures (7.0 MPa) and temperatures, the heat efficiency of a NPP with BWRs is about 30-35%.



(1) reactor, (2) core, (3) absorbing rods, (4) primary cooling circuit, (4a) steam for turbine, (4b) water for reactor, (5) high-pressure cylinder, (6) steam superheater, (7) low-pressure cylinder, (8) generator, (9) condenser, (10) cooling water circuit, (11) condensate, (12) transformer.

Figure 3 - Main components of NPP with BWR

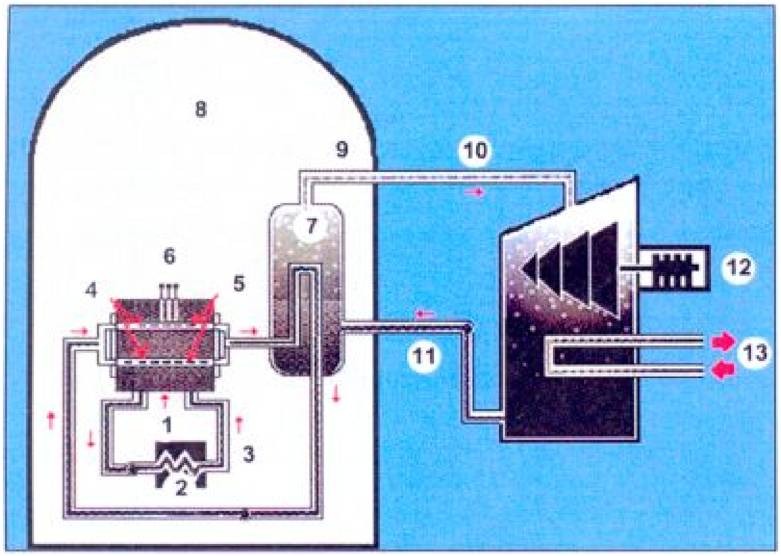
2.3.3 Pressurized heavy water reactor (CANDU)

In CANDU reactors, deuterium oxide (as a special type of water) is used as a cooler and a moderator. As a result, low-enriched or natural uranium (UO_2), placed in zirconium tubes, is applicable as a fuel. A CANDU reactor design is similar to PWR, but, instead of large strong vessel, fuel elements are placed in many (several hundreds of) horizontal tubes (channels), being under the working pressure of a coolant. Heavy water is used to cool these tubes; it removes heat from a reactor core, similarly to PWR. Tubes under pressure are placed in a large vessel, or a calender, containing separate heavy-water moderator under low pressure (see Figure 4).

The specific volume power of CANDU reactors is about one tenth from that of PWR; as a result, for CANDU reactors, a protective containment must be much larger than for PWR having equal power.

CANDU fuel is different from that of PWR or BWR: it is much shorter, with several bundles of fuel elements (usually, 12.5 cm each), placed against each other in a fuel channel. Such mounting of a fuel tube and a bundle of fuel elements means that it is possible to replace fuel during operation, with a reactor not stopped; as a result, availability ratio of an installation is increased. As a rule, for a primary cooling circuit, the operating pressure is 12 MPa, and the operating temperature is 285ºC, resulting in heat efficiency about 30%.

Modified CANDU reactor, ACR, is a hybrid of PWR and CANDU. In this type of reactors, slightly enriched fuel and light water, as a coolant, are used. As a result, power density and fuel burn-out are increased, making it possible to reduce a reactor size and quantity of used fuel, in comparison with its natural equivalent.



(1) reactor, (2) heat exchanger, (3) moderator, (4) fuel channels, (5) fuel, (6) control rod, (7) steam generator, (8) protective containment, (9) steam, (10) steam line, (11) pump, (12) turbine generator, (13) water for a condenser cooling.

Figure 4 - Main components of NPP with a pressurized heavy-water reactor (CANDU, ACR type)

2.3.4 Reactors comparison using main criteria

For comparison of reactor types considered above, see Table 4.

Table 4 – Main characteristics of reactors of various types

Reactor type, heat energy conversion cycle	Fuel	Coolant	Operating pressure, MPa	Core outlet temperature, °C	Specific volume power (1,0 for PWR)	Efficiency, %	Containment	Note
PWR, double-circuit	Low-enriched uranium, 3 – 5% ^{235}U	water	16	300 - 330	1.0	32 - 37	yes	The secondary cooling circuit is not radioactive. The primary cooling circuit equipment is fully protected by the containment
BWR, single-circuit	Low-enriched uranium, 3 – 5% ^{235}U	water	7.0	about 300	0.5	30 - 35	reactor only	The circuit is radioactive everywhere. High dose burdens during maintenance. Larger size than that of PWR.
CANDU, hybrid, double-circuit	Natural uranium	heavy water	12	285	0.1	30	yes	The secondary cooling circuit is not radioactive. The primary cooling circuit equipment is fully protected by the containment. Larger size than that of PWR.

As you can see in the table 4, PWR reactors have some positive characteristics:

- maximum power density in a core and, therefore, minimum size per unit power;
- double-circuit structure of NPP provides location of radioactive equipment (primary circuit) within a protective containment;
- minimum dose burden during maintenance.

As a result of these advantages, reactors of this type are widely applied in electric energy production (about 60% of world energy production).

The main worldwide vendors of NPPs with PWR units are Westinghouse-Toshiba (USA, Japan), Atomstroieksport (Russia), Areva NP (France and Germany) (see Table 5).

Table 5 – Reactors considered as alternatives for Belarusian NPP

Electric power, MW	Type	Model	Vendor	Generation	Website
600	PWR	AP -600	Westinghouse-Toshiba	III+	www.ap600.westinghousenuclear.com
1006 1200	PWR	B-428, B-412 B-491	Atomstroieksport	III+	www.gidropress.podolsk.ru/energlish/raszrad_e.html
1100	PWR	AP - 1000	Westinghouse-Tosiba	III+	www.ap1000.westinghousenuclear.com
1660	PWR	EPWR	Areva NP	III+	www.areva-np.com

These NPPs conform the requirements of IAEA, EUR, and national norms of nuclear and radiation safety. For main characteristics of reliability of these NPPs, see Table 6.

Table 6 – NPP reliability

NPP type	Heavy damage of core, per reactor, annually	Emergency limit radiation release from a reactor unit, per reactor, annually
AP - 600	$< 1.0 \times 10^{-7}$	$< 1.0 \times 10^{-8}$
AP - 1000	$< 2.4 \times 10^{-7}$	$<3.7 \times 10^{-8}$
NPP - 2006	$< 5.8 \times 10^{-7}$	$<1.0 \times 10^{-8}$
EPWR	$< 3.9 \times 10^{-7}$	$< 6.0 \times 10^{-8}$

2.4 NPP construction alternatives

As alternatives (considering a decision not to build the NPP as “zero” alternative), the opportunities are considered for generation of electric energy on up-to-date organic-fuel electric power plants in quantities, equal to that generated on the NPP.

Anthropogenic influence of the energetic objects upon the surrounding ambience possesses much forms. The effect of this may bring changes into the composition and characteristics of the atmosphere, as well as various changes, which are taking place in hydrosphere and lithosphere.

TES differ by consumption of primary power resource, from which characteristics considerably hang the conditions and the form of the station influence on the surrounding ambience.

Practically there are no objects, which completely do not influence upon the surrounding ambience. At the same time in no event it is possible to consider all objects of electric energetic branch as ecologically equal.

In principle there are different from the ecological point of view such types of primary sources of energy, as organic fuel, nucleus fuel, water power, solar energy, wind energy, energy of tide, waves, geothermal energy.

Demonstrative presentation about their relative ecological capacity give the estimations, provided in Table 7.

As may be seen from the data, provided in the Table, depending on the characteristics of primary energy resources, used for production of heat and electric power, the energy enterprises in different degree pollute the surrounding ambience by the remainder of its production.

The most "clean" production is realized at installations, using solar energy, wind, hydro resources and heat of geothermal wells. However the share of these sources in covering the need for energy is small, there is no trend of its growth in the nearest prospect, consequently, there are no grounds to expect, that development of the energy branch on the basis of these "clean" sources to some degree will reduce sharpness of the problem for protection of the surrounding ambience.

The greatest number of negative influence is connected with development and usage of the thermal electric station/ operating on organic fuel.

The TES, burning organic types of fuel, render influence on all spheres of the surrounding ambiences (the air, water, ground, vegetation and fauna). There are received determined dependencies between the level of contamination the atmospheric air and sickness rate of the population.

At the same time it should be born in mind, that the scales of this influence hang from the power of the TES, type and features of the burnt fuel, the level nature defending actions, the degree of technological perfection for the power station and many other factors.

To the main interaction of the TES with the surrounding ambience pertains consumption of fuel, water, oxygen of the air, change of the landscape, as well as any types of emission into all parts of the geosphere.

Together with the smoke gases of the TES into the air pool there are thrown hard and gaseous contaminators, amongst which there are such polluting materials, as ash, oxides of sulphur and nitrogen. Besides them into the air pool arrives big amount of carbon dioxide, which is absent in the list of the polluting materials, and water vapors.

Carbon dioxide and vapors of water enter into the atmosphere, they are included into the natural cycles and are absorbed by vegetation in the processes of the organic compounds synthesis and regeneration of oxygen. In this quality it is impossible to acknowledge these waste as harmful.

Table 7 - Main trends of the influence rendered from the electric energy objects on the surrounding ambience

Spheres and types of the influence	HES	TES using organic fuel	Fuel base of the TES	Transportation of the fuel for TES	NPP	Solar electric station	Wind electric station	Tide electric stations	Geothermal electric stations
Contamination of atmosphere with hard and gaseous materials	-	+	+	+	-	-	-	-	+
Contamination of atmosphere with radioactive particles	-	+	-	-	+	-	-	-	-
Contamination of the surrounding ambiences with heat emission	-	+	-	+	+	-	-	-	+
Contamination of the water wells	+	+	+	-	+	-	-	+	+
Contamination of the land	-	+	+	+	+	-	-	-	+
Usage of land resources	+	+	+	+	+	+	+	-	+
Usage of non-recoverable mineral resources	-	+	+	+	+	-	-	-	-
Usage of water resources	+	+	+	+	+	+	-	+	+
Usage of aerial resources (oxygen)	-	+	-	-	-	-	-	-	-
Influence of the radiation	-	-	-	-	+	-	-	-	-
Influence of the noise	-	+	-	+	+	-	+	-	+
Hotbed effect	-	+	-	-	-	-	-	-	-
Total amount of positions	3	24			9	2	2	2	7

However the scales for usage of the organic fuel and accordingly for emission of the carbon dioxide according to some estimations exceed the regeneration capabilities of the vegetable world. As the result in the atmosphere there is observed increase of the specific gravity of the carbon dioxide (of the carbonic acid gas), which creates hotbed effect, which leads to the total increasing of the temperature on the planet. In the opinion of many scientists, this may bring about a number of disastrous consequences possessing global scale, melting glacier inclusive, increasing the level of the world ocean and flooding enormous and the most made habitable coast territories of the ocean, to redistribution of precipitation and etc.

The TES emission, thrown into the atmosphere, pollute the soil and its vegetable cover. The main role in this phenomena belongs to some ingredients, being contained in the emission of the ash: quicksilver, lead, zinc, chromium, arsenic and others. Oxides of nitrogen and sulphur being present in the smoke of gases also may render negative action on the soil, particularly on the vegetable cover.

Contamination of the soil upper layer occurs under precipitation of the TES atmospheric emission directly on the ground, as well as the result of washing the polluting materials with atmospheric fallouts.

Damage of the vegetation in the region of the TES action is caused mainly by contact of the plants green parts with the polluting material, being kept in the atmospheric air, as well as deterioration of the ground quality. Together with that it is necessary to bear in mind, that plants possess different stability for contamination. The damages appear, when the contents of the polluting materials exceed the critical level for adaptation and the plants stability for the weather factors.

The TES influence on the land facilities first of all is conditioned by the need of bringing the lands for their construction. The difference in the size of bringing away the lands is defined mainly by the system of technical water supply aimed at the electric power stations. For electric power stations, working on coal, in addition there are arranged lands for ash remainders. Raising dust from the surfaces of the ash remainders worsens condition of the agricultural facilities adjoining to the electric power stations. That is why there are required special measures for prevention of their raising dust.

The radioactive materials, being kept in primary fuel (the contents natural radio nuclides may constitute 7,4 - 518 Bq/kg), are brought beyond the limits of the thermal electric station with hard particles (with ash remainders). They are deleted into ash slag, are scattered with smoke gases, are precipitated on the under laying surface and are involved into the biological cycle.

The negative influence of the TES is aggravated with the fact, that their work must be supplied with constant fuel mining (the fuel base), accompanied with additional negative influence on the surrounding ambience:

- by contamination the air pool, water and land;
- by consumption of land and water resources, by exhaustion of non-recoverable stock of fuel (the natural mineral resources).

Contamination the natural ambience also takes place at transportation of the fuel as in the manner of its direct losses, so and as the result of consumption of power resources for its transportation.

Thereby the TES, which is burning organic types of fuel, may disadvantageously affect practically all spheres of the surrounding ambiences and subject the nature to all considered type of the influence. Their direct influence upon the surrounding ambience very powerfully depends on the established ecological situation. For prevention of the TES negative influence it is obligatory to observe the standards for guarding the natural ambience and safety of the people.

The main influence on the surrounding ambience rendered by steam-and-gas and dust-and-coal electric power stations, being considered as alternatives for the NPP construction, will be connected with consumption of natural resources (the land, water, fuel, oxygen of the air), as well as with emission into the atmospheric air of the polluting materials, which are created at incineration of organic fuel. Except for this, the source of polluting materials emission, like the NPP, will be auxiliary productions, located on the territory of the station.

With the standpoint of the influence, rendered by modern electric stations (operating on organic fuel) to the surrounding ambience, the selected variants reflect the situation of maximum (dust and coal) and minimum (steam and gas) affect.

The following alternatives are considered:

– alternative 1: gas-and-steam electric power plant (heat power plant) with five power generating units, 450 MW each (total electric power of gas-and-steam power plant is 2250 MW);

– alternative 2: powdered-coal power plant with four power generating units, 660 MW each (total electric power of powdered-coal power plant is 2640 MW).

For both alternatives, the site chosen for the NPP construction is considered as the site for these power plants.

The results of the executed estimation for the influence, rendered by modern electric power station in the considered variants to the atmospheric air, the surface and underground waters, ground, vegetable and animal world, health of the population are indicative of ecological admissibility for their exploitation without negative consequences for the surrounding ambience under observance of all design solutions, since the received quantitative features, which condition the influence, do not exceed the stipulated standards and criteria, used as admissible:

- the fuel burning equipment observes the standards for contents of the polluting materials in the escaping smoke gases;
- maximum near ground concentrations do not exceed the MAC in the atmospheric air of the settlements and the maximum admissible concentrations for plants;
- the degree of contamination the atmospheric air corresponds to the admissible. Under admissible degree of contamination there is forecasted the background level for sickness rates of the population. The individual risk and the risk to the population health is valued as acceptable;
- precipitations of the polluting materials below critical loads, developed for natural ecological systems in Belarus.

However, in case of refuse from construction of the atomic electric power station, for production of the same amount of electric power, as the result of organic fuel incineration, annually, in addition to the existing emission, into the atmospheric air over the territory of Belarus there will be thrown polluting materials in volume 12,8 and 47 thousand tons/year accordingly in variant with steam-and-gas and dust-and-coal electric power stations.

Except for emission of the polluting materials into the atmospheric air will be thrown out the carbon acid gas (CO_2), with which there is tied manifestation of the hotbed effect, and there will be consumed large amount of oxygen from the air. It is expected, that in variant with steam-and-gas station for incineration of the fuel there will be required approximately 6,5 mlrd.m^3/year (9,3 million tonnes/ year) of the oxygen from the air. The CO_2 emissions will herewith constitute the volume approximately 6,5 million ton/ year.

Under conditions of construction for a dust-and-coal station there will be required approximately 9 mlrd.m^3/year (12,9 million tonnes/ year) of the oxygen from the air. Into the atmospheric air will be thrown CO_2 in the volume approximately 15 million tonnes/ year.

Herewith annually into the ash-slag remainder there will be taken away approximately 1,2 million ton of ash-slag materials.

The main ecological factors are shown in Table 8.

Table 8 - Consolidated table of the ecological factors according to EIA

Name of the factors	Dimensionality	Steam-and-gas TES	Dust-and-coal TES
Composition of the main equipment: - steam caldrons for high pres sure		10хП-96	4хПп-225-240-570/570

- steam caldrons for low pressure - steam turbines - gas turbines		4xE-50-1,4-250 5xK-150-7,7 10xV94,2	4xE-50-1,4-250 4xK-660-240 -
Total gross TES emission, as a whole, including: - SO_2; - NO_2; - NO; - CO; - ash of the fuel oil (V); - hard particles (ash of coal) ; - benzopyrene	t/year	12822,1 49,25 4045 657,3 8070,55 - - -	47018,76 10277,3 8213,6 1334,7 25654,5 0,12 1538,5 0,00007
Total gross emission of maximum allowable concentrations	t/year	50,64	50,64
Emission CO_2	million. t/year	6,5	15,2
Consumption of oxygen from the air	million. t/year	9,3	12,9
Maximum concentrations near the ground (with provision for background): - SO_2; - NO_2; - NO; - CO; - benzopyrene; - hard particles (ash of coal) ; SO_2+NO_2 SO_2+NO_2+NO+ ash of the fuel oil (V)	maximum allowable concentrations	 0,19/- 0,29/0,28 0,01/0,01 0,41/0,41 $<$0,01 - - 0,42	 0,29/0,23 0,5/0,5 0,03/0,03 0,45/0,45 $<$0,01 0,67/0,68 0,73 0,82
Radius of the influence zone	km	11	30
Area of the arranged lands, including:	hectares	59,6	210,18
- for ash-and-slam removal		-	112,08
Water consumption by TES, including:	thousand. m^3/year	75931,94	162019,35
- from the river Viliya;		75875	161898,9
- from artesian water extraction pipe (for domestic and drinking needs)		56,94	120,45
Water pouring by the TES including:	thousand. m^3/year	57811,64	124026,75
- into the river Viliya;		57379	123906,3
- into the domestic sewerage		432,64	120,45

End of Table 8

Water consumption of maximum allowable concentrations from artesian water extraction pipe	thousand. m^3/year	690,98	690,98
Water pouring of maximum allowable concentrations into the domestic sewerage	thousand. m^3/year	210,23	210,23
Number of the personnel	people	795	1898
Note – In the numerator there are specified maximum concentrations near ground within winter period (with provision for maximum allowable concentrations), in the denominator – the same in the summer period.			

The NPP has advantages over the alternative sources of energy:

- it does not use organic fuel for production of electric power;
- it does not pollute atmosphere with emission of hard particles (created by ash) and different gas-forming materials;
- it does not use oxygen of the air;
- it does not throw hotbed gases into the atmospheric air;
- it does not contaminate land and water facilities with ash-and-slam remainders;
- it does not serve as the source of spreading cancerigenic and even radioactive materials under normal usage (the emission is limited with allowable quota, radioactive waste is localized, concentrated and buried) ;
- there are absent such phenomena, as raising dust of ash remainders, contamination of atmosphere with products of combustion from ash-and-slam remainders;

Besides, the reduced use of organic fuel (natural gas) as the result of the NPP commissioning will result in reduction of discharges of hothouse gases to atmosphere by 16 – 24 mln. Tons, what complies with the requirements of the Kyoto Protocol to the UN Framework Convention about climate changes, dated December 11, 1997, signed by the Republic of Belarus.

Thereby, in respect of contamination of the air pool with usual chemical contaminators the NPP may be considered as ecological clean objects.

2.5 Project sources and purposes

As a result of comprehensive analysis of industrial reactor units, the Russian project, NPP-2006 of the third generation with water-cooled reactors (hereinafter the PWR), was chosen for the Belarusian NPP. The third generation reactors are reactors of increased security and reliability. This project conforms to modern international nuclear and radiation safety requirements. In the present century the world nuclear power industry will develop on the basis of the improved reactors of the third generation.

The advantage of NPP-2006 project is that in comparison with other projects the main equipment and security systems of NPP are already tested on operating NPPs. The nearest prototype of NPP-2006 project was putted into revenue service in 2007 in China (2 power supply units). 2 units upon the Russian third generation projects are in construction process now in India. The construction of 2 units in Bulgaria and 4 units in Russia is already started.

According to Russian legislation the supplied by Russian party nuclear fuel after its using in reactor could be accepted for long-term storage and follow on refinement on the territory of Russian Federation.

The target characteristics for the project safety system configuration are specified in Table 9.

Table 9 – Project targets

Required qualitative and quantitative safety level a) safety systems b) calculated probability of heavy damage of core for all initiating events c) calculated probability of limit radiation release in case of an accident beyond the design basis	 active and passive $\leq 10^{-5}$ per reactor annually $< 10^{-7}$ per reactor annually
Low susceptibility to human factor (errors, incorrect personnel decisions)	5.6×10^{-8}
Low susceptibility to failures of supply and control systems (failures of power supply or cooling water supply systems)	

These targets can be achieved as follows:

a) increasing of safety level by:

- improvement of characteristics of nuclear fuel and main equipment of reactor unit;
- development of improved safety systems, including active and passive systems;
- reduction of susceptibility to human errors;
- improvement of reliability of the NPP equipment operation;
- maximum consideration of experience in design and operation of power units with PWR, PWR-440 and PWR-1000;

b) improvement of economic characteristics by:

- reduction of capital investments per unit of power;
- reduction of operating costs;
- developmental approach in making technical decisions and selection of equipment to be used.

The principal differences of this project from existing NPP projects with PWRs from previous generations, offering an opportunity to achieve the before-mentioned targets, are:

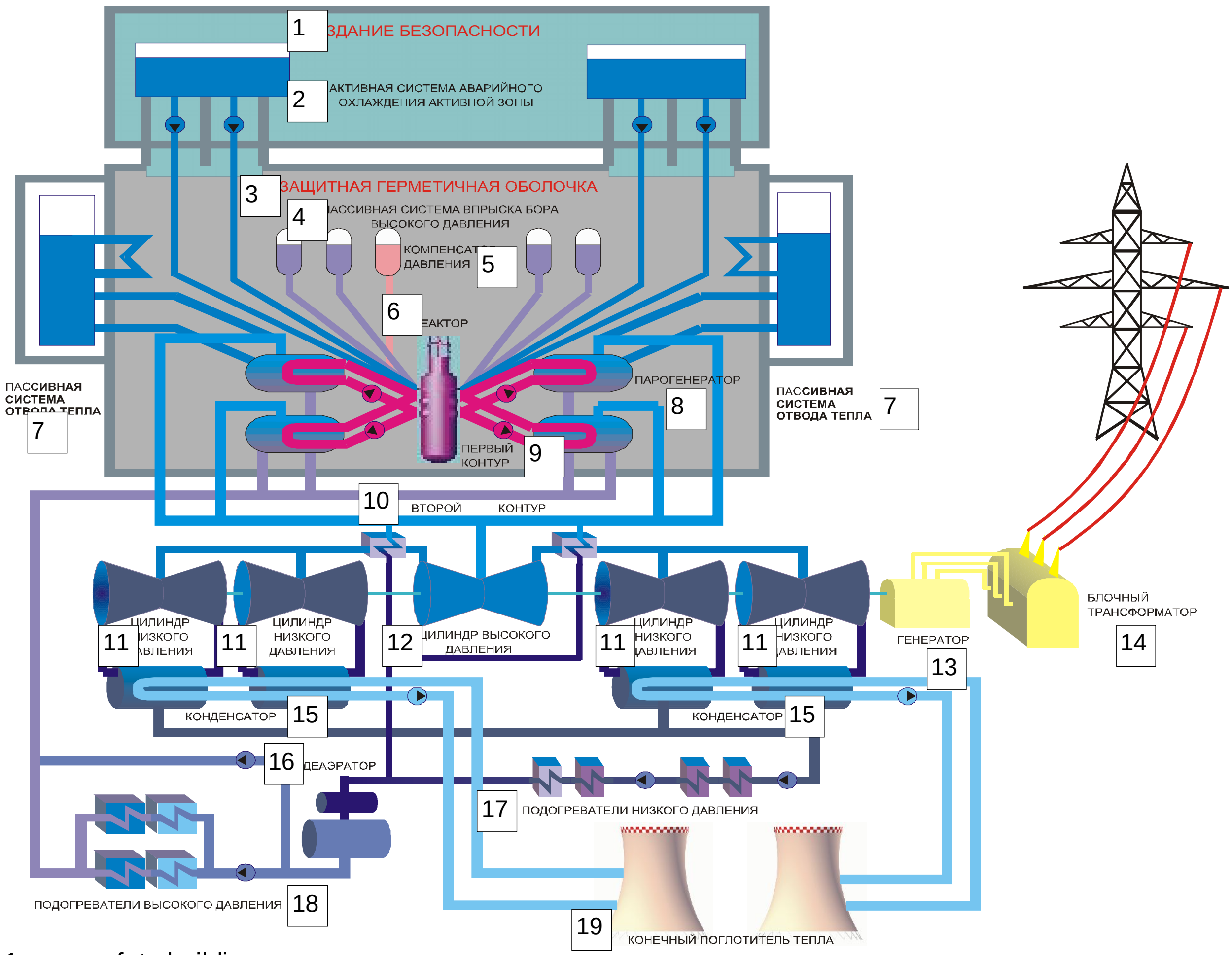
- quick termination of a nuclear reaction in a core by action of two fully independent reactivity control systems;

- removing of residual heat during a long time and keeping a reactor in a safe condition by operation of active and passive (i.e. not requiring any operator's intervention or external power supply) safety systems;

- using of double protective containment, stressed (internal) and solid (external), providing a wide range of internal and external events, for restriction of products in case of an accident.

The project is based on a developmental approach for application of technologies, assemblies, systems, and for consideration of experience in design, manufacturing and operation of NPPs of previous generation with PWRs (PWR-1000).

For the "NPP-2006" power unit process flowchart, see Figure 5.



1 safety building
2 active system for the core emergency cooling
3 hermetic protective containment
4 high-pressure passive boron injection system
5 pressure compensator
6 reactor
7 passive heat removal system
8 steam generator
9 primary cooling circuit
10 secondary cooling circuit
11 low-pressure cylinder
12 high-pressure cylinder
13 generator
14 unit transformer
15 condenser
16 deaerator
17 low-pressure heater
18 high-pressure heater
19 final heat absorber

Figure 5 – "NPP-2006" power unit process flowchart

Safety systems, both active and passive, are mounted in a reactor block. These systems include:

– active system of emergency core cooling;
– corium localization device;
– primary circuit;
– external protective containment;

– external protective containment;
– passive filtration system for inter-containment space;
– hydraulic reservoirs system;
– inter-containment space;
– system of passive removal of heat from a steam generator.

The reactor block building with sealed protective containments, safety systems buildings, electric systems and control systems, are designed to withstand external impacts, both natural and anthropogenic, including seismic impacts, floods, hurricanes and whirlwinds, airplane crash, shock waves etc.

The turbine room includes the turbine installation with the regeneration system, the water supply installation, the electric generator, the heating system boiler installation and other supplementary systems. It is designed to keep functional properties of the equipment during a period until a rated earthquake (with 100 years interval).

Figure 6 illustrates natural and anthropogenic impacts, that the reactor protective containment is designed to withstand, and their numeric characteristics.

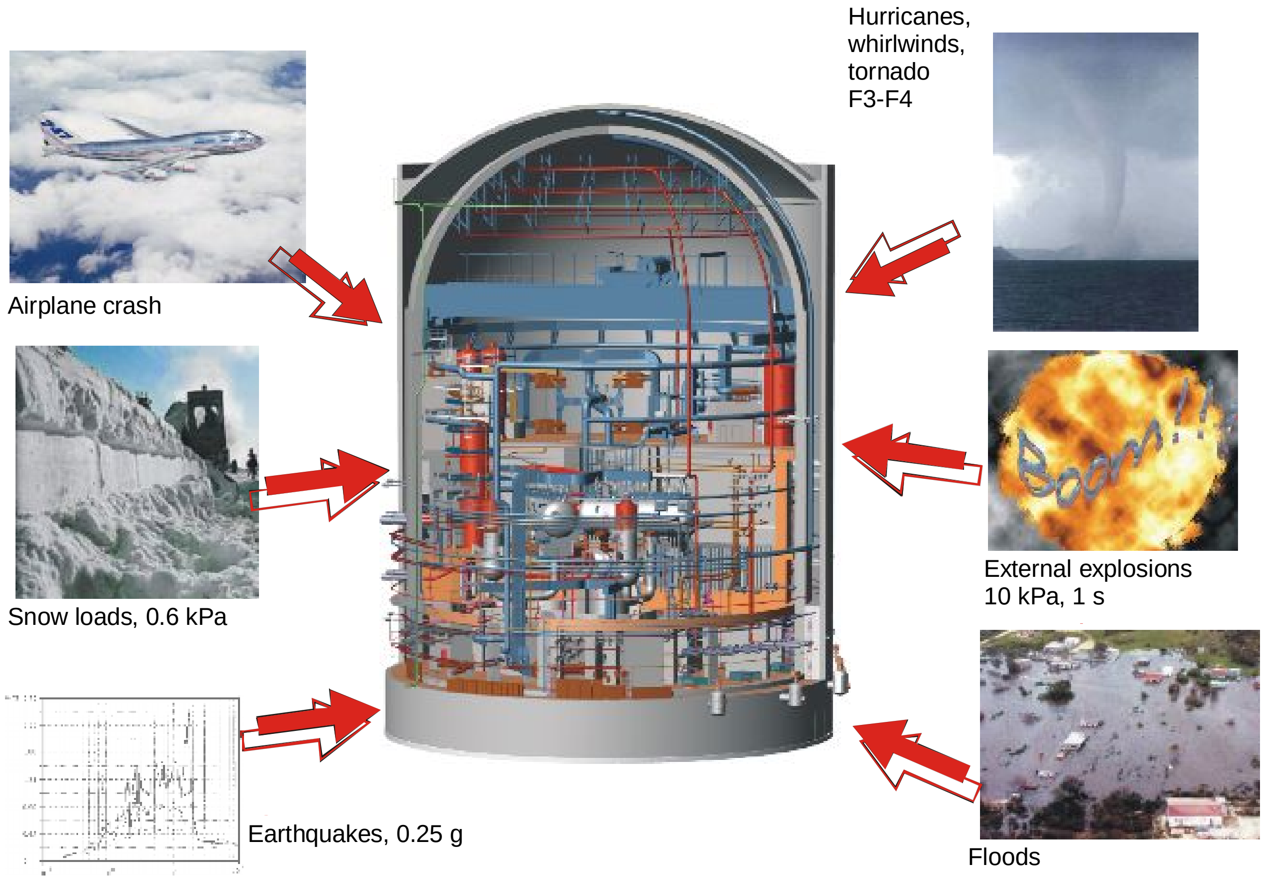
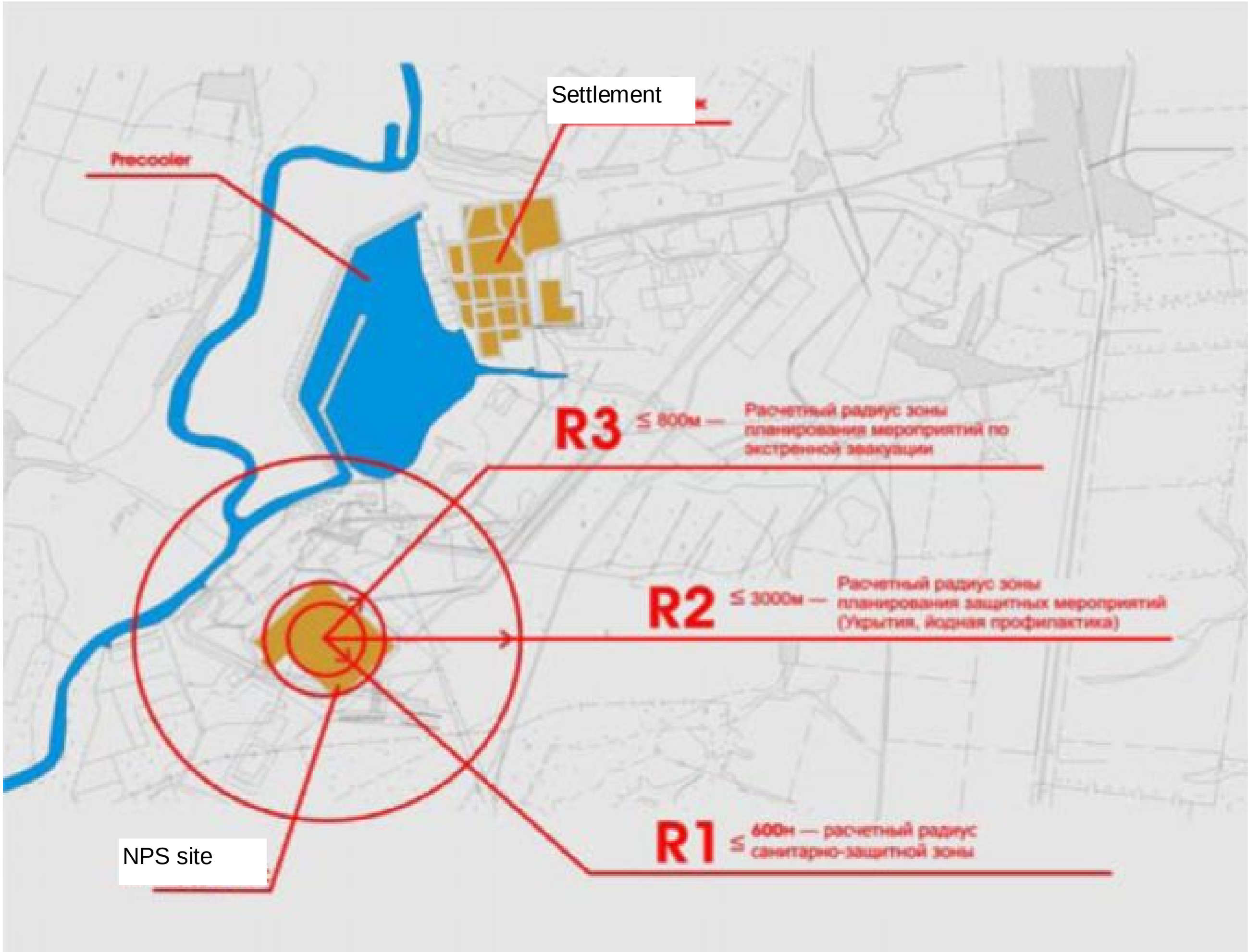


Figure 6 – Reactor protective containment



R1 ≤ 600 m	calculated radius of the sanitary protective zone
R2 ≤ 3000 m	calculated radius of the protective measures planning zone (shelters, prophylactic iodine taking)
R3 ≤ 800 m	calculated radius of the emergency evacuation planning zone

Figure 7– Zones for protective measures in case of an accident

Figure 7 is an illustration of zones, where, in case of an NPP accident, appropriate measures must be implemented. For example, calculated radius of the zone, where measures for emergency evacuation of population are planned in case of a severe accident, is within 800 m; it means that these measures are practically not required, because this zone is within the NPP territory.

The NPP-2006 project successfully combines positive experience of operating the equipment and systems of the existing NPPs. Essential progress in technology made it possible to approach a new safety level and simultaneously it improved economical features of the NPP-2006 project as compared with preceding projects.

2.6 Safety criteria and design limits for NPP 2006 project

Safety criteria and design limits must be specified in accordance with applicable normative documents, recommended by International Commission on Radiological Protection, and in accordance with IAEA recommendations. For dose burden design limits, specified in the NPP-2006 project in accordance with applicable normative documents, see Table 11 (in accordance with NRB-99 of Russian Federation).

Table 10 – Design limits for effective radiation dose

Name	Effective dose, μSv/year
Population, lower limit during normal operation of the NPP	10
Population, upper limit	100
Population, critical group on the sanitary protective zone border: whole body body organs, during the first year after an accident	 5000 50000
Acceptance criteria for design accidents: - in case of an accident with a probability more than 10^{-4} events/year - in case of an accident with a probability less than 10^{-4} events/year	 <1 mSv/event <5 mSv/event
Population, in case of an accident beyond the design basis, equivalent radiation dose for the critical group on the border of the protective measures planning zone: whole body body organs, during the first year after an accident	 5000 50000
Personnel (A group): any 5 years in succession during a year	20000 <50000
Personnel (A group), during normal operation: - average - average effective collective doze for one power unit (1000 MW, electric power) during preventive maintenance and other operations, during the whole design operation period	 <5000 0,5 man-Sv/year
Target annual limit for personnel on a control unit in case of accidents provided in the design	25000

During normal operation and in case of abnormalities in operation, annual liquid disposal of radioactive nuclides from a power unit to the environment (except for tritium), annual aerosol disposal of inert gases, aerosols and iodine isotopes must meet the requirements of “Sanitary regulations for design and operation of nuclear stations” SP AS-03, taking into consideration the EUR recommendations.

For the purpose of prevention of nuclear accidents, the design must match the criteria of nuclear safety; as a result:

- reactor core monitoring and control must be provided;
- local criticality during loading, transportation and storage of nuclear fuel must be prevented;
- fuel element cooling must be provided.

For operating limits and safe operation limits, specified by applicable norms and regulations, see Table 11.

Table 11 – Operating and safety limits

Name	Value
Permissible number of damaged fuel elements: “gas leakage”: - operating limit - safe operation limit	0.2% of fuel elements 1.0% of fuel elements
Permissible number of fuel elements with a direct contact between fuel and coolant: - operating limit - safe operation limit	0.02% of fuel elements 0.1% of fuel elements
Fuel elements cladding temperature	< 1200°C
Depth of local oxidation of fuel elements cladding	< 18 %
Proportion of reacted zirconium (% from zirconium weight in fuel elements claddings)	< 1 %
Number of damaged fuel elements in a core for accidents within the design basis: - probability more than 10^{-4} 1/year - probability less than 10^{-4} 1/year	 < 1 % < 10 %
Calculated total probability of heavy accident beyond the design basis for all initiating events, 1/year of reactor operation	< 10^{-6}

These operating limits and safe operation limits are specified with conservative safety factors, determined from the experience of operation of stationary and transport power installations, and taking into consideration IAEA recommendations.

As for consideration of international experience for NPP 2006 project and formulation of offers for the foreign market, the designer paid special attention to:

- IAEA recommendations and safety norms;
- publications (reports) of International Nuclear Safety Advisory Group (INSAG1 – INSAG12);
- European Utility Requirements for the projects of NPPs of new generation with LWR reactors (European Utility Requirements (EUR), Revision «C»).

2.7 Reactor installations: general information and equipment

The reactor installation (RI), PWR-1200, was designed on the basis of developmental improvement approach and direct application of reliable systems and equipment, that were in operation of other NPPs during a long time.

The materials for main equipment and pipelines are chosen in accordance with the requirements of applicable normative documents and on the basis of long-term experience of design, construction and operation of equipment for PWR reactor installations, considering that the NPP design service life is 50 years.

The reactor installation includes:

– primary cooling circuit and related systems;
– reactor vault equipment;
– secondary cooling circuit in a protective containment;
– transport section;
– automated process control system, including systems for monitoring, control, adjustment, protection, interlocking, alarm and diagnostics;
– heat insulation for the equipment and pipelines of the reactor installation;
– fasteners for protection of the equipment and pipelines against dynamic loads;
– equipment for maintenance and service;

– systems for the equipment and pipelines metal condition monitoring;

– systems providing control in case of an accident beyond the design basis and diminishing the consequences of such an accident, including the system for the core melt trapping and cooling.

For the basic rated parameters and specifications of the reactor installation, see Table 12.

Table 12 – Reactor installation basic parameters and specifications

Name	Value
Rated heat power, MWт	3200
Steam generator capacity (for feed water temperature 225°C, continuous blowing flow rate 15 t/hour), t/hour	1600+112**
Coolant flow through the reactor under rated duty, m^3/hour	85600±2900*
Absolute rated pressure on the core outlet in a stationary mode, MPa	16.2±0,3
Coolant temperature in the core under rated duty, ºC – inlet – outlet	 298.6^{+2}_{-4}* $329.7^{\pm 5}$*
Absolute pressure of generated saturated steam on the steam generator outlet under rated load, MPa	7.00±0.10
Humidity of generated steam on the steam generator outlet under normal operation conditions, %	≤0.2
Maximum linear fuel element rating, W/cm	420
Feeding water temperature under rated duty, °C	225±5
Fuel staying in the core, years	4-5
Maximum fuel burn-out, MW x day/kg U	70
Effective time of utilization of installed capacity during a year, hours	≥8400
Fuel assemblies in the core	163

* Must be determined more exactly during the reactor installation design.

** Maximum variation, resulting from variations in heat power values of steam generators.

2.8 Basic safety criteria and principles

The purpose of the NPP-2006 project was to provide conformance to main criteria and principles, resulting from applicable normative documents, concerning NPP safety provision during the stages of design, construction and operation. Several requirements were added to existing norms, including:

- IAEA recommendations for new reactors generations;
- decisions of international conferences concerning safety.

The decisive stage in development of NPPs of new generation is the technology design stage, based on the developmental approach, when, in combination with scientific and technical studies of problems, other approaches are also applied, including using of operation experience, probabilistic safety analysis, and reliability study results, primarily, from the point of view of heavy accidents control, for the purposes of decisive reduction of radioactive emissions to the environment. As a result, main characteristics, related to safety, were formulated:

- prevention of abnormalities in operation, requiring intervention of safety systems. Reliable structures are preferable, with high thermal inertia and increased differences between rated values of operating parameters and settings for safety system operation;

- minimization of general-cause failures and dependent failures by selection of appropriate decisions in design and layout, and by backing-up safety functions;

- multifunctional emergency reactor cooling system, based on application of several different principles of main safety functions and on combination of passive and active channels. The system provides probability of core damage (beyond the limits, specified for the accidents within the design basis) not more than 10^{-6} for one reactor annually;

- accident products localization system, based on containment, designed with a provisions for keeping the accident products, in case of severe accident, within maximum permissible emission parameters for most significant dose-making nuclides;

- reduction of irradiation doses by appropriate design, materials, protection and layout.

2.9 Protection in depth principle

The principle of protection in depth is implemented by making of series of barriers (fuel matrix, fuel cladding, primary cooling circuit borders, localization system), that must be protected and, in turn, any harm for human or environment must be possible only in case of overcoming all these barriers. These barriers may be intended for operation and safety purposes or for safety purposes only. For an outline of this protection principle, see Figure 8.

1 Protection in depth
2 Barriers, preventing fission products from emission to the environment
3 Fuel matrix
Prevention of fission products from emission to the space under the fuel element cladding
4 Fuel element cladding
Prevention of fission products from emission to the coolant in the main circulation loop
5 Main circulation loop
Prevention of fission products from emission to the space under the hermetic containment
6 System of hermetic protective containments
Prevention of fission products from emission to the environment

Figure 8 – Protection in depth

2.10. NPP structure. Main equipment.

NPP structure.

All the objects of the NPP are functionally subdivided into the main objects and the auxiliary and servicing objects.

The main objects include:

–the basic buildings and constructions of the power unit No 1;

–the basic buildings and constructions of the power unit No 2;

–the electrotechnical constructions;

–the cable trenches and tunnels of the power units No 1 and No 2 along the territory of the

–the platforms and canals of the technological pipe-line along the industrial area;

–the constructions of the technical water supply.

The remaining objects are parts of the auxiliary and servicing objects.

The basic buildings and constructions of the power unit include the buildings and constructions of the nuclear island and the buildings and constructions of the non-nuclear (turbine) island.

The power unit consists of the reactor plant and one turbine installation.

The first circuit is formed by the reactor, the main circulation loop, the main circulation pump, the pipe area of the steam generator.

The water-cooled power reactor is the heterogenous warm neutrons reactor. The heat-carrier and the retarder is water with the boric acid solution as an absorber. The estimated period of the reactor casing service is 60 years while the estimated period of nuclear power plant service is 50 years.

A weakly-concentrated uranium dioxide is used as nuclear fuel.

The heat-carrier of the first circuit, passing across the active reactor zone, is heated, and along the main circulation pipe-line of the four parallel circulation loops comes to the pipe still of the steam generator (SG) where it gives its energy to the second circuit. The heat-carrier from the steam generator returns to the reactor for the repeated heating along the main circulation pipe-line. The circulation in the loops is carried out by means of the four main circulation pumping unit (MCPU).

The second circuit is not radioactive. It consists of:

–the steam-producing part of the steam generators;

–the steam pipe-lines of the fresh steam;

–the turbine;

–the condensate removal pumps;

–the system of the regenerative heaters;

–the deaerator;

–the system of the supplying pumps and pipe-lines.

The turbo plant provides the conversion of the heat energy into the mechanical energy of rotating the turbine rotor. The generator, set on the same shaft as the turbine rotor, converts the mechanical energy of the rotor rotation into the electric energy.

The orientation list of the main equipment is given in the table 13.

Table 13 – The orientation list of the main equipment

Name	Quantity
The main equipment of the systems of the normal operation	
The main equipment of the first circuit	
The reactor	1
MCPU	4
The steam generators	4
The pressure compensation	1
The main equipment of the second circuit	
The turbine	1
The condensation plant	1
The condensation pumps of the 1st level	3
The condensation pumps of the 2st level	3
The separator steam superheater	4
The supplying pump	5
The auxiliary supplying pump	2
The deaerator of the increased pressure	1
The system of the turbo plant lubrication	1
The system of supplying the oil to the regulation system	1

2.11. General layout.

The general plan of the Belarusian nuclear power plant will be developed for two energy units with RI PWR-1200.

The orientation of the units will be determined by the technical solutions on the systems of the technical water supply of the main equipment of the buildings of the turbines and the responsible consumers of the reactors buildings, and also by the conditions of the electric power output.

When arranging the general plan, the following requirements will be taken into account:

– providing the maximum autonomousness of the power units (the nuclear island);
– the modular principle of building on the industrial area with the unified modules of the power units;
– the zoning of the territory on the buildings of the main production purpose and the auxiliary buildings, and dividing the territory into the zones of “strict” and “free” regime;
– the optimal blocking of buildings and constructions of the main production, and also the auxiliary production buildings and constructions;
– providing the straight main routes (corridors) for laying out the engineering communications;
– reducing the technological, transport and pedestrian communications.

2.12. Fuel handling and storage.

The fresh fuel, designed for loading the reactor, will at first pass to the storage of the fresh fuel.

The capacity of the storage of the fresh fuel is determined in the quantity required for the normal loading of the two reactors (with the reserve of 20 per cent) and the full starting loading of the reactor (with the reserve of 10 per cent).

All the spent fuel will be kept under the cover in the building of the reactor. The capacity of the storage – the basin of the spent fuel – will be sufficient for keeping the spent fuel during ten years of the operation of the station. Besides, there will be provided the place for the emergency fuel unloading of the active zone.

In accordance with Russian legislation the spent nuclear fuel, after three years of keeping in the basin of the spent fuel, may be removed from the building of the reactor of the energetic unit to the factory of regenerating the nuclear fuel or for long-term storage.

The loading and unloading of the fresh cassettes out of the casings into the shelves and into the reactor, and also the spent cassettes out of the shelves into the transport container will be performed by the reloading vehicle.

The transportation of the nuclear fuel along the territory of the nuclear power plant is planned to perform by a specially equipped motor-vehicle transport.

The fresh fuel is to be transported to the NPP in plant-made sealed special transport containers. The disposed nuclear fuel is to be removed to processing plants or to the supplier-country of the nuclear fuel in special shipping packaging sets (SPS).

2.13. Radioactive waste handling.

2.13.1. Gaseous radioactive waste handling systems.

The system of refining the radioactive gas is aimed at reducing the activity of the gas blow-out caused by the blowings out of the technological equipment up to the admissible limits.

The system of refining the gas blowings out of the tanks of the auxiliary systems is designed for limiting the activity of the gases blown – out into the atmosphere, caused by the technological blow – out from the tanks of the system, up to the admissible limits.

2.13.2. Systems for collection and treatment of liquid radioactive substances and for processing and storage of liquid radioactive waste.

When the nuclear power plant operates, the liquid radioactive substances, which are liable for collection and refinement, are produced, and hence liquid radioactive waste are formed.

A number of the technical solutions will be adopted in order to minimize the formation of the volumes of the liquid radioactive waste and reducing their salt content:

–the separate collection of the radioactive substances depending on the activity, the salt contents and the chemical composition, the use in the technology of special water treatment “SWT” of the ion-selective sorbents;

–the application of the small-waste methods of the deactivation and the moving modular plants for deactivation;

–the refuse from the regeneration of the filters of refining the low-salt middle-active waters;

–the use of the refined circuit water only for feeding the 1st circuit.

In the process of operating the plants for the retreatment of the liquid radioactive waste and the plants of special water treatment “SWC”, the liquid radioactive waste – the cube still remnants of the evaporation plant, the pulps of the spent ion-exchanging resins and the spent ion-selective sorbents and slimes-are produced.

For the intermediate storing and the subsequent retreatment of the liquid radioactive waste, it is planned to use the following systems:

–the system of the intermediate storing of the cube remnants and the spent sorbents;

–the system of condensing and hardening of the liquid radioactive waste with the preliminary concentrating.

The system of the intermediate storing of the liquid radioactive waste provides the keeping of the liquid radioactive waste in reduce the radioactivity level by the decay of short-term living radionuclide.

In order to receive the hardened product for the burying, the system of hardening the liquid radioactive waste will be provided. The provides the capability to concentrate the cube remnants by mixing them with the cement and packing the cement compound into the concrete irrevocable protective containers.

The irrevocable protective containers are designed for the temporary storing of the radioactive nuclear waste at the territory of the nuclear power plant and for the further transporting them for the long-term storage.

2.13.3. Solid radioactive waste handling system.

The solid radioactive waste (SRW) include:

– the contaminated disassembled equipment, the pipe-lines and the fittings that are not liable for the repair;
– the contaminated instruments;
– the overalls, foot-wear, the individual protection means that are not liable for deactivation;
– the construction and heat-isolating materials;
– the filters of the systems of gas refining and ventilation;
– the hardened liquid radioactive waste, and etc.

The system of collecting, transporting, conditioning and storing the SRW operates when it is required in the mode of the operation of the energetic units of the nuclear power plant during the period of the technical servicing or the routine repairs of the equipment, and also during the periods of the stoppage of the energetic units for reloading the fuel and for performing the repairs.

The designing and operating of the systems of handling the radioactive waste is based on the IAEA recommendations and the international practice of designing (EUR, version “C”).

The total amount of the SRW, taking into account their retreatment (pressing, cutting), of the energetic unit in a year is approximately 60m^3 and make up:

–the low-active waste – 76 per cent out of the total amount of the SRW;

–medium-active waste – 23 per cent out of the total amount of the SRW;

–highly-active waste – 1 per cent out of the total amount of the SRW.

When operating the nuclear power plant, the hardening of the liquid radioactive waste is performed; in the result the low-active and medium-active radioactive waste are formed. Their volume makes up nearly 30 m^3 per year per a unit. The collecting and sorting of the low-active and medium-active SRW is performed taking into account the level of their activity and the methods of the retreatment at the locations of their forming by means of loading the waste into the corresponding containers.

The collecting of the highly – active SRW is performed during the stoppage of the energetic unit when conducting of preventive works (CPW) are carried out by means of the special equipment.

The delivery of the solid radioactive waste to the location of the storage of the solid radioactive waste (SSRW) for conditioning and placing for the temporary storing is provided by means of the standard load-lifting mechanisms and special transport vehicles.

In future the SRW will be buried in a regional storage of radioactive waste (RSRW) which is going to be designed according to another order, and this issue is not considered in the given report on EIA.

3. NPP ENVIRONMENTAL IMPACT TYPES.

Below is the nuclear power plant with the reactor with water under the pressure of "PWR – 1000", having the total efficiency of nearly 33 pct. The main units of the action of the reactor "PWR" are shown in Fig.9.

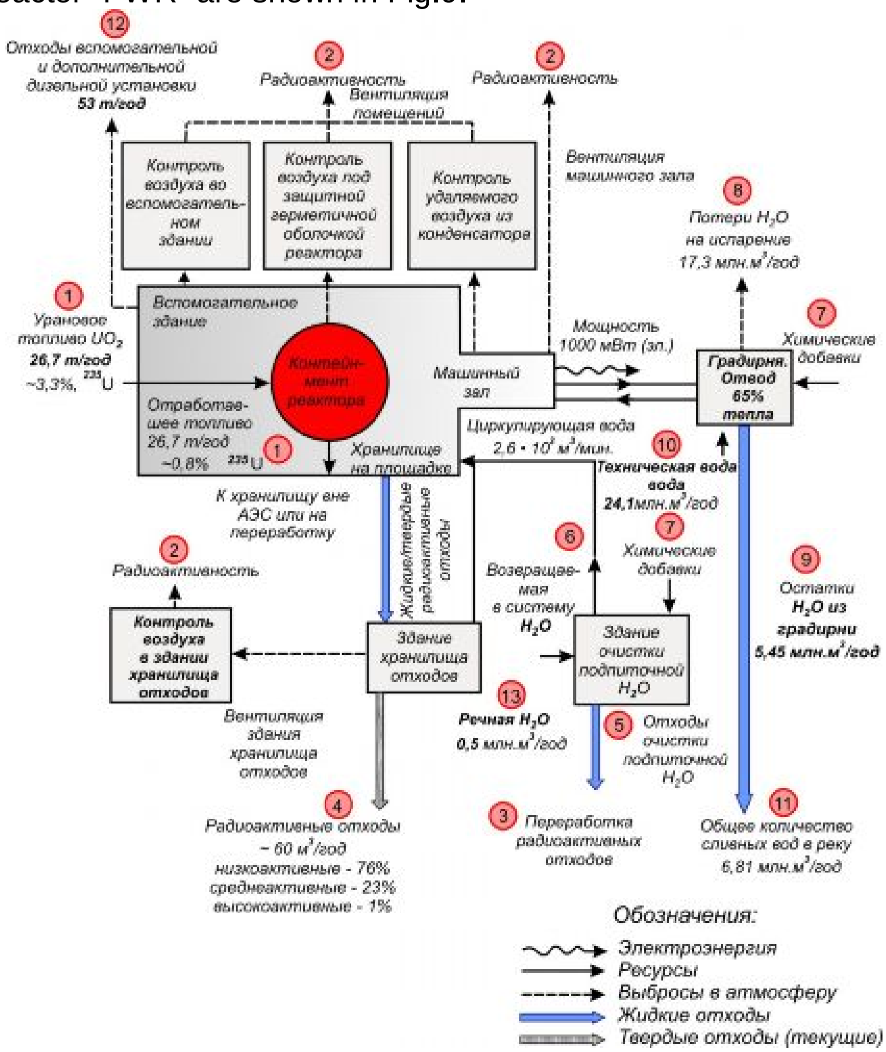


Fig.9 – The units of the action of the reactor "PWR" upon the environment

Отходы вспомогательной и дополнительной дизельной установки – 53 т/год	The waste of the auxiliary and additional diesel installation – 53 t per a year.
Радиоактивность	The radioactivity.
Радиоактивность	The radioactivity
Вентиляция помещений	The ventilation of the locations.
Контроль воздуха во вспомогательном здании	The check of the air in the auxiliary building.
Контроль воздуха под защитной герметичной оболочкой реактора	The check of the air under the protective airtight cover of the reactor.
Контроль удаляемого воздуха из конденсатора	The check of the removed air from the condenser.
Вентиляция машинного зала	Ventilation of the machine location
Потери H_2O на испарение 17,3 млн.м^3/год	The losses of H_2O in the evaporation 17,3 mln. m^3 per a year.
Урановое топливо UO_2 26,7 т/год ~3,3%, ^{235}U	The uranium fuel UO_2 26,7 t per a year ~ 3,3 per a cent ^{235}U.
Вспомогательное здание	The auxiliary building.
Контейнмент реактора	The reactor containment.
Машинный зал	The machine location.
Мощность 1000мВт (эл.)	The power 1000 MWatt (el.).
Градирня. Отвод 65% тепла	The cooling tower. The lead-away of 65 per cent of heat.
Химические добавки	The chemical additions.
Отработавшее топливо 26,7 т/год ~0,8% ^{235}U	The spent fuel 26,7 t per a year ~ 0,8 per cent ^{235}U.
Хранилище на площадке	The storage at the ground.
Циркулирующая вода 2,6 * 10^3 м^3/мин.	The circulating water 2,6*10^{3}m^3/min.
К хранилищу вне АЭС или на переработку	To the storage out of the nuclear power station or for the retreatment.
Жидкие/твердые радиоактивные отходы	The liquid/solid radioactive waste.
Возвращаемая в систему H_2O	The returning H_2O to the system.
Техническая вода 24,1 млн.м^3/год	The technical water 24,1 mln. m^3 per a year.
Химические добавки	The chemical additions.
Радиоактивность	The radioactivity.
Контроль воздуха в здании хранилища отходов	The check of the air in the building of the storage of the waste.
Здание хранилища отходов	The building of the storage of the waste.
Вентиляция здания хранилища отходов	The ventilation of the building storage of the waste.
Здание очистки подпиточной H_2O	The building of the decontamination of the additional H_2O.
Остатки H_2O из градирни 5,45 млн.м^3/год	The remainders of H_2O from the cooling tower 5,45 mln. m^3 per a year.
Речная H_2O 0,5 млн.м^3/год	The river H_2O 0,5 mln. m^3 per a year.
Отходы очистки подпиточной H_2O	The waste from the refining of the additional H_2O.
Радиоактивные отходы ~ 60 м^3/год Низкоактивные – 76% Среднеактивные – 23% Высокоактивные – 1%	The radioactivity waste 60 m^3 per a year, low-active – 76 per cent, medium-active – 23 per cent, highly- active – 1 per cent.
Переработка радиоактивных отходов	The retreatment of the radioactivity waste.
Общее количество сливных вод в реку 6,81 млн.м^3/год	The total quantity of the bleed-off water into the river 6,81 mln. m^3 per a year.
Обозначения: Электроэнергия Ресурсы Выбросы в атмосферу Жидкие отходы Твердые отходы (текущие)	The notations: The electrical energy. The resources. The blow-out into the atmosphere. The liquid waste The solid waste.

The units, critical in their influence upon the environment, are marked by the circle in the Fig. These units are the main sources of the radioactive and non- radioactive blows-out, and also the main consumers of the fuel and water resources. The waste storages, where the systems of treatment of gaseous, liquid and solid radioactive waste are located, the building of the system of the addition, where there is the system of refining the water, the cooling tower – are of special interest.

The corresponding numbers of units, critical by their influence on the environment, designate in the figure the following objects:

Unit 1. The need in the uranium and the placing of the spent fuel. For loading the active zone about 80 t of UO_2 fuel is required. One third of this amount is loaded during the loading. The cyclic recurrence of the loading is determined by the fuel cycle – 12,18 or 24 months. The off-loaded spent fuel is then stored at the nuclear power plant in the basin of keeping the spent fuel. The activity of the spent fuel after unloading is about 10^{20} Bk. After the three year stay in the swimming-bath the burnup nuclear fuel in shipping containers will be transported from the power block building to the nuclear fuel reconditioning plant.

Unit 2. The annual admissible blows-out of the radioactive gases and aerosols. The reason of the gaseous blows-out of the nuclear power plant is the outflow across the looseness's of the units and getting the gaseous products of splitting into the heat-carrier of the first circuit. These gases are removed out of the heat-carrier, and after the corresponding treatment pass into the environment across different filters. The refining systems, used in the projects, provide the 99 per cent refinement from the organic forms of the iodine, the 99,9 per cent refinement from the aerosols. Their concentration in air chimney emission doesn't exceed value of the maximum allowable concentration.

Unit 3. The liquid radioactive drops of the activated products of the corrosion and tritium.

Unit 4. The expected activity of the low-active solid radioactive waste makes up about $2*10^{14}$ Bk per a year.

Unit 5, 6, 8-11 and 13. These units mark the drains of non-radioactive water and effluent waters of the enterprise.

Unit 7. In the make-up water treatment building the different chemicals are added into the river water before the water is used at the station. These chemicals are necessary for the refinement, demineralization, stabilization, control pH of the purified water. Their amounts differ for different stations depending on the quality of the river water.

Unit 12. Products of organic fuel combustion are formed at the nuclear power plant in relatively small quantities. SO_2, NO_x, CO and their compounds will be formed during operation of diesel power plants and the start-up and standby boiler plants.

Thus, in the period of the operation and removing from the operation, in the area of the location of the nuclear power plant the following kinds of influences will be fixed:

–the heat influence connected with the operation of the systems of cooling the technological equipment of the nuclear power plant (the spaying basins and the cooling towers);

–the chemical influence caused by the use of the chemicals in the technological processes of the nuclear power plant, by the operation of the systems of refining, the preparation of water, etc.

–the electromagnetic influence, the sources of which may be high-voltage line, the high voltage equipment;

–the noise influence;

–the radiation influence.

3.1 Physical and chemical types of impact

3.1.1 Thermal impact

In case of the circulation water cooling circuit – with the use of cooling towers and spraying pools – thermal contamination will be insignificant and it will not practically influence atmospheric processes.

For power blocks of water-water reactors PWR-1200 a circulating cooling systems is stipulated at the NPP site along with evaporating cooling towers when fresh water is used along with the respective procession. In total, two cooling towers are located at the site of two cooling towers. Technical water will be supplied to cooling towers from Viliya-river for replenishment of losses for evaporation and discharge of liquid and drop moisture.

The total overheating of the steam and water mixture in relation to the ambient atmosphere is equal to about 10 ^{0}C, the total volume of evaporated moisture discharge from every cooling tower is equal to ~ 2000 m^3/h, and liquid-drop discharge – 3.5 m^3/h. Such structures will change the microclimate of the terrain. The thermal discharge to atmosphere from one power block of PWR – 1200 will constitute less than 2000 Gcal/h.

Operation of the cooling tower is accompanied with formation of steam condensate torches, and their spreading in atmosphere may result in changes of air temperature, fog formations, drizzling precipitations, higher probability of icy conditions in the zone of torch existence.

Torch sizes, terms of its spreading and the character of influence depend on peculiarities of the microclimate in the region and very low temperatures, horizontal sizes of torch saturation have the biggest importance.

Discharge of water drops from the cooling tower nozzle is accompanied with precipitations from the windy side. The adopted design of water catchers makes it possible to reduce the drop discharge by 0.002 % of the full consumption per cooling tower.

Intensity of precipitations, as well as the area of their spreading depend on wind velocity and direction. In case of weak and middle winds intensity of precipitations is maximal near the cooling tower, and they are sharply reduced at long distances, small precipitations can be observed at the distance of 1-3 km.

The performed analysis shows that fog formation and drizzling precipitations near cooling towers can promote formation of icy conditions during the winter time on parts of civil structures, overhead power supply lines, roads. Being so, the microclimate can slightly be changed due to moisture and heat removal from the torch action area.

Intensity of deposition increases along with growth of relative humidity, and being so, if at humidity of 80% maximal values of deposition constitute about 230 mg/(m^2day), at f_{2M} = 90 % - these values will be equal to 340 mg/(m^2 day). Being so, the maximal values can be observed at the distance of 1 - 3 km from the cooling tower.

Water component deposition is only essential in the closest 1-2 km area by varying from several thousandth to hundredth of millimeters per day.

The principal technological scheme of water treatment for feeding the circulating systems with spraying pools:

– removal of coarse disperse admixtures at meshed filters of preliminary cleaning;
– straight current coagulation;
– removal of suspended substances and organic admixtures at the ultra-filtration unit;
– acidification with sulfuric acid for destruction of bicarbonates;

– removal of disperse particles at cartridge filters;
– water demineralization at the reverse osmosis unit.

Additional cleaning of demineralized water for replenishment of losses in NPP contours after installation of the reverse osmosis is to be performed according to the following scheme:

– hydrogen zeolite softening in counter-current filters;
– carbon acid removal in decarbonizers;
– anioning in 2-chamber counter-current filters;
– profound demineralization and desiliconization of water in mixed filters.

Capacity of a water preparing unit for demineralized water for feeding the spraying pools of two power blocks of the NPP - 174 m^3/h.

Demineralized water has contents of salt 73 mg/l, alkalinity 0.04 mg-eq/l, contents of chlorides 40.7 mg/l, contents of sulfates 1.8 mg/l, suspended substances are missing. The obtained composition of feeding water allows to fulfill the requirements to water quality of circulating systems with spraying pools with the estimated steaming factor in spraying pools К =1,53 – 1,68 depending on the season.

Capacity of a water preparing unit for replenishment of losses in NPP contours of one block – 90 m^3/h.

3.1.2 Chemical impact

Chemical impact on atmosphere, water environment and soil can be caused by chemical components and substances included effluents and discharges.

Sources of chemical impact on atmosphere include gaseous discharges during operation of the process equipment via ventilation systems and chimneys.

A starting stand-by boiler plant is the main source of these discharges. It provides 85-90% of total annual discharges from the NPP.

The aforesaid discharges contain chemicals and components causing the harmful impact on the environment. Majority of sources are operated in the periodic mode, and therefore the quantity of gross annual discharges is small.

Sources of non-radioactive impact on the air environment is shown in table 14.

Table 14 – Sources of chemical impact on the environment

Source description	Operation mode	Main harmful components of discharges
1 Starting and stand-by boiler plant	Periodical	NO_x, $S0_2$, CO, fuel oil ash recalculated to vanadium, soot
2 Oil and fuel oil facilities	Periodical	Hydrocarbons
3 Stand-by diesel boiler plants	Periodical	NO_x, $S0_2$, CO, soot
4 Centralized repair shop	Periodical	Welding aerosol, non-organic dust containing less than 70% of SiO_2

5 Repairing and construction enterprisee	Periodical	Non-organic dust containing SiO_2 less and more 70 %, wood dust, NO_x, $S0_2$, CO, soot
6 Automobile transport facilities	Permanent	NO_x, SO_2, CO, soot, hydrocarbons, sulfuric acid, toluene, ethanol, acetone, petrol, kerosene, etc.
7 Residential and communal department	Periodical	CO, NO_X, wood dust. manganese, welding aerosol, hydrocarbons
8 Complex of procession of solid radioactive wastes	Periodical	$C0_2$, NO_x, $S0_2$, HCl.

Harmful components of chemical discharges to atmosphere from NPP sources are:
- dust;
- sulfur dioxide (sulfuric anhydride);
- carbon oxide;
- nitrogen dioxide;
- ammonia;
- benzol;
- xylene;
- toluene;
- phenol;
- manganese and its compounds;
- anhydrous hydrogen;
- soot;
- sulfuric acid vapours.

All data regarding discharges from sources at the industrial site of the NPP with water-water reactor PWR-1000 (two blocks) are shown in table 15.

Table 15 - Estimated values of total gross discharges to atmosphere

Harmful substance description	Estimated value of gross discharge, t/year	Agreed value of gross discharge, t/year	Actual data, t/year
1 Nitrogen dioxide	2,2912	44,178	14,557
2 Sulfuric anhydride	15,6727	1120,74	343,648
3 Carbon oxide	25,900	250,396	90,133
4 Soot	0,1595	7,348	2,487

5 Non-organic dust containing more than 70% of SiO_2	4,0174	3,370	1,097
6 Non-organic dust containing SiO_2 20% to 70 %	14,9195	14,074	3,010
7 Non-organic dust containing less than 20% of SiO_2	5,9511	4,252	4,252
8 Wood dust	7,583	2,689	2,678
9 Abrasive dust	0,4512	0,154	0,154
10 Emulsol	0,00653	0,004	0,004
11 Ammonia	0,0008	0,0008	0,001
12 Manganese and its compounds	0,0103	0,00697	0,007
13 Kerosene	0,00405	0,00413	0,004
14 Limit hydrocarbons C_{12}-C_{19}	2,577	2,577	2,577
15 Fluorides, gas. Compounds	0,00262	0,0016	0,002
16 Welding aerosol	0,06775	0,045	0,045
17 Benzol	0,00192	0,019585	0,002
18 Xylene	0,001	0,00927	0,001
19 Toluene	0,612	0,6124	0,597
20 Naphthalene	0,0000817	0,0025	0
21 Phenol	0,0000327	0,0010	0
22 м-Cresol	0,0000327	0,0010	0
23 Ethanol	0,2610	0,2614	-
24 Butylacetate	0,1460	0,1455	0,146
25 Acetone	0,2150	0,2148	0,215
26 Petrol	5,5955	5,1867	5,368
27 Sulfuric acid	0,001	0,0061	0,001
28 Solvent-naphtha	0,204	0,2038	0,204
Total	84,890	1461,78	472,907

This table shows that the total actual gross discharges do not exceed the agreed values.

The permanent control has been established over the quantity of discharges at the plant.

3.1.3 Liquid discharges to the environment

Production and household waste waters undergo cleaning and respective treatment. Purified and treated waste waters are used in the technological cycle and they are not disposed to water pools of the general use. Chemical impact on the soil may take place due to deposition of chemical components and compounds from atmosphere. Table 16 shows sources of effluents and description of their impact on the environment.

Table 16 — Sources of effluents and description of their impact

Description of the source	Type of impact	Impact result

1 Main building. Block desalting units	Discharge of regeneration waters	Practically no impact, as after neutralization these waters are discharged to the river.
2 Main building. Premises in the free mode area	Discharge of oily waste waters	No impact, as oils and petroleum products are cleaned, and seized contaminations are combusted.
3 Main building. Equipment and mechanisms cooling system	Discharge of cooling water	No impact as there are no harmful components in the cooling water
4 Stand-by diesel power stations	Discharge of cooling water	No impact as cooling takes place along the closed contour
5 Water purification system	Discharges from shower rooms and special laundry	No impact as cleaning and radiation control take place
6 Starting and stand-by boiler plant	Discharge of rinsing and blowing waters, cooling water, leakages	No impact, as slag and petroleum products are removed
7 Oil, fuel oil and diesel fuel facilities	Discharge of cooling water, storm waters contaminated with petroleum products, clean condensate and condensate contaminated with	No impact as cleaning and control take place
8 Nitrogen and oxygen unit	Discharge of cooling water	No impact as water cooling takes place along the closed contour
9 Compressor units at the industrial site	Discharge of cooling water	No impact as water cooling takes place along the closed contour

10 Automobile transport company	Discharge of production waste waters from washing automobiles	No impact as they are cleaned in recirculation water supply circuits
11 Desalting unit. Feeding of thermal circuit, feeding of the cooling system of consumers of “A” group	Discharge of blowing and regeneration waters	Practically no impact, as blowing waters of clarifiers are returned to the chemical water treatment cycle after slag deposition, and regeneration waters are discharged to the river after neutralization.
12 All production premises with permanent of staff staying	Household waste waters	No impact at they undergo complete biological treatment and additional treatment in ponds.
13 Industrial site territory	Storm water wastes	No impact as they are cleaned and returned to chemical water treatment

The sources of formation of liquid non-radioactive wastes are:
- production processes related to the use of water (production wastes);
- household and storm water wastes;
- blowing of the closed (recirculating) technical water supply system

3.1.3.1 Production wastes

1) Chemical water treatment

A desalting unit is operated at the NPP for water treatment for feeding up the NPP cycle and a water treatment unit for feeding up the responsible consumers and feeding up the thermal circuit.

The water treatment scheme for cycle feeding up: lime pretreatment and coagulation in a clarifier – clarification at mechanical filters – three-stage desalting.

Capacity of the desalting unit during operation of two power blocks -145 m^3/h.

The water treatment circuit for responsible consumers and feeding up the thermal circuit: lime pretreatment and coagulation in a clarifier, clarification at mechanical filters, acidification of clarified water with sulfuric acid, filtration at buffer filters. Capacity of the unit - 320 m^3/h.

During operation of the desalting unit and water purification unit for the responsible consumers and feeding up the thermal circuit the following wastes are formed:

- slag containing waters of clarifiers;
- rinsing waters of mechanical filters;
- washing and regeneration waters of ionite filters.

Presently, blowing waters of clarifiers are delivered to a slag accumulator. After settlement in the accumulator clarified water (~ 70 %) is returned to the chemical water treatment plant for the repeated use.

After settlement in tanks of the dewatering unit water will be returned to the chemical water treatment cycle, and the slag pulp will be delivered to the filter-press for dewatering.

Quantity of the dewatered slag at moisture content 50% will constitute 0.38 t/h when two power blocks are operated.
The averaged slag composition formed during treatment of 1 m^3 of original water:
– $CaCO_3$ - 290 g; $Mg(OH)_2$ - 30 g;
– $Fe(OH)_3$ - 18 g.
The total quantity of the formed slag during operation of two blocks:
$510 \times 0,338 \times 6500 \times 10^3 = 1120$ t/year

wherein 510 – volume of treated water, m^3 /h;
0,338 – volume of the formed slag, kg/m^3;
6500 – estimated hours of operation, h/year.
The lime slag may be used for deoxidization of soils in agriculture, as an additive for making silicate bricks and cement mortars.
Rinsing waters of mechanical filters are used in the chemical water treatment cycle. Regeneration waters of the desalting unit of the chemical water treatment plant after neutralization are directed to the technological systems. The averaged discharge of neutralized waters will constitute 17 m^3/h or 110500 m^3/year.
Quality of averaged discharges:
– calcium - 365 mg/l;
– magnesium - 34 mg/l;
– sodium - 1200 mg/l;
– sulfates - 2780 mg/l;
– chlorides - 250 mg/l;
– contents of salts - 4750 mg/l.
The volume of salts discharged along with regeneration water of the chemical water treatment is shown in table 17.

Table 17- The volume of salts discharged along with regeneration water

Description of discharges	Volume of salts	
	kg/h	t/year
Calcium	6,2	40,3
Magnesium	0,6	3,9
Sodium	20,4	132,6
Sulfates	47,3	307,5
Chlorides	4,3	28

2) Oiled waters
Oiled waters from the machine hall, storm waters from the territory of oil and black oil facilities are to be cleaned at the unit located in the starting and stand-by boiler plant. The volume of oiled waters - 30 m^3/h.
The cleaning scheme:
– collection and averaging in a reception tank;
– sedimentation and preliminary cleaning in a settling tank;
– cleaning at mechanical and coal filter.
Water free of oil and petroleum products are directed to technological systems, and seized petroleum products – for combustion in the starting and stand-by boiler plant.
Cleaned water has composition of cooling water, contents of oil - 1 mg/l.
Volumes of discharges during operation of two power blocks - 195000 m^3/year.

3) Block desalting unit

Condensate is cleaned according to the scheme “Deironing at electromagnetic filters, deironing at filters of mixed action”. Capacity of the unit - 3600 m^3/h.

Rinsing waters of the electromagnetic filter mainly containing corrosion products are delivered to the tank of regeneration water and used in the chemical water treatment cycle.

Regeneration waters of the filter of mixed action are delivered from the machine room to control tanks of acid and alkaline waters.

If active, acid effluents are delivered to the water cooling system, if it is unavailable, - for neutralization and further discharge.

Alkaline effluents of the desalting block are directed to retaining tanks, and then after radiation control to mutual neutralizing with acid waters along with the subsequent discharge.

The averaged volume of waste waters from the desalting unit in case of operation of 2 power blocks will constitute 7 m^3/h or 45500 m^3/year. He averaged quality of waste water at the desalting unit:

– NH_4 - 425,0 mg/l;
– Ca - 3,7 mg/l;
– Mg - 0,8 mg/l;
– Cl - 1,4 mg/l;
– $S0_4$ - 918,0 mg/l;
– Na - 575,mg/l.

The volume of salts discharged along with regeneration waters of the desalting unit is shown in table 18.

Table 18 - The volume of salts discharged along with regeneration waters of the desalting unit

Description of discharge	Volume of salts	
	kg/h	t/year
Ammonia	3,0	19,5
Calcium	0,03	0,2
Magnesium	0,006	0,04
Sodium	4,0	26,0
Chlorides	0,01	0,07
Sulfates	6,4	41,6

4) Shower waters

Shower waters, discharged water from basins of a special laundry, a water cooling unit system, discharges from laboratories, as well as water after last rinses are delivered to two tanks of dosimeter control. After performance of the dosimeter control these waters are delivered to the strict mode household sewerage system or to the water cooling system for cleaning if activity in waters exceeds the control level of discharge. Capacity of every dosimeter control tank - 40 m^3. Discharge of water from dosimeter control tanks to the household sewerage area of the strict mode is performed by means of a pump, pump capacity - 8 m^3/h.

According to a report of the radiation safety department volumes of water from showers to the strict mode household sewerage system from water – water reactor PWR -1000 constitute from 750 m^3 to 1350 m^3 per month.

5) Household waste waters

Household waste waters will be delivered from the NPP territory to the sewerage pump station and pumped by means of pumps to cleaning facilities of the complete biological cleaning along with profound removal of nitrogen and phosphorus and additional cleaning which are to be placed in the sanitary protecting area of the NPP.
As location of residential settlement of the NPP is stipulated on the basis of Ostrovets town, cleaning of waste waters from the town territory is stipulated at the existing cleaning facilities along with their reconstruction and expansion.
The use of modern cleaning facilities ensures the minimal impact onto surface waters.

3.*1.4 Impact and evaluation of impact by noise, electrical field, oil-filled equipment*

Impact and evaluation of noise

The following original data were adopted for evaluation of noise impact:
– assessment of noise sources which appear simultaneously with putting the power block in operation;
– due to the fact that working places for the servicing staff are not available at the industrial site outside production building and structures the noise impact is only assessed inside these buildings and structures;
– due to absence of any residential or administrative and household premises within the sanitary protecting area with the permanent staying of people, who are not employees of the NPP (population), state standards GOST 12.1.003-83 were adopted for evaluation of noise impact – the limit values of sound pressure for working places of the servicing staff on the permanent or periodic basis.
In production buildings and structures of the NPP the installed rotating equipment (turbo units, pumps, diesel generators, ventilation units), as well as reducing equipment are the sources of noise.
The list of buildings and structures of the power block PWR -1200 , wherein equipment is located< is shown in table 19.
In the majority of these production premises (pos. 5, 6, 7, 8, 9 ... of the list) the production process is fully automated, and permanent working places for the servicing staff are missing. During operation of the installed equipment the servicing staff either is not present there , or stays there only on the periodical or short-term basis (patrol servicemen).

Table 19 – List of buildings and structures with the installed sources of noise impact

Description of premise	Description of equipment	Operation mode
1 Main building. Reactor section	Main circulation pumps Other pump units	Permanent Permanent
2 Main building. Turbine section	Turbo unit Pump units РОУ 14/6; 14/3 БРУ-К, БРУ-СН	Permanent Permanent Permanent Periodically

3 Main building. Deaerator section	Feeding electrical pumps Other pump units Ventilation equipment	Periodically Permanent Permanent
5 Storage of solid radioactive wastes. Processing complex	Pumping equipment Ventilation units Press	Periodically
6 Stand-by diesel generator power plant	Diesel generator with auxiliary equipment	Periodically
7 General block diesel generator power plant	Diesel generator with auxiliary equipment	Periodically
8 Block pump station of technical water supply system	Pumping units	Permanent

In individual buildings and structures permanent working places of the servicing staff are located in special premises of control boards or other rooms equipped with sound insulating guarding structures. The estimated level of sound pressure in these premises complies with the requirements of the state standard GOST 12.1.003-83 "The system of labour safety standards. Noise. General safety requirements" for control premises does not exceed the allowed value shown in table 20.

For other working places the requirements of the aforesaid standard are applied to sound pressure level at permanent working places which is a conservative approach, as the servicing staff stays at these working places on the periodical and short-term basis.

Table 20 - Allowed sound pressure levels in control premises, laboratories

	Octave bands with average geometrical frequencies, Hz								
	31,5	63	125	250	500	1000	2000	4000	8000
Allowed level of sound pressure, dB	93/96*)	79/83	70/74	63/68	58/63	55/60	52/57	50/55	49/54
Integral sound level, DBA	60/65								

* Values for control premises are shown in the numerator, for laboratories – in the denominator

As according to the technical documentation for equipment which is the source of noise in premises of pos. 1-3 of the list. The level of sound pressure at the distance of 1 m from the source must not exceed the values indicated in GOST 12.1.003-83 for permanent working places (see table 21) the requirements of this State Standard are considered fulfilled.

Table 21 – Allowed levels of sound pressure

	Octave bands with average geometrical frequencies, Hz							
	63	125	250	500	1000	2000	4000	8000
Allowed level of sound pressure, dB	99	92	86	83	80	78	76	74
Integral sound level, DBA	85							

Impact and assessment of electrical field influence

Electric equipment installed in premises of NPP is not a source of harmful effluents, radio obstacles and noise.

Sources of harmful impact on environment may include overhead power supply line ВЛ-330 kV and HV equipment comprising block transformers, stand-by transformers of the own purposes, a communication automatic transformer, linear reactors.

In accordance with the sanitary standards protection of the population from impact of the electric field of overhead power supply lines having voltage 220 V and lower meeting the requirements of “The rules of installation of electrical units” is not required.

The overhead power supply line ВЛ-330 kV is stipulated on the territory of the NPP industrial site:

– from the transformer of power block No.1 to secondary distribution system - 330 kV;

– from stand-by transformer for the own purposes No. 1 to secondary distribution system - 330 kV;

– from stand-by transformer for the own purposes No. 2 to secondary distribution system - 330 kV;

– from secondary distribution system - 330 kV to the communication automatic transformer.

Provision of allowed levels of electric field strength of flexible links (ВЛ-330 kV) is carried out along with observance of standardized overall dimensions – i.e. minimal distances of overhead line wires to the earth when the allowed strength levels are ensured by 5 kV/m – see table 22.

Time of staff staying under the electric field is not limited. The allowed time of staying under electric field having strength above 5-20 kV/m inclusive is determined in the calculation according to “The rules of servicing staff protection from impact of electric field”.

Table 22 – Minimal distance of ВЛ 330 kV wires to the earth

Overhead line bay location	Minimal distance of overhead line wires to the earth, m at rated voltage of the line, kV	
	330	
	As per standards	As per design
At unpopulated location (NPP territory)	7,5	25 (17)*
At automobile cross-roads	8,5	25-17(10-25)

____

* Values with the account of the maximum boom overhang are shown in brackets

Supports of ВЛ-330 kV of flexible links are made of galvanized metal. All lines of flexible links are made with lightning protecting ropes and they are equipped with a discharger for protection from overvoltage. Overhead line supports are to be earthed.

Height of equipment installation has been chosen with the account of the Rules of installation and operation of electrical overall dimensions to insulation and busbars with the account of booms for wires overhang adopted in the design and possibility of installation of cable ducts, safety rules during performance of repairing works and staff protection from impact of the electrical field.

Stationary protecting means are stipulated for staff protection from impact of the electrical field. At the closed distributing unit:
– shields mounted over the working places near clamping boxes, actuators, distributing cabinets;
– vertical screens between switches of adjacent cells, additional screens of switches.
For protection from electric shock when insulation at the distributing unit is damaged the earthing contour has been provided along with connection of all current non-conduit equipment parts.
Outlet overhead lines of power supply 330 kV from distributing units of the Belarusian NPP have been constructed with the account of requirements of “Sanitary standards and rules of population protection from impact of electric field created by overhead lines of AC power supply with the industrial frequency”

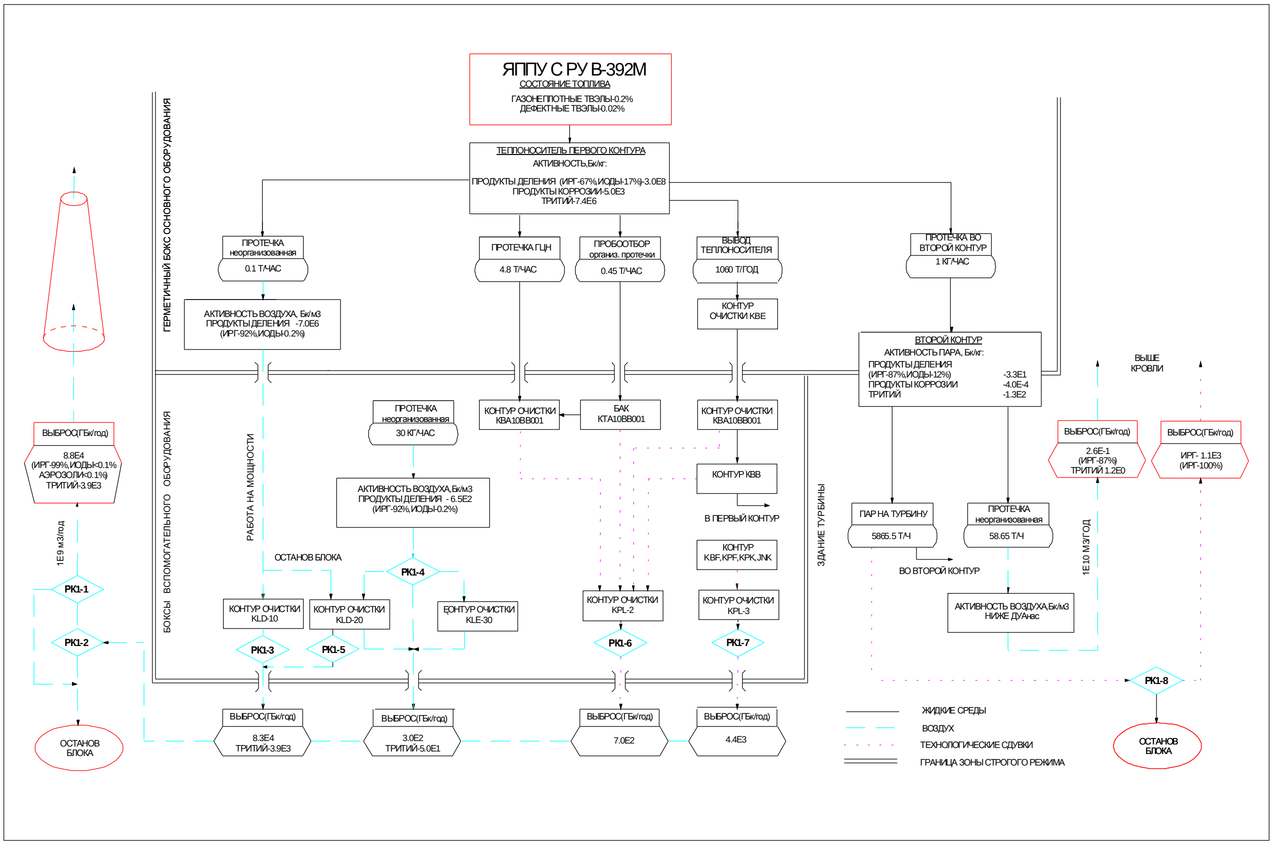
Impact and assessment of oil filled equipment influence

Oil-filled transformers will be installed on the Belarusian NPP territory from row Г of the turbine section. They include a block transformer of 3хОРЦ-417000/750/3 type, transformers for own purposes of 2хТРДНС-63000/35 type, stand-by transformers for own purposes of the power block of 2хТРДНС-63000/330 type.
For prevention from oil and fire spreading in case of damages an oil receiver has been arranged for every transformer and reactor intended for the full oil and water volume during fire extinguishing along with diversion of effluents to the oil collector.
All transformers and reactors are equipped with the automatic water extinguishing system.
For maintenance of the oil-filled equipment at the NPP centralized oil facilities are stipulated equipped with tanks for oil storage and procession, pumps, units for oil cleaning and regeneration, mobile oil cleaning and degassing units.

3.1.5 Radiation impact

Discharges of radioactive gases and aerosols from the station

Gas aerosol wastes of the power block with the removed radioactive contaminants and the exhaust air from station premises are discharged to the environment via a high ventilation pipe. The pipe is situated at the reactor section, the top elevation is at least 100 m. Pipe design is not intended for aircraft falling down. Control of discharges is continuously carried out by means of the automated radiation control system. Exhaust air of the turbine building and removal of the steam and air mixture from the turbine condensers are additional sources of possible penetration of radioactive substances to atmosphere. Ventilation discharge from the turbine building has been arranged above the roof.
The balance scheme of possible penetration of radioactive gases and aerosols to atmosphere in case of long operation of the power bloc with the distributing unit В-392М in conditions of the normal operation is shown on figure 10.



(See translation in Annex 1)

Figure 10 – The balance scheme of possible penetration of radioactive gases and aerosols to atmosphere

In case of operation violations at the station accompanied with additional outlet of radioactive substances to air of process premises, the low level of radioactive iodine isotopes and aerosols in the gas aerosol ventilation discharge is maintained owing to effective filtration of exhaust air from auxiliary buildings and structures.

For NPPs in the Russian Federation limitations have been set up for discharges of radioactive gases and aerosols to the environment on the allowed level according to recommendations of СП АС-03. Values of radioactive discharges of inert radioactive gases and aerosols at NPPs of Russia in 2005 along with assessment in relation a to annual allowed discharges according to СП АС-03, are shown in table 23.

Table 23 – Values of radioactive discharges

NPP	Radioactive substances	I-131	Co-60	Cs-134	Cs-137
	TBk (% from allowed level)	MBk (% from allowed level)			
NPP with PWR-1000 and PWR-440					
Novovoronezhskaya	110 (16)	1700 (9,4)	350 (4,7)	41 (4,6)	140 (7)
Kolskaya	4,2 (0,6)	134 (0,7)	88 (1,2)	0,01	53 (2,7)
Rostovskaya	0,2 (0,02)	57 (0,3)	0,8 (0,01)	0,2 (0,03)	0,1 (0,01)
Balakovskaya	0,2 (0,02)	223 (1,2)	7,7 (0,1)	2,4 (0,3)	7 (0,4)
Kalininskaya	49 (7)	512 (2,8)	4,1(0,1)	0,7 (0,1)	1,8 (0,1)

NPP with РБМК-1000					
Kurskaya	403 (11)	1632 (0,6)	39 (0,6)	2,1 (0,2)	25(0,6)
Leningradskaya	597 (16)	985 (1,1)	190 (7,6)	50 (3,6)	155 (4)

NPP	Radioactive substances	I-131	Co-60	Cs-134	Cs-137
	TBk (% from allowed level)	MBk (% from allowed level)			
Smolenskaya	130 (3,6)	157 (0,2)	252 (10)	0,01	13,7 (0,4)
NPP with АМБ-100, АМБ-200 and БН-600					
Beloyarskaya	6,8 (1)	0,1 (0,01)	1,1 (0,01)	0,01	14 (0,7)
NPP with ЭГП-6					
Bilibinskaya	409 (21)	11 (0,1)	14,6*		

* Contents of Co-60, Cs-134 and Cs-137 in discharges from Bilibinskaya NPP is below the minimal detected activity. Therefore, the total activity of long living radio nuclides in discharges is provided.

In 2005 gas and aerosol discharges of NPPs were below the allowed level and they did not exceed the levels set up in СП АС-03, i.e. by radioactive substances — 20,5 % (Bilibinskaya NPP), I-131 — 9,4 % (Novovoronezhskaya NPP), Co-60 — 10,1 % (Smolenskaya NPP), Cs-134 — 4,6 % and 3,6 % (Novovoronezhskaya and Leningradskaya NPPs) and Cs-137 — 7 % (Novovoronezhskaya NPP).
There were no cases of exceeding the discharges of radio nuclides per day and per month above the control levels according to СП АС-03.

Discharges of radioactive substances from the station
After radiation control carried out by means of CBSRC sensors in control tanks and analysis of samples in a radio chemical laboratory, debalance water are discharged from station premises. If necessary, water is delivered from the control tanks to repeated purification to the system of trapped water treatment.
The balance scheme of possible delivery of radioactive substances to hydrosphere in case of long operation of the power block in the normal mode is shown on figure 3.3. Volumes of liquid discharges to the environment and delivery of radio nuclides to surface waters in 2005 in relation to the allowed discharge for NPPs are shown in table 24.

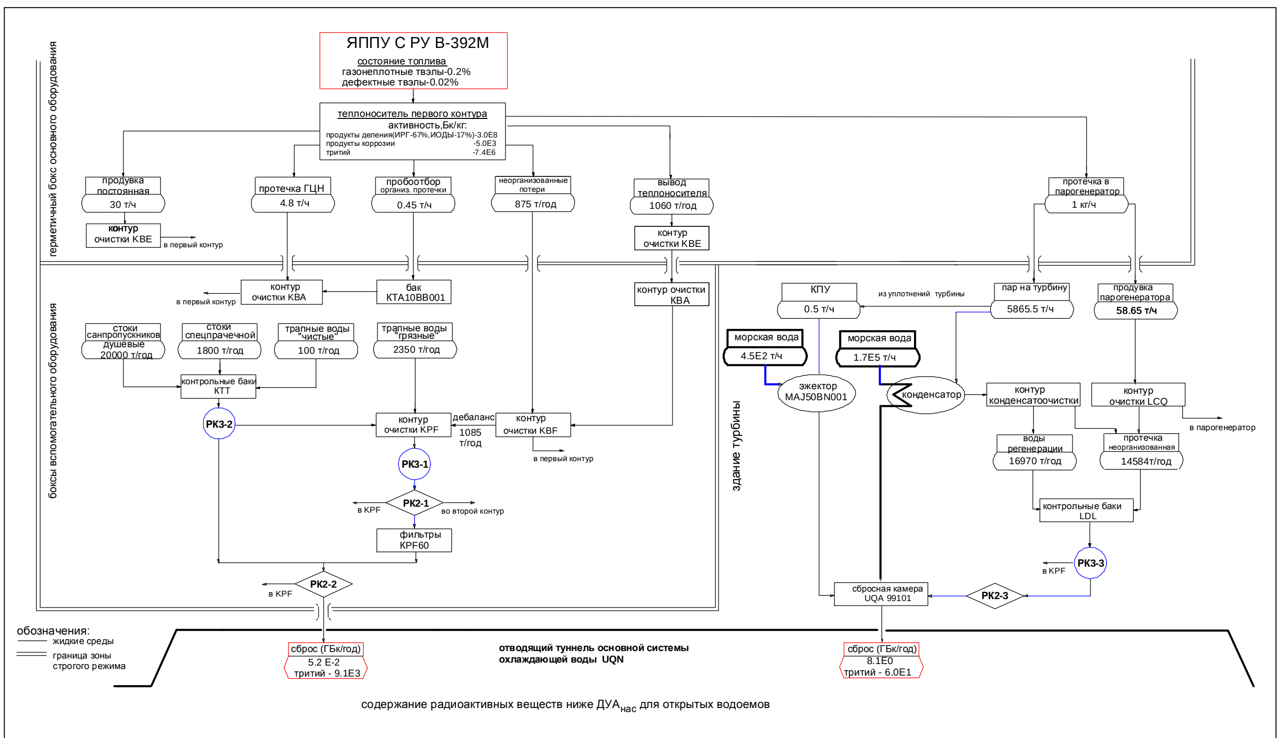
Table 24 – Volumes of liquid discharges and delivery of radio nuclides to reservoirs

NPP	Volume of discharged water, m^3	Delivery of radio nuclides to reservoirs, in % of allowed level
	NPP with reactors of types PWR-1000 and PWR-440	
Novovoronezhskaya	51000	18,9
Kolskaya	16102	0,01
Rostovskaya	Circulation water supply is used at NPP	—
Balakovskaya	40500	0,4
Kalininskaya	79097	8,1
NPP with reactors of type РБМК-1000		
Kurskaya	29970	0,5

Leningradskaya	13500	0,01
Smolenskaya	52762	0,1
NPP with reactors of type АМБ-100, АМБ-200 and ВН-600		
Beloyarskaya	37863	0,02
NPP	Volume of discharged water, m^3	Delivery of radio nuclides to reservoirs, in % of allowed level
	NPP with reactors of types PWR-1000 and PWR-440	
NPP with reactors of type ЭГП-6		
Bilibinskaya	2384	0,04*

* Data for all NPP, except for Bilibinskaya one< are shown by Cs-137, which provides main contribution (by 70 %) to the total activity of discharged water. For Bilibinskaya NPP data on radioactivity of discharged water is shown by Co-60, with its contribution to the total activity of discharge equaling 75%.

Delivery of radioactive products with liquid discharges of NPPs of Russia were lower than allowed limits and they did not exceed 18,9 % of the allowed limit (Novovoronezhskaya NPP)



(See translation in Annex 1)

Figure 11 – Delivery of radioactive substances to environment with liquid non-radioactive discharges during block operation in the nominal mode.

4. NPP POSSIBLE ENVIRONMENTAL IMPACT.

4.1. Landscapes.

Landscapes. The region of the constructing of the NPP is fully located within the limits of one landscape province – Poozersk province of the lake-glacier, morainal and hilly – morainal – lake landscapes. By its height, the landscapes of the region refer to all the three groups of the landscapes available on the territory of the Republic of Belarus – high – altitude, medium – altitude and low – altitude. The high – altitude landscapes occupy its outlying districts – the north – eastern part and the south – western part. In the direction to the centre they are replaced by the medium – altitude landscapes and the low – altitude landscapes.

4.1.1. Landscapes potential.

The natural fertility of the soils of the majority of the landscapes is relatively not large, it is lower than the medium value in the region. The increased partition of the relief results in small outlines of the lands. This is why the level of the development of the 30 km zone round the NPP (hereinafter the 30 km zone) is not very intensive. Here the natural complexes are still kept and among them the forest predominate. The agricultural lands occupy about half its territory.

A comparatively low economic development of the 30 km zone in addition to its natural qualities – a great number of lakes and the favourable state of the environment – create the favourable preconditions for the recreative use of the given territory. According to the diagram of the regions of the territory of the Republic of Belarus, for the sanatoria and health resorts and for the recreation development, in the considered 30 km zone – three landscape – climatic regions are chosen: Narochansko – Gluboksky (the north – eastern part), Molodechensko – Vileysky (the central part) and Oshmyansky (the south – western part).

Among the three estimated region, one – Narochansko – Gluboksky – is characterized by the most favourable health – resort conditions, the other two are favourable.

The potential objects for the recreation are also the especially protected territories in the region – the reservations of the republican and local significance. They are promising for the development of the ecological tourism.

The mineral and raw materials potential of the considered territory is formed by the deposits of the construction raw materials, peat and sapropels. 7 deposits of the construction materials are located within the borders of this territory. These are the deposits of the construction sands, the gravel – sand rocks and the clays. Among them, only two are developed: one – of the construction sands and one – of the clays.

There are 11 deposits of the peat. Their area is mostly not large and varies from 100 to 700 hectares. And only two, the largest of all, have the area of more than 1000 hectares. The medium depth of the peat varies within 1,1 – 2,7 m, and the geological stocks are in the range of 60 – 2500 thousand tons. The total stocks of the peat are relatively not large. All the large peat – bogs are drained and are used mainly as agricultural lands.

The region possesses the significant resources of sapropels. On the whole there are 46 lakes with sapropel on its territory. They contain 88,5 mln. m^3 of raw sapropel. Two types of sapropel predominate: silica and carbonate. At present, the sapropel deposits are not developed.

4.1.2. Landscapes pollution resistance.

Within the 30 km zone, about 50 per cent of the total are is occupied by the eluvial landscapes, and together with the eluvial-accumulative and accumulative-eluvial landscapes, they occupy about 90 per cent. About 7 per cent are occupied by the superaqual landscapes. The landscapes structure is similar in the natural ecosystems.

According to the granulometric analysis the sandy soils predominate on the porous dusty – sandy and sandy soils that occupy about 52 per cent of the total area of the 30 km zone. In the natural ecosystems the sandy soils dominate, occupying 58 per cent of their total area.

The soil – forming species have non – uniform structure; two – or three – part structure of the soil profile may be often found. The specific weight of the sandy soil having a two – part structure (loam – weak clay) is rather high and equals 35 per cent. The uniform structure of the soil profile is specific most of all for the sandy varieties that occupy about 34 per cent of the 30 km zone area.

The acid eluvial landscapes with forests (mostly – the coniferous woods) on the sandy soils are spread within the 30 km zone to a greater extent. They are widely spread in the valley of the Viliya river, in the western part of the 30 km zone, in the inter-river area of the rivers Oshmyanka and Viliya, and also in the northern and north-western parts.

The natural conditions of the ecosystems of the 30 km zone territory of the nuclear power plant area on the whole favor the formation of the acidic reaction of the environment, and this causes a high mobility of the chemical elements in the landscapes and provokes their extraction from the soils with the infiltration waters and the transition into the plants.

In general, according to the natural factors, the landscapes, standard to the chemical contamination, predominate in the region. They occupy 57 per cent of its total area, in the natural ecosystems – 64 per cent. This means that for the dominating automorphic eluvial landscapes, developed on the light granulometric depositions, the processes of extracting the chemical elements by the water flows are characteristic (by means of the surface outlet and the intrasoil infiltration).

The estimation of the present – day content of heavy metals (Pb, Zn, Cu, Ni, Cr) in the mineral and peat soils on the nearest to the nuclear power plant territory has shown that their concentrations are characterized by the significant variability (see table 17). The peat soils, in comparison to the mineral soils, contain higher medium amount of zinc, copper and nickel and have smaller variability of all the researched elements.

Table 25 – The contents of heavy metals in the soils of the 30 km zone, mg/kg.

Index	Pb	Zn	Cu	Ni	Cr
Minimum quantity, mg/kg	6,9	5,2	0,9	1,4	6,7
Maximum quantity, mg/kg	42,0	65,5	10,3	10,9	91,4
Medium for a sample, mg/kg	14,7	20,9	3,8	4,9	41,3
Frequency of amounts higher “MAC/MBC”, per cent	isolated sample	isolated sample	–	–	–
Maximum rate of exceeding “MAC/MBC”	1,3	1,1	–	–	–
Background contents	6,0	28,0	11,0	15,0	30,0

Considering the researched metals, it is seen that the higher concentration in soils (in comparison to the background index) have zink and chrome. And their contents exceed the admissible levels (“MAC/MBC”) only in isolated cases and to a small amount. The contents of other elements does not exceed the background and the admissible limit by any index.

For a long-term period (50 years), as modeling of some heavy metals (lead and cadmium) has exposed, their concentration in mineral soils of the natural ecosystems will not exceed “MAC/MBC”. The critical loads of this metals on the natural ecosystems will not be exceeded either.

4.2. Vegetation.

4.1.2. Terrestrial and water ecosystem vegetation characteristic.

The modern structure of the plants of the terrestrial and water ecosystems of the 30 km zone corresponds well to its soil – hydrological, orographic, climatic conditions. The ratio of the areas, occupied by the main types of the vegetation (wood, lawn, swamp and water) has not lately changed greatly.

In the structure of the land fund of the test grounds (in the borders of the Republic of Belarus), the natural terrestrial vegetation occupies 112,6 thousand hectares (45,9 per cent), including the forests that occupy 92,6 thousand hectares (37,73 per cent), swamps – 16,4 thousand hectares (6,68 per cent), meadows – 3,6 thousand hectares (1,47 per cent). The great part of this territory (51,69 per cent) is used for economically developed lands.

The wood vegetation – the forest dominate on the territory of the test grounds. The thickness of the woody lands is not uniform. The less woody parts are the central part (8 per cent), south (11 per cent) and north – eastern (22 per cent). The medium woodiness of the 30 km zone makes up 37,7 per cent.

The classification diagram of the wood vegetation of the test grounds includes four classes of formations, 16 formations, 23 series and 75 types. The pine forest predominates (68,1 per cent of wood area). The fur-trees (12,1 per cent) and drooping birch - trees (13,4 per cent). Fragmentarily, the black alder trees (2,7 per cent), the grey alder trees (1,4 per cent), the fluffy birch – trees (0,9 per cent) and the broad – leaved (oak, lime, ash - tree) woods are represented, occupying 0,49 per cent of the territory of woods. As for the typological spectrum, the vegetation of mossy (35,2 per cent), bilberry (16,2 per cent), wood sorrel (9,8 per cent), heather (7,4 per cent) series of wood types predominate.

On the whole, the typological structure of the woods of the region is like the structure of the background vegetation of Naroch – Vileyka geobotanical region. However, it is necessary to state that the 30 km zone, in comparison to the geobotanical region, is characterized by the lower availability of the coniferous woods (1,79 per cent against 4,21 per cent) and the leaf – bearing swamp woods (3,69 per cent – 6,84 per cent) and, on the contrary, the larger availability of the pine forest (44,92 per cent – 37,18 per cent), growing on the sandy soils.

The medium class of the bonnitette of the vegetations is 1.6. The highly productive (1^b – 1 classes) woods occupy 79,6 per cent of the woods area and are located in the outlying districts, especially in the western and north – eastern parts, and also along the river Viliya. The medium – (II – III classes) and low – productive (IV – V^a classes) vegetations occupy correspondingly 47,4 per cent and 3,0 per cent.

According to the calculations made, the first class of the natural fire danger includes 22,8 per cent of woods, the II class – 0,4 per cent, III class – 41,9 per cent, IV class – 30,7 per cent and V class – 4,2 per cent. The woods of the very high natural fire danger (I class) spread relatively uniformly over all the 30 km zone and are combined with the woods of the medium and low fire danger. The larger accumulation of the forests with the high natural fire danger are situated to the east and south - east from the place of the nuclear power plant location. Small areas of forests of high natural fire danger are far from the industrial ground (at about 1,5 km distance).

In the 30 km zone the I group forests occupy 62,5 per cent of the territory covered with forests and include the forbidden (water – protective) areas, the protective areas along the roads, the protective areas along the railways, the forests of the republic reservations, the forests - park zones, timber – industry parts of the green zones.

The bog vegetation – the total area, occupied by the bog vegetation in the 60 km zone around the nuclear power plant maces up 16412,2 ha, or 6,69 per cent. The researched territory has all the main types of the bogs of the taiga zone – upper (3284,9 ha – 1,34 per cent), transitional (283,4 ha – 0,12 per cent) and low –lying (12843,9 ha – 5,23 per cent). In the results of the intensive land – reclamation carried out in 1960-1970 years, the greater part of the large bog massives on the territory of the 30 km zone was drained. The remaining parts of the bogs are fine outlined. The most marsh – ridden parts are the eastern and northern parts of the 30 km zone. The most widely spread are the hephtrophic bogs represented mostly by grass bogs.

The meadow, sinantropic and waste ground vegetation – the meadow lands (hay – mowing and pastures) occupy 3606,3 ha or 1,47 per cent (together with river – side plants – over 2 per cent). In spite of the small occupied area, they are represented by all the three categories: water – meadow, waterless and low – land, and include different elements of the relief. The natural fodder lands are most widely represented in the water – meadow of the Viliya river, in the water – meadow of the Oshmyanka, Stracha, Losha and in the valleys of some laces.

All the ecological spectrum of the grass vegetation is represented in the list of the phytocompanies worked out on the basis of 168 geobotanical descriptions, performed at 27 key areas. The list consists of 12 classes, 17 orders, 27 unions and 73 associations.

The water vegetation – the plant cover of the reservoirs and overflows consists of the vegetation associations and populations of the water (hydrophytes), air-water and near-water (hydrophytes) kinds of plants. The vegetation represents a complex of phytocenosis, formed by the kinds of plants of different systematic reference, texture, peculiarities of growth, reproduction, nutrition and requirements to the conditions of the environment.

In the water basins and constant overflows of this territory, there are kinds of superior (vascular) plants (out of 183 met in the Republic of Belarus), including 24 kinds of the water, 20 air – water and near-water plants.

The richest vegetation is found on the lakes (Svir, Vishnevskoye, the lakes of the Sorochanskaya group), less diverse is the vegetation of the rivers Viliya, Stracha. In the shallow rivers of the second order, the vegetation of the water plants is poor.

The especially valuable vegetation associations – they occupy the total area of 6598.4 ha (7.1 per cent of the forest covered area of the region), having the stock of the plantations of 1319.6 thousand m3. The especially valuable vegetation associations are represented by the following categories:

the highly – and diversely – grassy pine – woods;

the highly – and diversely – grassy Zone fur – woods, rare by the degree of safety;

the plating oak woods of age;

rare for the territory of the Republic of Belarus and of the reservation, the woods in which broad – leaves trees (ash-tree, maple, lime); the aspen woods of age;

the exceptionally old black alder woods at the low-lying marshy lands with the complex of megathrophic – marshy kinds of plants and animals, rare by the degree of safety;

the rare wood associations;

the associations including rare broad-leavers kinds: maple, elm (rough and smooth), lime;

the wood associations complicated by the composition and structure; the wood areas in the water-meadows;

the location of the kinds of plants and animals written in the Red book of the Republic of Belarus.

The researches of the 30 km zone have shown non-uniform-ness in the location of the populations of the protected kinds of plants. The most representative ecotops for their growth are the river valleys, the hollows of the lakes and the larger areas of the wood massif.

4.2.2. Expected natural and anthropogenic changes in vegetation in the region resulting from NPP construction and operation.

The variation of the state of the vegetation of the land ecosystems – there were no significant variations in the ratio of the areas, occupied by main types of vegetation (woody, meadow, marshy). In the formative structure of forests, on the whole, there is a tendency, stipulated by the natural processes on the background of insignificant increase of the area of the small – leavers trees (birch, grey alder tree, black alder tree), for great decrease of the specific weight of the coniferous plants (pine, fur) by 10.8 per cent, mainly owing to the pine-trees (10.3 per cent). Besides, in the pine-woods, as the most spread and required formation for the recreation, in the 30 km zone, in connection with the supposed growth of the population, the intensity of recreation loads will greatly increase.

The prospective and construction works performed in the zone of the planned construction of the nuclear power plant influences the environment. In the process of carrying out the planned kinds of work, in the result of the action of the direct and indirect factors, the changes in the outer appearance of landscapes, the type composition and the structure of the plant cover will take place at the construction ground and the neighbouring territories. The greatest changes will take place in the natural landscapes and the plant cover in the result of direct influence, when the works on making the foundation-pit for constructing the nuclear power plant, the sand-pits for the extraction of the sandy – gravel mixture, the construction of the railroad and the highway, the communication nets, houses, enterprises producing the concrete, the metallic constructions, etc. by an open method, causing a large movement of the ground. Certain impact on appearance of landscapes and the vegetable cover structure will be caused by withdrawal of the forestry fund lands having the area of 88.0 hectares planned in the design for NPP construction, and by cutting down the forests having the total reserve of timber of about 15.5 thousand m^3. In the process of NPP construction indirect impact on vegetation will considerably be intensified. Transportation of big volumes of various cargoes will result in higher loading on automobile roads by increasing the pollution of roads themselves, their sides and adjacent areas with fuels and lubricants, products of tires abrasion and road coatings (mainly - with cadmium, frequently – with benzo(a)pyrene, asbestos dust), solid effluents of vehicle engines, dust and rubbish. Aero pollution of vegetation with lead, sulfuric compounds, nitrogen oxides, solid aerosols (including ash and soot) will become higher.

4.2.3. Vegetation changes forecasts.

The increase of the anthropogenesis load connected with the growth of the quantity of the population will lead to the radical variation in the species composition and the structure of the vegetation associations and, first of all, in the forests, because they are mostly used for the people's recreation. The recreative use of the territory is accompanied, as a rule, by the effect of a number of unfavourable factors (trampling down, mechanical damage of trees and bushes, contamination of forests with pollution). The outer manifestation of these effects is the degradation of the forest ecosystems, the increase of the specific weight of the try-top trees and the drying trees in the phytocenosis.

Besides, the decrease of the natural meadows areas, occupying 1.5 per cent in the 30-km zone will be observed, especially near the populated areas.

The open and bushy marshes (mainly of eutrophic and partially of mesotrophic types) will be reclamated.

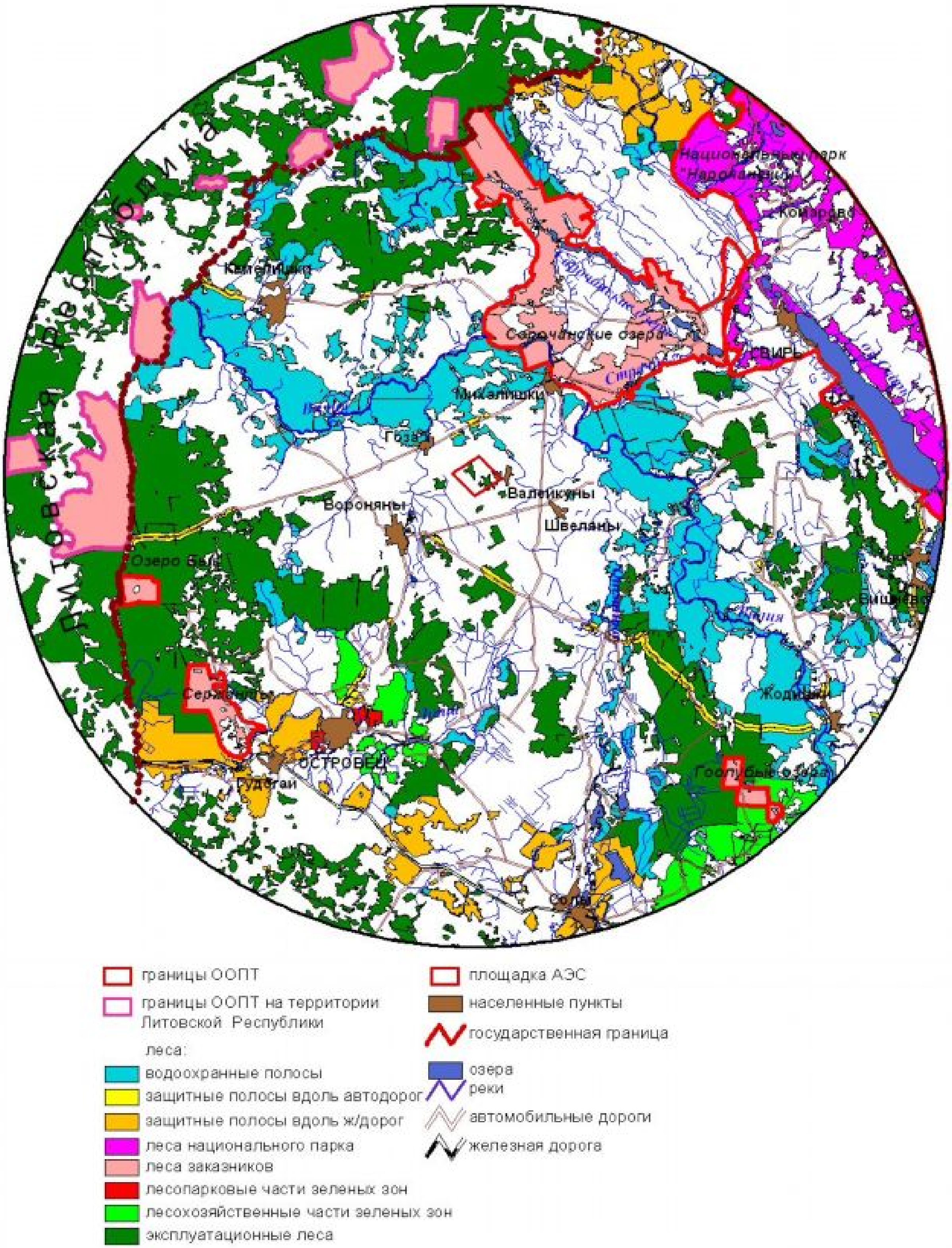
The calculated values of forming the dosed loads on the vegetation within 30 km zone show that, on the whole, the radiation effect (at the normal operation of the nuclear power plant) will not greatly influence the vegetation cover. However, besides the radiation effect on the vegetation, there are a number of other factors of the anthropogenous influence connected with the functioning of the nuclear power plant. The main anthropogenous factors of the changes and the decrease of the steadiness of the plant associations in the 30 km zone are the following: the ploughing, the cutting, the pasture, the hay-mowing, the recreation, the reclamation, the construction, the excavation of the soil, the artificial planting of forests that do not correspond to the ecological conditions, the fires, etc.

Some negative effect on the water vegetation may be manifested – while constructing the nuclear power plant – by the disappearance of the indicators types fastidious to the high quality of the water medium (sword – grass), the reduction of the species variation, the area and the depth of the growing plants, the appearance of the types of the indicators of the euthrophia and the contamination.

Thus, the construction and the operation of the nuclear power plant will produce the significant influence on the appearance of the landscapes and the structure of the vegetation cover and, first of all, of forests. However, this changes will be connected not with the direct effect of the radiation, but, first of all, with the production of the large-scale construction of the nuclear power plant and the accompanying transport and settling infrastructure, and also with the sharp rise of the population quantity. The unique forest massif of the Vileisk low – land may experience the active anthropogenous pressing.

4.2.4. Specially protected natural areas, protected forecasts, protected plant and animal species.

Within the 30 km zone round NPP site, there are 5 especially protected nature territories (Fig. 12).


Литовская Республика
Кемелишки
Сорочанские озера
СВИРЬ
Михалишки
Гоза
Валейкуны
Вороняны
Швеляны
ОСТРОВЕЦ
границы ООПТ
границы ООПТ на территории Литовской Республики
леса:
водоохранные полосы
защитные полосы вдоль автодорог
защитные полосы вдоль ж/дорог
леса национального парка
леса заказников
лесопарковые части зеленых зон
лесохозяйственные части зеленых зон
эксплуатационные леса
площадка АЭС
населенные пункты
государственная граница
озера
реки
автомобильные дороги
железная дорога

1. the borders of the specially protected natural areas;
2. the borders of the specially protected natural areas on the territory of the Republic of Lithuania;
3. the forests;
4. the water protecting areas;
5. the protective areas along the highways;
6. the protective areas along the railroads;
7. the forests of the national park;
8. the forests of the reserves;
9. the forest – park parts of the green zones;
10. the forest – economic parts of the green zones;
11. the exploiting forest;
12. the nuclear power plant ground;
13. the settlements;
14. the state border;
15. the lakes;
16. rivers;
17. highways;
18. railroads.

Fig. 12. the specially protected natural areas and the forests of the 1st group of the 30 km zone of the locating the nuclear power plant.

Among them there are: a part of the territory of the National park “Narochansky”, the whole of the republican landscape reservation “Sorochansky lakes”, and also three local landscape reservations (“Blue lakes”, “Sergeant”, “Bull lake”) and two local nature monuments (“The lime avenue with three oaks” and “The ancient oak”).

In total, the especially protected nature territories occupy about 15 per cent of the lands of the 30 km zone, and this is two times larger than the medium amount for Belarus and it is the evidence of the great importance of the region for the presser of the biological and landscape variability at the national level.

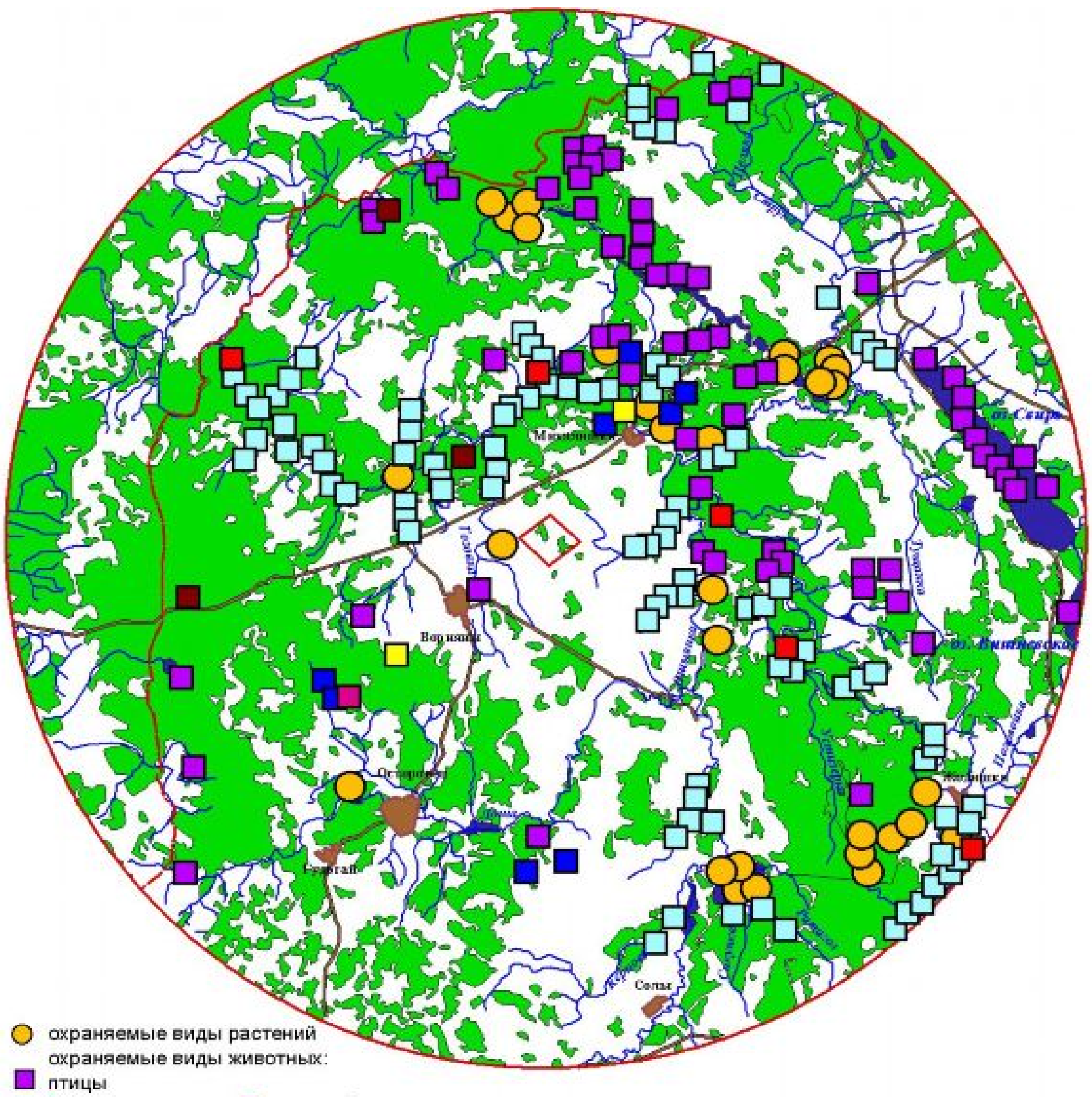
The protected forests available in the region include the water-protective areas, the protective areas along the highways and railways, the forests of the national parks, the forests of the republican reservations, the forests of the green zones of cities. The water protecting forests are concentrated mainly along the river Viliya. They play the role of the ecological corridor of the international importance, connecting especially protected nature territories of the Republic of Belarus and Republic of Lithuania.

The forests of the 1st group occupy totally 62.5 per cent of the territory, covered with forests of the 30 km zone, and that is 12 per cent higher than the medium index for the Republic of Belarus and also is the evidence of the great nature-protection importance of the region.

On the whole, 17 protected species of vegetation were found in the region (Fig. 13). The most representative ecotopes for their growing are the valleys of the rivers and brooks, the hollows of lakes and large areas of the forest massives.

Practically, all the found populations of the protected species of the vegetations are situated at a significant distance from the ground of the construction of the nuclear power plant, and the planned works cannot directly influence them.

The main areals of dwelling of the protected kinds of birds and mammals are concentrated at the distance not less than 10 km from the ground and are mainly timed to large lakes and the forest massives with the water basins. Therefore the construction itself will not influence them.



Protected vegetation species: *1. Huperzia selago (L.) Bernh.* – Fir-moss*, 2. Berula erecta (Huds.) Cov.* – Berula eraecta, *3. Carex rhizina Blytt ex Lindbl.* – Rhizomatous sedge, *4. Pulsatilla pratensis* – Meadow Pasqueflower, *5. Ajuga pyramidalis L.* – Horn Bugle, *6. Lilium martagon L.* – Martagon Lily, *7. Listera ovata (L.) R. Br.* – Twayblade, *8. Malaxis monophyllos (L.) Sw.* – Orchis Unifoliate, *9. Liparis loeselii (L.) Rich.* – Fen Orchis, *10. Saxifraga hirculus L.* – Yellow Marsh Saxifrage, *11. Trollius europaeus L.* – European Globeflower, *12. Anemone sylvestris. L.* – Wood anemone, *13. Gymnadenia conopsea (L.) R.Br.* – Mosquito Rein Orchis,*14. Coeloglossum viride (L.) C.Hartm.* – Frog Orchid, *15. Orchis morio L.* – Green-winged Orchis, *16. Baeothryon alpinum (L.) Egor.* – Baeothryon alpinum, *17. Eriophorum gracile Koch* – Cotton grass.

Protected animals kinds: ***Birds***: 1 – Black-throated Loon (*Gavia arctica),* 2 - Smew *(Mergellus albellus),* 3 – Buff-breasted Merganser *(Mergus serrator),* 4 – Common Merganser (*Mergus merganser),* 5 – Black Stork *(Ciconia nigra),* 6 – Large Egret *(Egretta alba),* 7 - Bittern (*Botaurus stellaris*), 8 – Fish Hawk (*Pandion haliaetus*), 9 – Sea-Eagle (*Haliaeetus albicilla*), 10 – Blue Hawk *(Circus cyaneus),* 11 – Lesser Spotted Eagle (*Aquila pomarina*), 12 – Common Gull (*Larus canus*), 13 – Common Crane (*Grus grus*), 14 - Crake (*Crex crex*), 15 – Little Crake *(Porzana parva),* 16 – Greenshank (*Tringa nebularia*), 17 – European Curlew (*Numenius arquata),* 18 – Eurasian Pygmy-owl *(Glaucidium passerinum),* 19 – Siberian Grey Owl *(Strix nebulosa),* 20 – Common European Kingfisher (*Alcedo atthis*), 21 – Green Woodpecker (*Picus viridis*), 22 – White-backed Woodpecker *(Dendrocopos leucotos),* 23 – Three-toed Woodpecker *(Picoides tridactylus);* ***Mammals***: 1 – European Lynx (Common) *(Lynx lynx),* 2 – badger (*Meles meles*); ***Amphibian:*** 1 – Pectinated Newt *(Triturus cristatus),* 2 – Running Toad *(Bufo calamita);*

Fig. 13. – The protected species of the vegetation an animals of the 30 km zone round NPP site.

4.2.5. Environmental impact and nature protection measures during NPP construction.

The site selected for the construction of the nuclear power plant occupies mainly agricultural and the small areas of the forest. The latter have no status of protected, in them there are no rare species of vegetation and animals. They do not have great ecological importance, and their cutting will not cause any unfavourable consequences for the biological variability.

The construction ground occupies the elevated place inclined in the direction of the rivers Gosovka and Polle, the tributaries of the river Viliya. The surface outflow from the river will be directed to them. The contaminating substances may penetrate into these rivers with the outflow. They may pass to the land surface when the construction equipment, autovehicles and other objects work.

To prevent the contamination of the named rivers, it is necessary to perform the water-protecting activity. Such measures may include, first of all, the creation for them – the water-protecting zones with the river side areas occupied by the woody-bushy vegetation; and, secondly, the creation of the settling basins – the accumulators for collecting the rain - water and the melted snow from the territory of the ground and their subsequent decontamination. Besides, it is expedient to create the post of the hydrochemical monitoring at the river Gosovka in order to control the quality of the water.

Performing the construction works and the further operation of the nuclear power station will cause the rise of quantity of the population in the region, and this will result in the increase of the recreation loads on the natural ecosystems. They may cause the degradation of the forest vegetation, the increase of the fire danger in the forests, the rise of the anxiety factor for the animals.

In order not to admit the named negative consequences, it is necessary to realize the measures for organizing the monitoring of the vegetation and animal world, for developing and applying the special regimes of the forest – use in the most attended forests, for increasing the control of using the hunt animals and fish, for rise the fire safety in the forests.

The component part of constructing the nuclear power plant is also the construction of the power transmission lines. Their constructing may cause the fragmentation of the valuable natural ecosystems, and also the violation of the living conditions of the rare species of the vegetation and animals. The measure for preventing these threats is to take into account – when projecting the lines of electric power transmission – the locations of specially protected natural areas, the protected species of plants and animals, other important – for saving the biological and landscape variability – natural ecosystems.

4.3. Agriculture

The intensive agricultural and forest production is carried out on the territory of the 30 km zone around the supposed place of the location of the Belarusian nuclear power plant. The agricultural enterprises specialize in cultivating the corn, the flax, the sugar beet, the rape, the potato, the fodder crops, the production of milk and meat.

The density of the soil contamination with the cesium – 137 at this territory makes up 0.7 - 2.0 kBk m-2, the density of the soil contamination with the strontium -90 is 0.2 – 0.95 kBk . m-2, the power of the equivalent doze in the air is 0.10 – 0.15 mkZv . h-1, and by these indices it is comparable with the remaining territory of the republic, contaminated only by the global falls – out from the nuclear weapon test (the density of the contamination is less than 2.6 kBk . m -2 by the cesium – 137 and less than 1.8 kBk . m -2 by the strontium – 90).

By the amounts of the contents of the cesium – 137 and the strontium – 90 in the agroecosystems, the researched territory does not differ from the neighbouring regions, contaminated only by the global falls – out in the result of the nuclear weapon tests.

The predicting calculations show an extremely low entrance of the radionuclide into the environment because of the radioactive falls – out in the regime of the normal operation of the Belarusian nuclear power plant. Even if the cesium – 137 continuously falls out onto the same territory during all the period of the operation of 50 years, the maximum activity of the surface layer (0 – 30 cm) will be 12 Bk – m-2, and this will make up less than 1 per cent comparing with the existing level. The activity of the strontium -90 in the standard falls – out is extremely low (several Bk in 24 hours), therefore its contribution into the soil contamination is extremely small and can be neglected.

These calculations are given proceeding from the conservative supposition about the continuous deposition on the same territory, it is evident that the real values – taking into account the wind rose – will be lower by an order.

Calculation results show that the continuous exploitation of the NPP will not result in exceeding of RAL-99 standards by the content of cesium – 137 in agricultural products.

The predicted calculations of the content of the radionuclides in the agricultural products for the emergency falls-out are performed for the rated density of the soil contamination 1 Bk . m-2 and for the specific points at different distances from the nuclear power plant.

In the first vegetal season of the emergency falls-out, the largest content of the radionuclides is possible during the deposition of the radioactive substances in the period of the maximum growth of the overground phytomass of the vegetation, therefore the most unfavourable variant – in the sense of the pollution of the agricultural products – is possible when the emergency fall – out takes place on the eve of the harvesting.

The maximum indices of the activity of the agricultural products – at the aerial pollution – is predicted for the parts of the plants directly exhibited to the falls – out. Still greater activity is predicted for the leaves greens and the grass of the fodder lands (0.3 – 0.7 Bk . kg-1 at the density of the soil pollution of 1 Bk . m-2), the pollution of the cereals is expected to a lower degree (up to 0.2 Bk . kg-1), and, to a minimum degree – the pollution of the milk and the beef. During the first vegetal period after the falls – out, it is predicted the decrease of the activity of the radionuclides because of their radioactive decay and the removal of the particles of the falls – out from the surface of the plants. The period of the "dry" half-decontamination of the long-living radionuclides makes up ~ 20 days and nights and 6 days and nights for 131I, during the atmospheric rainfalls it reduces in proportion to their quantity and intensity.

When considering the maximum projected damage as the most probable variant of forming the radiation situation, it is necessary to state sufficiently low densities of the soil contamination. The exceeding of the given index for 137Cs over 0.37 kBk . m-2 is predicted on the area of ~ 1000 ha. For 131I, the area with the contamination density over 37 kBk . m-2 will make up about 700ha, and from 3.7 up to 37 kBk . m-2 – 12000ha.

In the first 24 hours for the vegetation with great overground phytomass directly exhibited to the aerial falls – out (the leaves green and the grass of the fodder land), the specific activity in the zone of the maximum deposition of the radionuclides may reach ~ 102 Bk . kg-1 for 137Cs and up to ~ 104 Bk . kg-1 for 131I. The grain will be polluted to a smaller extent – not more than 102 Bk . kg-1 for 137Cs and up to 104 Bk . kg-1 for 131I. The stated values – with the 90 per cent probability – will not exceed the admissible levels of RAL-99 by the content of 137Cs, that are in force in the Republic of Belarus.

The minimum levels of the contamination will characterize the root-crops and the tuber-bearing plants closed from the aerial falls – out (less than 10 Bk . kg-1).

The content of radionuclides in the researched kinds of the agricultural products – at the distance of more than 20 kilometers from the nuclear power plant – is predicated of approximately 50 times lower in comparison to the maximum supposed values because of the smaller value of the deposition of the radionuclides at this distance (0.28 kBk . m-2 for 131I). Correspondingly, the levels of the content of these radionuclides in all kinds of the agricultural products will be lower.

In the following vegeta seasons, when the aeral pollution is absent, the content of the radionuclides in the agricultural products – in case the radionuclides enter through the roots – is predicted in the amount of two orders lower. In this case the exceeding of the standard of the admissible levels of 137Cs content is not predicted for any kind of the agricultural plants and the products of the cattle – breeding. The grasses, growing on the peat – marshy soils, contain units of Bk . kg-1 of 137Cs at the maximum densities of the pollution at the axis of the trace. The turf – podzol sandy soils contain the specific activity of 137Cs in grasses not exceeding the tenth of Bk . kg-1, the same indices are predicted for the grain and potato.

The volume activity of 137Cs in milk in the following vegetal seasons will not exceed units of Bk – l-1 by the typical levels of pollution. For the beef, the range of the specific activities is from units up to ten Bk – kg-1.

At the distance of over 20 km from the nuclear power plant, that corresponds to the distance up to the neighbouring state, the specific activities are predicted as 20 – 40 times less compared to the maximum values.

Later on, the reduction of the specific activity of 137 Cs in the agricultural products, having the effective period of the half-refinement from 1 to 3 years in the first years after the damage and 20 -25 – in the following years, is predicted.

Thus, in case of the maximum projected damage, the density of the contamination with 137 Cs will reach the value, comparable with the values of the global radioactive falls-off. Some limitations on the use of the agricultural products would be introduced near the axis of the trace at the distance of 500 – 7500m from the nuclear power plant in the first vegetal period after the damage. In the following vegetal seasons, the limitations on the use of the agricultural products would not be necessarily introduced; however, in order to rise its computability and, in case it is economically justified, it is desirable to take some specialized protective measures in the zone of the maximum deposition of the radioactive substances.

In order to determine the critical components of the biote of the agroecosystems, the literary data on the affect of the ionizing radiation on the kinds of agricultural plants and animals were analyzed. As the literary data state, the 50 per cent losses are possible when the absorbed doses are in the range of 3 – 6 Gr for the mammals and over 5 Gr for the majority of the agricultural plants. The chronic irradiation in the dose less than 100mcgr/h will not cause any injuring effects on the mammal animals. The indicated value of doses may be considered as the minimum admissible values of the ionizing radiation. The negative effects of the radiation are not predicted for the biote in case the accumulated dose is 0.3 Gr in the first month after the irradiation, when the medium dose power is 10 mGr/day.

The prediction of the dose loads on the representatives of the agrosystems biote makes it possible to make the conclusion about the absence of the radiation – induced effects in the time of the standart falls – out of the nuclear power plant. The range of the doses of the outer radiation will make up from several mZv at the soil surface because of the doses from the stream of the radioactive gases, flowing from the ventilation pipe, up to the portions of mkZv from the rest sources (the clouds of the radioactive gases and aerosols, the radiation of radionuclides deposited on the soil).

The irradiation in time of the falls – out of the maximum projected damage will also produce no radiation – induced influence because of the insignificant doses of the ionizing radiation. The maximum doses of the outer radiation will make up from several mZv at the surface of the soil because of the doses of the stream of the radioactive gases, flowing out of the ventilation pipe, up to the portions of mZv from the remaining sources (the clouds of the radioactive gases and aerosols, the radiation the radionuclides deposited on the soil).

Accordingly, the radiation influence on the biote of the agroecosystems both at the standard falls – out, and at the emergency falls – out will not result in the ruin of the vegetation, the reduction of the harvest, the loss of the cattle or other negative influences.

The planning of the possible measures during the liquidation of the consequences of the damages at the nuclear power plant is based on the division of the after-damage radiation situation into two periods:

- taking the urgent organizational measures directly after the radioactive fall-out and during the first afterdamage year designed for minimizing the results of irradiating the animals;
- taking a complex of measures directed on obtaining the products of the plant-growing and the cattle – breeding corresponding to “RAL” in the following years.

In order to get the full and detailed information about the levels of the contamination of the agricultural plants and products, and also for predicting the radiation situation under the conditions of the intensive conducting of the forest economy on the territory of the 30 km zone, the proposals on the system of the local radioecological monitoring were worked out. The system is based on the monitoring static grounds in the three zones of observation and the information necessary for the monitoring will be received by taking the measures of the operative control, in order to detect additional contamination and to control periodically for the evaluation of the radiation – ecological state of the agro – and – forest ecosystems. The developed system will become a safe bases for solving the complex problem of the effective management of the territory neighboring to the Belarusian nuclear power plant.

4.4. Biological components of water ecosystems.

4.4.1. Assessment of water ecosystems condition within 30 km zone round NPP site.

On the territory of the 30 km zone, there are a number of the water-flows and the water reservoirs having a significant ecological importance. The unique ecological water – flows include the ecosystems of the rivers Viliya and its tributaries, in which live and spawn rare for the Republic of Belarus kinds of the salmon fish, put into the Red book. A part of the water ecosystems of the 30 km zone is included into specially protected natural areas (SPNA). Here are situated the extremely picturesque, having the high recreation potential the Sorochansky lakes that are the heart of the “Sorochansky lakes” reservation, and also the great reservoirs that are very important in the fish economy and the recreation – the Svir lake and the Vishnevoye lake (the National park “Narochansky”). The biotic associations (the plankton, periphyton, bentos, macrophyts) in the life process actively influence upon the formation of the quality of waters, determine the intensity of the biological selfrefinement and the level of the efficiency of the water reservoirs. The biological process in a great extent, determine the action in the reservoirs of such specific contaminators as radionuclides, connected with the nuclear power plant. The main biological processes, determining the transport of the radionuclides in the water basins and the regularity of their distribution in the components of the water ecosystems, include the processes of the biosystesis of the organic substance and its further biogenous transformation. The biological structures, constantly formed in the process of the photosynthesis, are represented by the phytoplankton, periphyton, macrophyts, and also by the products of their transformation – the detritus and the heterotrophic organisms, - immobilize the radionuclides, including them into the composition of the biomasses. Thus, the new formation of the organic substance (the primary product) is connected with the functioning of the biological pump, continuously pumping the radionuclides from the solution into the suspension state. The further destiny of the radionuclides and other contaminators, associated with the biological structures, is determined by the biotic circulation, the main element of which are the strophic relations of the water organisms. Being the suspension form, the radionuclides migrate along the food circuit, accumulating partially in the biomass, and returning partially into the water medium with the products of the metabolism of the water organisms.

Within the frames of the project, the expeditionary research of the water ecosystems located in the 30 km zone, and the structurally – functional parameters of their biotic associations were researched. The aim of the researches was the estimation of the level and the intensity of the biological processes, determining the formation of the quantity of waters, and also the analysis of the structural organization of the associations of the water organisms as the index of the ecological state of the researched water basins and water – flows. The objects, the stations and the alignments of the observation have been chosen so that the results of their research would give the integral estimation of the ecological situation in the water basins and the water – flows, and later might be used in the system of the ecological monitoring of the surface waters.

The characteristic feature of the water ecosystems is the availability of the special structural and functional component – seston (the aggregate of the suspended parties in the thick of the water).

The role of the seston in functioning of the water ecosystems is great and diverse. Because the living organisms are a part of the seston, all the aspects of the plankton metabolism are closely connected with this structural block of the ecosystem, and, first of all, the main links of biotic rotation – the products, the transformation and the mineralization of the organic substance. However, not only the plankton organisms, but also the whole complex of the seston as the aggregate of the fine – dispersion parties produce significant influence on the rotation of the substance and the energy streams in the ecosystem. So, for example, the suspended substances influence actively on the processes of the destruction and the vital activity of the microbial association. The suspension totally determines the possibility of existing of the most important and specific component of the water ecosystems – the association of the organisms with the filtering type of feeding. Through the mechanisms of the sedimentation, the seston is connected with the vital activity of the bentosous associations and is an important functional link in the system of "water – ground depositions".

The quality of water, the biological productivity and the ecological state of the water ecosystem is formed in the in the course of the complex process of the biotic rotation, the starting mechanism of which is the functioning of the autotrophic associations. In the result of their vital activity, in the process of the photosynthesis, the new formation of the organic substance (the primary product) takes place, that then is transformed and mineralized by the heterotrophic associations.

In the researched water basins and water – flows of the 30 km zone, simultaneously with measuring the gross primary product of the plankton, the destruction (the speed of consuming the oxygen in the thick of the water), characterizing the heterotrophic activity of the plankton association, was determined. The value of the biochemical consumption of the oxygen was also measured – "Biological oxygen demand in 5 days". The latter index, often used in the practice of the sanitary researches, characterizes an important parameter of the quality of the water – the amount of the labile fraction of the organic substance.

In the river Viliya at both alignments, an extremely high gross primary product of the plankton (7.9 and 7.7 mg O2/l per 24 hours) was observed. At a relatively low destruction of the organic substance, the pure product of the plankton appeared to be significant (7.01 and 6.76 mg O2/l 24 hours). The values of "Biological oxygen demand in 5 days" – 4.01 and 4.66 mg O2/l exceeded the fishing industry norms of "MAC" (3.0 mg O2/l). The high values of the gross and pure primary product were noted also in the river Oshmyanka (5.8 and 5.2 mgO2/l per 24 hours) at a relatively low value of "Biological oxygen demand in 5 days" (2.85 mg O2/l per 24 hours). In the remaining rivers, the values of all the considered indices were significationtly lower and corresponded to the level characteristic for moderately eutrophic waters.

Thus, among the water basins and the water – flows of the 30 km zone it is possible to distinguish the river Viliya having a highly level of trophies, the high speeds of the new formations of fine-dispersed biological structures (the phytoplankton organisms and the products of their transformation).

4.4.2. Biotic communities structure.

The phytoplankton. The species richness of the phytoplankton of the water-flows and water basins of the 30 km zone is sufficiently high. In the period of the researches, 209 species were detected.

The comparison of the species composition and the quantitative growth of the phytoplankton in the researched rivers and lakes has shown that the greatest species variability and the highest indices of the quantitative growth of the phytoplankton and also the level of its product can be found in the river Viliya. In other rivers compared to the river Viliya, the biomass of the phytoplankton, for example, was almost 5 times lower.

The researched water – flows distinguished by various saturation: kinds of classes of the water – plants that indicates the peculiarity of their species composition. In all the researched water – flows the diatomaceous water – plants predominated. The peculiarity of the researched water – flows, to differentiate from the large rivers of the republic, in the period of the researches the golden water – plants were abundantly growing. In the large rivers the golden water – plants make up, as a rule, 4 – 6 per cent of the total number of the discovered species. In the river Viliya they made up 9.6 in the tributaries – 27.8 (the river Stracha), 18.0 (the river Losha), 15.3 (the river Oshmyanka), 14. 3 per cent (the river Gosovka). In the majority of the small rivers the golden water – plants were a part of the dominating complex either in the range of the dominants (more than 10 per cent) or the subdominants (5.1 – 10.0 per cent), giving way to the main dominants – the representatives of the diatomaceous and cryptophytous water – plants.

The indices of the species diversity (the idex of Shennon) and the levellinfg of the associations (the index of Pielou) for both the lakes and the rivers turned out to be high, close to the upper level of their values. The high values of the indices manifest a large diversity of the phytoplankton associations in the researched period of time and their polydominantress, and this in turn, means a sufficiently high degree of their structural organization and stability to the existing modern factors of the environment.

The zooplankton. The river plankton of the 30 km zone, in the period of the research, had 21 species, and the lake plankton – 32 species of the invertebrates, and this manifests the significant species wealth of the zooplankton of the researched region. Among the rivers the greatest number of species were found in the river Viliya (21), and the smallest number – in the river Gosovka (9).

A high indicator significance among the organisms of the zooplankton have the Rotifera of the genus Brachionus. Practically in all the researched rivers, except the river Gosovka, the species of the given genus – Brachionus angularis, B. calyciflorus and B. urceus. In the river Oshmyanka B. angularis was a part of the species – dominants with the portion in the total amount of the zooplankton equal to 15.4 per cent.

The value of the index of Shennon, characterizing the total diversity of the association, and the index of Pielou characterizing the leveling both for the rivers and for the lakes, are sufficiently high. So, the value of the index of Shennon ranged within the limits 1.54 – 3.07 bit/specimen (0.94 0 2. 34 bit/g); the index of Piolon – 0.49 – 0.96 bit/specimen (0.29 – 0.75 bit/g).

Thus, by the totality of the indices, characterizing the structural organization of the associations of the zooplankton, it is possible to conclude that the ecosystems of the researched water basins and the water – flows of the 30 km zone function in a standard regime.

The periphyton. The characteristic feature of any fresh water ecosystem is the availability in larger or smaller scales of the bordering surfaces, separating the liquid (water) and solid (the substratum of different character and origin) phase. At border of the separation of the phases, a complex of the specific physical – chemical – hydrodynamic conditions acts, these conditions determine the isolation of the independent biotope – the periphytaly. The existence of the periphyton is connected with the periphitaly.

According to the present – day ideas, the periphyton means the complex formed on the surface of the solid substrate, independently of the origin of the latter (natural, artificial), under the conditions more flexible than the bottom of the basin and including the autotrophic (the water – plants, the cyanic bacteria) and heterotrophic (the bacteria, the fungi, the inuvertebrate) organisms, and also the organic substance of different origin and different degree of processing (detritus). The periphyton may be considered a bright example of manifesting an "extreme effect", that is "condensing the life" at the bordier of separating the liquid (water) and the solid (the substrate of different character and origin) phases, where significantly increase the species diversity, the biomass and the metabolic activity of the organisms.

The abundance of the periphyton on the macrophytes in the lakes of the 30 km zone is significantly less than in the rivers.

The medium amounts for the lakes vary in the limits from 3.9 to 25.8 mg/10 cm2. The maximum amount of the general mass of the periphyton is noted in the lake Edy, the minimum amount – in the lake Zolovskoye.

In the periphyton of all the researched rivers, the mineral fraction predominates over the organic fraction. The minimum amount of the ashness made up 57.3 per cent (the rivers stracha), the maximum amount 78.6 per cent (the river Viliya). The ashness of the periphyton of the lakes is significantly smaller, comparing with the periphyton of the rivers: in the majority of lakes the amounts are within (49 – 61) per cent. The exception is the lake Golubino, in the periphyton of which the organic franction significantly exceeds the mineral franction (the ashness of 29.5 per cent).

On the whole, the indices of the periphyton structure of the researched water basins and water flows correspond the present ideas about the periphyton structural organization in the water ecosystems of the corresponding biolimnetic type and characterize the mode of their functioning as normal.

The springs. In the 30 km zone and the neighbouring territories, there are the water ecosystems of a special type – the springs having an important role in the formation of the general biological diversity of the water basins of the republic of Belarus. A number of cold – loving species of the fresh water invertebrates, originating from the rivers and lakes of the north of Europe and the mountaneouns water basins of the Central Europe, are able to exist on the territory of the Republic of Belarus only in pure and cold waters of the spring.

A very rare species of beetles, inhabiting the springs of the Republic of Belarus, is Agabus guttatus. This specimen may be supposed to be a representative of the relic water glacial fauna. Among cancroids, the crayfish with different legs Synurella ambulans Muller, 1846 (sem. Gammaridae). The synurella is the unique – for the fauna of Belarus – ancient fresh water species of the North American origin. As a relic of the pre – glacial epoch in the fauna of the Republic of Belarus, S. ambulans is of great scientific importance. The springs are the refugiums for a number of the relics of the previous geological epochs, and also a specific link between the fauna of the rivers and lakes of the north Eyrope and the fauna of the cold Alpine water basins of the central Europe. At the same time the spring ecosystems, compared to the lake and river ecosystems, are less resistant to the antropogenous influence. Thus, the ecological valuebility of the spring ecosystems, on one side, and their vulnerability, on the other side, determine the necessity of foreseeing the special measures for protecting the springs. Among these measures, the announcement that the springs are the nature memorials or the reservations and must be guarded may be actual.

4.4.3. Assessment of water quality and ecosystem condition: hydrobiological indicators.

The stress in any manifestation result in significant shifts in the structure and functioning of the associations. Therefore the indices of the associations are the most important indices for the evaluation of the state of the ecosystem and for the further calculation of the ecological risks.

The quality of the water in the researched rivers and lakes was evaluated on the basis the structural and functional indices of the biological associations and the biotic indices.

The indices of Shennon and Pielon in the associations of the phytoplankton in different rivers – compared to other associations – changed in a very small limits – correspondingly 3.2 – 4.0 and 0.7 – 0.8 bit /specimen. In comparison to the phytoplankton, the indices, computed for the periphytonic tests, manifest more exact differences between the researched water – flows, both by the level of the species diversity, and by the alignment.

In the lake ecosystems, the periphyton association was characterized by the maximum variations of the indices, that indicates the higher indicator potential of overgrowths.

The level of the biovaricty in the lakes did not significantly differ, the value of the indices of Shennon and Pielon were a little lower in the lake Golibino, maximum – in the lakes Turabveiskoye and Gubiza.

On the whole, the indices of the biovariety in the lakes, compared to the river ecosystems, were a little lower.

Indexes of the primary product and the destruction possess a rapid reaction on the variation of the conditions of the medium, and this allows to use the radio of the production – desctruction characteristics for the express – evaluation of the state of the water medium.

Thus, in the zones of the arrival of the contaminated sewage waters, the ratio of the production and the destruction drops below 1, and the high biogenous load increases greatly.

In the rivers, the ratio of the gross primary production of the plankton to the destruction (GPP/D) is between 3 and 9, the maximum values are noted for the rivers Oshmyanka and Viliya, the minimum values – for the river Stracha.

As distrinct from the rivers, the ratio of GPP/D in the lakes was lower, varying from 1 in the lake Golubino to 3 in the lake Vorobjy, and this indicates the greater balance of the production – destruction processes in the lakes.

The calculation of the index of the saprobousness in the rivers and lakes was conducted for the associations of the phytoplankton, the periphyton and the zooplankton, and the calculated data were sufficiently similar for the different associations, varying within 1.5 – 2.0.

On the whole, the researched rivers and lakes may be referred to the β - mezosaprobe zone, and the river Gozovka and the lakes are situated at its border with the oligosaprobe zone, and this allows to characterize the quality of water as sufficiently good.

The performed analysis of the rivers manifested that all of them are characterized by the similar values of the structural and functional indices of the biological associations and the good quality of water.

The highest indices of the quality of water are characteristic for the river Gozovka, then come the rivers Losha, Stracha and Viliya, the lowest indices are in the river Oshmyanka.

The researched lakes represent also the sufficiently uniform massif. The analysed data did not indicate significant differences between them. The values of the structural – functional indices and the saprobe indices in the different wter basins occurred to be alike, and, in the average, for the lakes, they were a little lower than in the rivers. A little-higher indices characterize the lake Gubuza, then come the lakes Vorobjy, uraveiskoye and Edy. The last in the researched row is located the lake Zolovskoye.

Thus, it may be concluded that all the researched rivers and lakes are characterized by the sufficiently good indices of the quality of their water.

4.4.4. Fund material analysis.

The generalization of the accessible materials (the fund and archives materials the period 1957 – 2007 years) of the ecosystem in the 30 km zone allows to conclude the following:

1. The evaluation of the state of the water – flows in the basins of the river Viliya in the 30 km zone indicates the normal functioning of their ecosystems. The associations of the phytoplankton, the phytoperiphyton, the zooplankton and the macrozoobentoses are characterized by the high species riches. The values of the biotical index were within 7 – 10 (I – II classes of cleanness), the values of the index “EPT” also reached 6 -15. The values of the index of the saprobeness, calculated by the phytoplankton, varied from 1.33 to 2.08, by the zooplankton – from 1. 34 to 2.31, by the phytoperiphyton – from 1. 60 to 2. 07 that correspond ends to II – III classes of the cleanness and allows to refer these water-flows to β - mezosaprobe zone.

2. The significant changes of the trophic status of the shallow water lakes of the Sorochansky group, during thje period of 11 years between the complex researches of the lakes in 1980 and 1991 years, did not take place. The appearance of the sharp deficit of the oxygen in the bottom layers in the summer of 1991 in the lakes Beloye, Podkostelok and Turoveyskoe manifests the significant role of the ground depositions in the formation of the oxygen regime in the lakes, and this may indicate the real appearance of the runt phenomena in the winter period.

3. There is a tendency of deteriorating the ecological state of the lake Tumskoye from the group of the medium deep Sorochansk lakes. So, the transparence in the lake in 1957 was 2.7m, in 1980 – 1.9m, and in 1991 – only 1.3 m. In 1991 the sharp oversaturation with the oxygen of the surface layers of water (177 per cent) was noted, and the sharp decrease of it at the depth, which was not observed before. The total biomass of the phytoplankton increased from 2.5 in 1980 to 7.0 g/m3 in 1991. The observed phenomena manifest the increase of the level of the trophium of the lake and the deterioration of the quality of water. The significant changes of the state of the lake Gubesa, in comparison to 1957, did not take place.

4. The increase of the level of the trophium of the lakes Edy and Golubino from the group of the deep Sorachansky lakes is observed.

5. The lakes Svir and Vishnevskoye are characterized as eutrophic water basins. The quality of water in the lakes, according to the indices of the saprobeness, is evaluated by III class (moderately contaminated water).

Thus, the generalization and the analysis of the results of the researches, performed in the frames of the given project, and also of the accessible materials of the last years, allows to make the conclusion that the water – flows and water basins of the 30 km zone are at different levels of eutrophic, however, they function in the normal regime, are characterized by the high species diversity, the great potential of the biological self-refinement and correspond to the basic condition of the water ecosystems of the corresponding biolimnical type.

Construction works will not practically impact on water ecological systems, because all water reservoirs and water flows are moved away from the construction site to a big distance. Viliya-river, which is closest to the construction site, flows at a distance of 6 km.

An important peculiarity of the design of the Belarusian NPP is that there are no cooling water reservoirs which suffer among all types of water ecological systems the biggest thermal, chemical and radiation loadings. The water supply and removal system will operate in a closed cycle without any massive discharge of waste water to Viliya-river. So, the negative NPP impact on the ecological system of Vilya-river will be minimal.

Lake ecological systems will not be subject to direct impact of liquid waste.

4.5 Physical geographical and climatic characteristic of the NPP area and site

The territory of a 30-km zone is located in the northeast of the Republic of Belarus in the Grodno region on the territory of the Narochano-Vilejskaya plain. The territory of the site is in the temperate climatic zone where temperate latitude circulation in the atmosphere prevails.

Depending on either a sea or continental origin of air circulation in the temperate zone they single out sea and continental types of the climate. The character and the intensity of the basic climate forming factors essentially differ in different seasons of the year.

The basic characteristics of a regional climate in the Belarusian nuclear power plant region are given according to the supervision data of the nearest meteorological stations Oshmyany and Lyntupy. The aerologic characteristics of an atmosphere boundary layer are cited basically according to the data of the aerologic stations Minsk and Kaunas. The meteorological stations are on the distance of 30 and 40km from the site of the nuclear power plant (Lyntupy and Oshmyany respectively).

The meteorological conditions of the northern part of the nuclear power plant zone are characterized by the meteorological station Lyntupy, the southern part – by the meteorological station Oshmyany. All the mentioned meteorological stations have long-term supervision periods (more than 40 years) of the basic meteorological parameters, this fact provides their reliability.

The average annual atmospheric temperature of the 30-km zone is within the limits of 5,2-5,4°C, the absolute maximal temperature- within the limits of 34,0-34,6°C, the absolute minimal - within the limits of -31,8 …-39,8°C. The temperature that is equal to 5,4°C is accepted as an estimated average annual atmospheric temperature for the nuclear power plant site. July atmospheric temperatures vary from 16,9 to 17,0°C, and January ones - from 6,5 to 6,7°C below zero. The frost-free period lasts on the average 140-149 days on territory of the zone. In this territory the maximal daily amplitudes of atmospheric temperature fluctuation are observed in the summer and they are 10,6-11,1°C.

In the territory that is under view the average annual temperature of the ground surface is 6-7^{0}C, that is a little bit above the average annual atmospheric temperature (5,2-5,4^{0}C). The absolute maximum of the temperature of the ground surface is within the limits of 54-60^{0}C, and the absolute minimum reaches -36^{0}C.

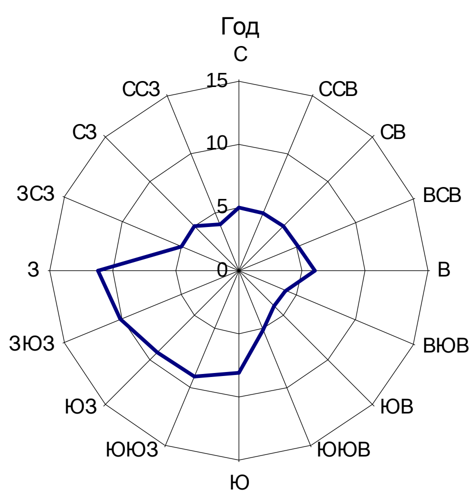
Within the limits of the examined territory the annual quantity of cloudiness is 6,9-7,1 points according to the general overcast and 5,1-5,4 points according to the lower overcast.

According to the amount of the fallen precipitation the examined region, as well as the whole territory of the Republic of Belarus is a sufficient humidifying zone. Here all kinds of precipitation are observed: liquid, firm and mixed. Within a year precipitation spreads unevenly. The maximal annual sum of precipitation of the Belarusian nuclear power plant zone is 1075mm in the north and 828mm in the south of the zone. The maximal monthly sum of precipitation is 215-322mm, it falls on August. On the territory of the zone the least annual sum of precipitation changes from 445mm in the southern part of the zone to 527mm in the northern part. On the examined territory the greatest daily maximum of precipitation was registered in May in the southern part, and in June in the northern part. At the same time the daily precipitation maximum of the zone southern part (101mm) exceeded the daily maximum of the zone northern part (80mm). Within the limits of the zone the average number of days with precipitation within a year varies from 184 till 193 days, the greatest - from 206 till 235 days. The greatest number of days with precipitation falls on July - about 15 days.

The number of days with snow cover in the Belarusian nuclear power plant zone is 111-120 days. On the examined territory an average decade height of snow cover is 19-26cm in the end of February; the greatest of averages - 25-34cm. In the winter a maximal height of the snow cover was 58-72cm and it was noted in the first ten-day period of March.

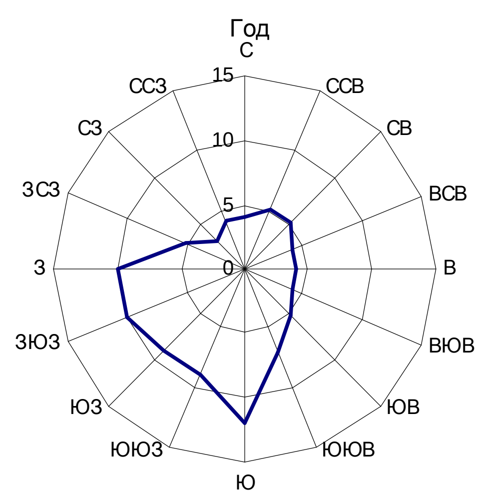
The average sum of the evaporation from the land surface (total evaporation) in the warm period is 370mm within the limits of the examined territory, the greatest monthly sum of 83mm falls on July.

Within a year on the 30-km zone territory of the nuclear power plant the horizon southwest quarter winds prevail. At the same time in the zone southern part the western direction is the most expressed (11 %), in the northern part the southern one is (12 %).



Calm 3

Annual wind rose, the meteorological station Oshmyany



Calm 3

Annual wind rose, the meteorological station Lyntupy

Год – year
С – N
ССВ – NNE
СВ – NE

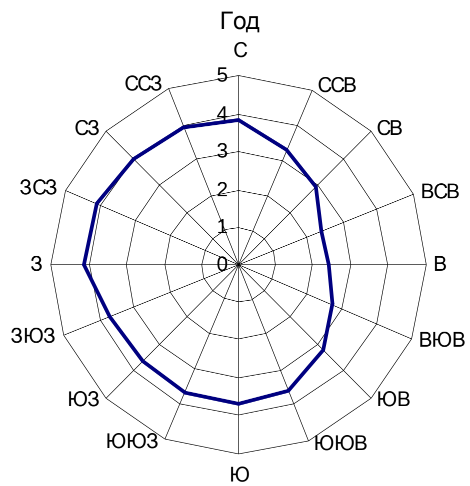
ВСВ – ENE
В – E
ВЮВ – ESE

ЮВ – SE
ЮЮВ – SSE
Ю – S

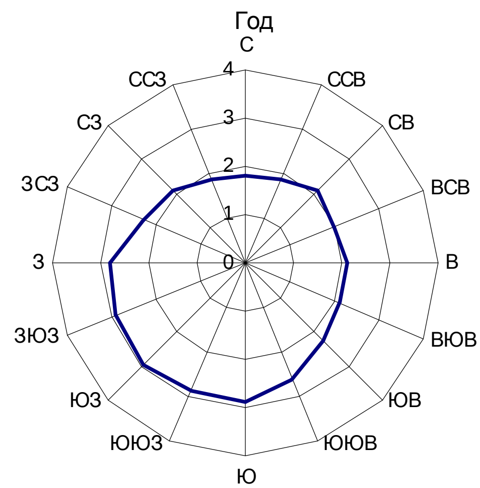
ЮЮЗ – SSW
ЮЗ – SW

ЗЮЗ – WSW
З – W
ЗСЗ – WNW
СЗ – NW
ССЗ – NNW

Within a year the number of calms is the greatest in the northern part of the zone (9%), the least - in the southern one (3%). In the section of certain seasons the greatest number of calms is observed in the summer. In the southern part of the zone there are 5%, in the northern one - 14 %.



Average annual wind speed wind in directions, the meteorological station *Oshmyany*



Average annual wind speed in directions, the meteorological station *Lyntupy*

Год – year
С – N
ССВ – NNE
СВ – NE
ВСВ – ENE
В – E
ВЮВ – ESE
ЮВ – SE
ЮЮВ – SSE
Ю – S

ЮЮЗ – SSW
ЮЗ – SW
ЗЮЗ – WSW
З – W
ЗСЗ – WNW
СЗ – NW
ССЗ – NNW

On the territory of the examined zone the average annual wind speed (without taking into account directions) increases from 2,5m/s in the northern part of the zone to 3,7m/s – in the southern one. During the winter period average monthly speeds of wind are within the limits of 2,8-2,9m/s in the northern part and 4,0-4,3m/s - in the southern one . The maximal impulse reaches 30m/s.

The repetition of calms and weak winds is within the limits of permissible conditions for the deployment of the nuclear power plant. As a whole annually it is about 30%, in the cold period (October-March) - about 24 %.

Within a year in the 30-km zone on the average there are 67 days with fog in the north of the zone and 70 days in the south. During the warm period in the north of the zone there are 20 days with fog, in the south - 22 days. During the cold period the number of days with fog changes from 47 days in the north till 48 days in the south.

On the examined territory the average annual number of days with a thunder-storm is 21-23, the greatest – 37-38. The greatest storm activity is observed during the summer period (May-August), and occasionally there are also winter thunder-storms.

The dangerous weather phenomena, significant for the region of the nuclear power plant can be revealed on territory that is greater than a 30-km zone. In this case the territory of the administrative regions is considered: the Grodno region, the Vitebsk region and the Minsk region. Among dangerous meteorological phenomena on the examined territory there has been strong rain (the number of precipitation is ≥ 50mm within 12 hours and less); heavy hail (diameter – ≥ 20mm); the wind with the speed of 25m/s, hurricanes, squalls and tornados; strong snowstorms (with the wind speed of 15m/s); snowfalls, (the number of precipitation – ≥ 20mm for 12 hours and less); strong fogs (visibility less than 100m); strong silver thaw (the diameter of deposition – ≥ 20mm). It is necessary to note, that the dangerous meteorological phenomena exert a versatile influence on the nuclear station - from additional loadings on the station design (a strong wind, tornados, silver thaw, snowfalls) to the conditions promoting the dispersion of impurity, as well as their transfer to significant distances (strong precipitation, a strong wind).

The distribution of an average wind speed at heights from 100 to 500meters has a seasonal character: the greatest speeds are noted in the autumn and in the winter, and fall on the winds of the western, southern and northern quarters. Average speeds vary from 6 - 7m/s at the height of 100meters to 12 - 13m/s at the height of 500meters. In the zone of the Belarusian nuclear power plant in the cold period the increase of the calm number and weak winds can promote the development of a winter air pollution maximum in separate years.

Ground temperature inversions are distributed evenly between the seasons of the year. In the winter the raised temperature inversions are observed almost twice more often, than in the spring, and almost three times more often, than in the summer. In the autumn their share is also significant. The maximum of ground inversion repetition falls on the warm period of the year, of the raised ones – on the cold period.

The average inversion layer power is the least in the summer and it does not exceed 0,30kilometers. The greatest values both ground, and the raised inversions reach in the winter months and they are 0,58 and 0,45kilometers respectively. Under special weather conditions the power of ground inversions can sometimes exceed 2,0kilometers, raised ones - 1,8kilometers.

At an operation phase of the nuclear power plant its infrastructure will not also exert a considerable influence on the climatic characteristics of the examined region. The Belarusian nuclear power plant can have an insignificant influence on a microclimate as a result of emissions of heat and moisture from cooling systems (up to 1,5 km). The emissions of transport and the formation of dust at the construction stage of the nuclear power plant will not influence climatic and aerologic parameters significantly.

4.6 Chemical and radioactive pollution within 30-km zone

The superficial water chemical composition analysis of the river Gozovka (village Goza), the river Losha (village Gervyaty), the river Viliya (village Mihalishki), the river Oshmyanka (village Velikie Yatsyny) shows, that the examined rivers belong to the rivers with small and average mineralization, the maximal value (according to the dry rest) - 324,8 mg/dm^3. The general rigidity in the rivers has a low value, and a maximal value is 4,90 mg-eq/dm^3 (the river Oshmyanka - settlement Velikie Yatsyny). Among the number of the main ions (macrocomponents) hydracorbonate ions and the ions of calcium dominate.

From the basic polluting substances in the waters of the rivers oil products have been found in the river Goza - 1,0km above the settlement Gozovka - 0,06mg/dm^3 (more than 1 maximum concentration limit), as far as phenols are concerned totally the values from 0,002 - 0,004mg/dm^3 are received. The maximal value of biochemical oxygen consumption parameter is received in the river Viliya within the precincts of the settlement Mihalishki - 5,93mgO_2/dm^3 (about 2 maximum concentration limits), it indicates that the content of the slightly oxidized substance is heightened in the water. The maximal values of ammonia nitrogen are received in the rivers: the Gozovka (1,0km above the settlement Goza) - 0,41mgN/dm^3 and the Viliya (within the precincts of the settlement Mihalishki) - 0,39mgN/dm^3 (more than 1 maximum concentration limit). The maximal value of the common iron content of 0,17mg/dm^3 (more than 1,0 maximum concentration limit) is found out in the rivers: the Goza – the settlement Gozovka and the river Oshmyanka – the settlement Velikie Yatsyny, that is significant practically for the all water objects of the Republic of Belarus. In this connection in the nuclear power plant project it is necessary to provide natural waters iron elimination measures that will be used in the manufacturing cycle of the nuclear power plant.

The maximum concentration limit exceeding of other parameters and components defined in the water objects, located in immediate proximity to a prospective construction site of the Belarusian nuclear power plant, is not registered.

The content of chemical polluting substances and heavy metals in the tests of the soil selected in the borders range of the NPP ground area, does not exceed maximum-allowable values.

The content of cesium-137, strontium-90 and plutonium - 238, 239,240 in the tests of the soil selected on the grounds of the ground area Ostrovets, is within the limits of:

Cesium-137 - 1,0 - 2,5kBq/m^2 (0,027 - 0,067Cu/km^2)

Strontium-90 - 0,17 - 0,37kBq/m^2 (0,005 - 0,01Cu/km^2)

Plutonium Isotopes - 0,026 - 0,074kBq/m^2 (0,0007 - 0,002Cu/km^2).

These values correspond to the level of natural fallout by the results of continued observations (for cesium-137 - 0,01-0,07Cu/km^2, strontium-90 - 0,01 0,05Cu/km^2, plutonium isotopes - 0,001-0,002Cu/km^2);

The content of natural radionuclides uranium-238, thorium-232, радий-226, potassium-40 in the tests of the soil selected on the grounds of the ground area Ostrovets is significant for sod-podsolic and sod-gley soils;

The results of the led soil generalization on the basis of the intensity of migratory processes show, that about 10% of the Belarusian territory of the 30-km zone round the Belarusian NPP site ground are occupied by the soils, which are characterized by a low intensity migration of cesium-137, slightly more than 60% - by the soils, characterized by a moderate migratory ability of this radionuclide, 4,4 % - by the soils, characterized by a high migratory ability, and 25,2 % - by the soils, in which rather high mobility of cesium-137 is observed.

A moderate mobility of strontium-90 is specific for a greater part of the territory of the 30-km zone (85,4% of the Belarusian territory of the 30-km zone). The area of the sites with a heightened mobility of strontium-90 is 9,4%, and the area of sites with a high mobility of radionuclide is 5,2%. According to the soil map, on the examined territory practically there are no soils with a high mobility of strontium-90.

Thus, more than 70% of the territory of the 30-km zone are occupied by the soils, in which the mobility of cesium-137 and strontium-90 is low and moderate, that is a positive factor at an estimation of an alternative ground from the point of view of its suitability for the building of the nuclear power plant. The territory of NPP site itself is practically completely occupied by the soils, in which the migratory ability of radionuclides is moderate.

The level of power of a doze at height of 1m from the ground surface on site is within the limits of from 0,1 to 0,17µSv/h. In nine settlements of the 30-kilometer zone of the nuclear power plant the levels of the soil pollution by cesium-137 are within the limits of: 3,7-10,4kBq/$м^2$ (0,1-0,28 Cu/km^2).

The analysis of the received information about radiation-chemical pollution in the 30-km zone allows drawing a conclusion, that this ground area has no interdictions for building there a radiologically dangerous object.

The received data about radiation-chemical pollution will be accepted as background for comparison and assessment of the influence of the nuclear power plant on the environment at all stages of its life cycle: in the phase of construction, during operation and the removal from the operation.

4.7 Surface waters

Within the limits of the 30-km zone there are 70 water objects, 5 of which are transboundary, 52 are located on the territory of Belarus, 13 – on the territory of the Republic of Lithuania.

The impact of the nuclear power plant on surface waters (quantitative and qualitative characteristics) will be exerted during its construction, operation and the removal from operation.

4.7.1 NPP construction

The basic influence source on the surface waters during the construction of the NPP is liquid waste, including drains, the rests of oil, etc. This waste will be directed to corresponding intermediate storehouse and/or drainage systems. Direct dump of the polluted sewer water in the water will be strictly forbidden. Drains will be processed by a corresponding mode on the installations of sewage processing. The system of gathering of storm water will be also introduced.

As during the construction of the nuclear power plant for the purposes of construction works and domestic water supply the water intake from surface water objects won’t be carried out (water delivery will be provided from the underground water sources) during this period the quantity indicators of the water conditions of the river Viliya and other water objects will not change significantly. During the specified period after the construction of local clearing constructions the dump of the cleared sewage will be carried out in the river Polpe (the tributary of the river Viliya) in the volume which does not exceed 1050 m^3/twenty-four hours.

4.7.2 NPP operation

The basic kind of influence of the nuclear power plant on the surface waters after putting into operation is the change of a hydrological mode of the water objects – the sources of industrial water supply of the nuclear power plant and the receivers of sewage.

Drinking (up to 1050 m^3/twenty-four hours) and technical (during the construction) water supply of the nuclear power plant in the volumes of up to 800 m^3/twenty-four hours will be provided from the underground water intake.

For industrial water supply of the nuclear power plant two alternative variants of the deployment of surface water intake on the left bank of the river Viliya (of the site) can be used: in the settlement Mihalishki and in the settlement Muzhily. Approximate distances from the deployment sites of water intakes on the river Viliya to the grounds are 6-8km. After the withdrawal the water from the river Viliya goes to the station of water-preparation using penstocks, and then to the corresponding constructions of the nuclear power plant. According to the parameters of intensity channel processes and the stability of the channel the deployment of water intakes on a site of the river Viliya near the settlement Muzhyly is more preferable. The water from the river Viliya is got and pumped using pressure water conduits to the ground of the nuclear power plant. Water delivery from water intakes on the river Viliya to the ground of the nuclear power plant is provided with two braches of steel water conduits, the diameter of which is up to 1200mm. Each branch of the water conduct is rated at the passing of the half consumption.

For the provision of the guaranteed uninterrupted water supply mode of the nuclear power plant alternative sources of water supply can be used:

– the Olhovskoe reservoir of a channel type on the river Stracha (the reservoir of the Olhovskaya hydroelectric power station (HPS)) - a priority source of reserve water supply with the distances on watersheds to the sites of water intake deployment up to 18,9km (the useful volume of the reservoir is 1.4 million m^3, a maximal level difference is 3,0m, a surface area is 0,7km^2, an average depth is 3m);

– the Snigyanskoe reservoir of a channel type on the river Oshmyanka (the reservoir of the Pachunskaya hydroelectric power station (HPS)) with the distances on watersheds to the sites of water intake deployment up to 55km (the useful volume of the reservoir is 1,21 million m^3, a maximal level difference is 5,0m, a surface area is 1,5km^2, an average depth is 1,42m).

After putting the nuclear power plant into operation for the industrial water supply of the nuclear power plant for two power units water withdrawal from the river Viliya will be carried out with the consumption up to 2.54 m^3/s. Deploying two power units and if the water discharge in the river is close to the long-term average annual one, water withdrawal from the river will be no more than 4% from the water consumption in the river. If the conditions are water-short and very water-short and there are two power units the water withdrawal is no more, than 8.7%.

The maximal downturn of levels on the site of the river Viliya below the water intake deployment can be:

– if there are two power units and the long-term average annual water consumption is up to 7cm (up to 5cm in a transboundary transit), the minimal consumption is up to 11cm (up to 6cm in a transboundary transit).

Domestic sewage from the territory of the nuclear power plant will come to a sewer pump station and are pumped over to a sewage treatment station. The sewage treatment station is designed in a sanitary-protective zone of the nuclear power plant. Sewage treatment provides full biological refinement with deep removal of nitrogen and phosphorus and additional refinement.

Cleared domestic sewage dump from the ground of the nuclear power plant is provided in the volume nearly 910 $м^3$/twenty-four hours (maximal increase can be up to 3600 $м^3$/twenty-four hours) to one of the nearest watersheds – to the river Polpe.

The forecast of the water quality in the river Viliya after the receipt of the cleared sewage has shown that the most essential influence of sewage extends on the distance up to 1km from the dump place. At the same time the values of quality parameters will be within the limits of or slightly exceed normative maximum allowable concentration (MAC) of the water objects for fishery. Practically full hashing with the river waters of the river Viliya is at the distance of up to 10,4km from the dump place (on the Belarusian territory and more than 20km from the Belarusian-Lithuanian border) with an insignificant change (within the limits of MAC) of water quality in the river to existing and insignificant transboundary influence on the water quality of the river Viliya and other water objects.

As the deployment of the inhabited settlement of the nuclear power plant is provided on the basis of the urban settlement Ostrovets, the sewage treatment from the settlement territory is provided on the existing clearing constructions with their reconstruction and expansion.

4.7.3 NPP decommissioning

During the period of nuclear power plant decommissioning water supply system and water drainage dismantling is made within the limits of the nuclear power plant manufacturing equipment decommissioning for the maintenance of ecological safety of the power unit removed from service, and the prevention of negative influence on the surface waters. Performing these conditions the negative impact of the nuclear power plant on the surface waters (including the ones of the neighbouring countries) will be minimized with quantitative and qualitative characteristics of the surface waters, not worse, than during the nuclear power plant operation period.

4.8 Underground waters

4.8.1 Current condition characteristic

According to hydro-geological division into districts the territory of researches is coordinated to the western slope of the Belarusian hydro-geological massif. The power of fresh waters zone changes over a wide range from 70,0m in the north of the territory to 300,0 and more meters in the south. Fresh underground waters are contained in the depositions of the quaternary, cretaceous, Devonian, Silurian, Ordovician and Cambrian systems and are, as a rule, hydracarbonate magnesium-calcium. Their mineralization changes in the range from 0,15 up to 0,76g/dm^3. The underground waters of not deeply lain aquiferous strata are subject to anthropogenous pollution (agricultural and household). In the fresh underground waters of the prequaternary depositions (cretaceous, Devonian, Silurian, Ordovician and Cambrian aquiferous strata) the traces of anthropogenous pollution are not marked now. The underground waters of the quaternary, Devonian, Silurian and Ordovician depositions are used for drinking water supply in such towns as Ostrovets, Oshmyany, Smorgon, the resort zone *Naroch.* The modern use of the underground waters on group water-intakes is 25-40% from the approved operational stocks. In the deployment area of the Belarusian nuclear power plant there is a significant reserve for satisfaction of drinking water needs due to the underground waters.

4.8.2 Forecast of changes in hydrogeological conditions

Hydrological conditions change is caused by the concentrated selection of the underground waters and territory anthropogenic underflooding. The influence estimation of the water intake *Ostrovetskiy* operation on the level mode of the adjoining territory, including the nuclear power plant deployment ground, has shown that its operation will not have an essential influence on the general regional hydrodynamic scheme of streams. The water-intake influence will be insignificant even in a 50 years. An average radius of the influence of the water- intake *Ostrovetskiy* will be fixed on the distance of 3km in the first water-bearing level and on the distance of 4km in an operated water-bearing level. The influence of this water-intake will not reach the nuclear power plant ground and all the more transboundary territories.

As a result of the solution to the prognostic problems of ground anthropogenic underflooding, i.e. the determination of flow dome sizes, formed due to leaks from water-bearing utility lines and water-containing constructions, it has been shown that anthropogenic water-bearing level maximal growth of one reactor of the Belarusian nuclear power plant (50 years) will be from 6,9 to 20,8m. The flow dome radius of the anthropogenic water-bearing level can be from 1,44 to 2,3km. Prognostic analytical calculations results are preliminary.

4.8.3 Forecast of possible radioactive pollution of underground waters

Prognostic calculations are carried out for two scripts of possible radionuclide receipt to the underground waters:

– as a result of emergency aerosol emissions of the NPP leading to the pollution of vast territories, i.e. from a ground source of pollution;

– as a result of emergency incidents on the NPP site during station operation and its removal from service, i.e. from a local source of pollution.

For a site source of pollution conservative estimation of the consequences of the heaviest radiating accidents on the NPP corresponding to the 5^{th} and 6^{th} classes of the international scale INES IAEA has been performed, in this case water-bearing levels pollution is possible due to radioactive products infiltration from the ground surface – the so-called *Chernobyl* type of underground waters pollution.

For prognostic estimation the program complex MULTIBOX is used, this complex has been developed in Joint Institute for Power and Nuclear Research – Sosny, National Academy of Science of the Republic of Belarus. The developed model and computing programs have been tested by comparing the results of calculations with international programs, such as DUST, GWSCREEN, AMBER. The model verification and approbation have been carried out on the basis of the comparison settlement researches while estimating the safety of numerous items of a decontamination waste burial place of the Chernobyl origin, located on the territory of the Republic of Belarus, with the data about underground waters monitoring near controlled objects. Settlement and experimental data are agreed within the limits of initial information uncertainty.

The forecast is carried out according to four representative grounds that reflect the most typical soil and geological-hydro-geological conditions for the 30-km zone territory. The ratio of polluting substance migration time *(Tm)* and pollution potential danger time (T_{pd}) - (T_m/T_{pd}) > 1 and the ratio of radionuclide concentration in the dissolved form (C_w) and the level of intervention according to potable water (C_{hc}) for examined pollutants $1 > C_{wotn} = C_w/C_{hc}$ have been used as criteria of ground waters invulnerability.

4.8.4 Forecast assessment results for cesium-137 and strontium-90

Forecast assessment results of cesium-137 and strontium-90 have shown that

1 The ground waters are poorly protected from pollution by strontium-90 on the sites with peat-bog soils. In the case of a nasty accident ground waters pollution with the concentration exceeding the intervention level is possible. If there are accidents of a

lower level the ground waters pollution by strontium-90 is possible probably, but with the concentration below the intervention level.

2 Seasonal fluctuations of the ground waters level and ploughed up soil condition are inauspicious unrecorded factors which can lead to migratory processes acceleration and radionuclide concentration increase of strontium-90 in the ground waters, it can vastly increase radionuclide concentration in a water-soluble condition and consequently in the ground waters too.

3 If an accident is beyond the project (INES 5) the ground waters are practically impregnable to the examined kinds of pollution on the chosen sites that are poorly protected. If operational emissions and accidents are below INES 5 on the designed nuclear power plant territory the probability of the ground waters pollution, and, consequently, deeper levels will be insignificantly small. It coincides with the conclusions of Russian experts about rather favorable radiating conditions on the territories adjoining to the nuclear power plant, when the station functions normally.

The researches of underground waters possible radioactive pollution of underground waters from a local source in the supervision zone of the designed nuclear power plant have been carried out on the basis of the hypothetical script of the emergency connected with the storehouse leaking of the liquid A-waste. According to this script $15m^3$ of the liquid A-waste, the total activity - 600Cu, presented by 25 radioisotopes, have been thrown out on the ground, as a result the territory of the area $37,5m^2$ on the depth of 1m has undergone to pollution.

The conservative estimation of underground waters possible pollution from an examined local source have been carried out for 16 radioisotopes with the half-life period $Td=1\text{-}10^9$ years with the least values of sorption characteristics. With the purpose of revealing of the most dangerous radioisotopes for some of them additional calculations according to the average values of migratory parameters have been performed. The ratio sum of the radioisotopes settlement concentration in water bearing levels (C_{wa}) to the corresponding intervention levels according to potable water ($\sum C_{wa.rel\ i} = \sum C_{wa\ i}/C_{hc\ i}$) 1) has been used as a criterion of safe water use.

The calculations of underground waters possible pollution from a local source in the most conservative assumptions have been carried out in the following sequence:

- the hypothetical script of the radionuclides fast vertical migration **(step 1)** in the surrounding geosphere right up to lower water bearing levels due to the water intake well deployment in immediate proximity to the polluted area;

- the script of the radionuclides migration in the geosphere with natural conditions of underground waters movement in a horizontal direction **(step 2)**, taking into consideration water exchange between water bearing levels.

For **step 1** it is received, that the receipt of the following radionuclides in the underground waters is possible:

tritium	$C_{wa.rel}$ (max) = 220 - 510	in 4 – 6 years;
strontium-90	$C_{wa.rel}$ (max) = 760 - 7600	in 90 – 150 years;
Iodine-129	$C_{wa.rel}$ (max) = 3,7 - 4.4	in 20 years;
technetium-99	$C_{wa.rel}$ (max) = 2,9 - 4,5	in 6 – 10 years.

The radionuclides niobium-94, plutonium-239,240, uranium-234 can reach water bearing levels as a result of a rapid migration, in the concentration close to the level of intervention ($1> C_{wa.rel} > 0,1$), and uranium-234 can do it in the nearest 20 years after an accident, and niobium-94, plutonium-239,240 – in more than 10000 years.

The assessment of average values K_d lead to the conclusion, that the dangerous pollution of all water bearing levels is possible only on non-typical grounds, tritium and the top water bearing level - strontium-90. The radioisotopes technetium-99, iodine-129 can introduce the contribution to the pollution of lower water-bearing levels as can reach the underground waters in the quantity close to the level of intervention (1> $C_{wa.отн}$> 0,1).

For **step 2** the following results are achieved:

According to prognostic conservative estimation the following radionuclides can come to the first water-bearing level in the concentration exceeding the level of intervention:

tritium	$C_{wa.rel}$ *(max) = 19 - 570*	in 4-8 years;
ctrontium-90	$C_{wa.rel}$ *(max) = (0,034 - 1.15) 104*	in 40 – 150 years;
Iodine-129	$C_{wa.rel}$ *(max) = 1,9 - 14*	in 10 – 20 years;
technetium-99	$C_{wa.rel}$ *(max) = 1,9 - 8,5*	in 8 – 10 years.

The maximal range of the radionuclides migration can be 2400m, the average one - 300-500m.

It is established by the prognostic estimation that even according to the most conservative approach the pollution of the second and the third water-bearing lines can be insignificantly small. These levels are well enough protected by natural barriers.

4.8.5 Forecast of possible chemical pollution of underground waters

The prognostic calculations of chemical pollution hearth formation during the Belarusian NPP operation have shown that the ground waters – the underground waters of the water-bearing level that is the first from the surface – are most subject to pollution. The concentration of polluting substances (a neutral contaminant), filtered to the ground waters, will be about ½ of the initial one in waste or industrial waters. On the area the aura of pollution can extend with the ground waters to the distance of about 2,5km from the station ground. The concentration of the polluting substances filtered to the confined water, will be about 10^{-4} from the initial one in waste or industrial waters. Proceeding from the above-stated, the chemical pollution of Dneprovsko-Sozhskiy pressure water-bearing level, that is first from the surface and is formed due to the sewage leak, is not predicted.

4.8.6 Water protection measures

1 The deployment of the Belarusian nuclear power plant ground on the territory, that is characterized by the aeration zone of more than 10m and it is combined by soils with great contents of clay particles which are a natural barrier against chemical and radioactive pollution penetration into the underground waters.

2 The organization of gathering, withdrawal and clearing of the superficial (rain, thawed, distributing) a drain from the industrial ground territory.

3 The localization of the territory sites where the pouring of liquid A-waste is possible{

4 Quite strengthened hydroisolation of water-bearing utility lines, and also the presence of water-catchers in water-cooling towers for prevention of the formation of the flow dome.

5 To provide an artificial drainage of the sites potentially subject to underflooding.

6 If the nuclear power plant operates in a normal way, according to the object status and the regulatory-legislative documentation requirements, the organization of the underground waters monitoring is necessary. The hydro-geological objects of supervision in the nuclear power plant deployment area, and also on the 30-km zone territory, are the water-bearing lines: the ground waters, Dneprovsko-Sozhskiy, Berezinskiy, Devonian, Ordovician-Silurian, Cambrian.

The following processes should be traced and supervised in the deployment area and the 30-km zone by constant supervision over the underground waters condition:

- the underflooding process of the territory and engineering-technological infrastructure of the nuclear power plant (the monitoring of underflooding processes);

- the process of underground waters chemical pollution (the monitoring of chemical pollution);

- the process of underground waters radioactive pollution (the monitoring of radioactive pollution).

7 The water supply of the 30-km zone settlements is necessary to organize due to the use of the underground waters that are protected from the penetration of water-bearing lines radiating.

4.9 Population and demography

4.9.1 Population. Demography

As of 01.01.2007 in the 30-km zone 36000 people are residing. At a distance of 1,5 km from the NPP site there are no settlements, at a distance of 3 km 200 people are residing, at a distance of 5 km - 800 people.

Density of the population in the region under consideration is 15 people/km^2 (disregarding the population of the Republic of Lithuania). In regards to the quantity in the structure of the populated points dominate small settlings (less than 100 people.), and their share constitutes 85,6 %.

4.9.2 Morbility

The comparative analysis made over the primary sickness rate of the Republic of Belarus population (the sickness sum total, on which cause the population applied for medical help for the first time in the given year), being performed in the division of 13 main sickness classes according to the International Classification of Diseases (ICD-10), within the period of 2004-2008 years, has shown, that there has not been any specific changes in 2008 year in contrast to 2004 amongst the analyzed classes of sickness.

In the first rank place, as over the whole of the republic, so for the regions there were found diseases of breathing organs - 36,5 %, in the second place there were found diseases of the bone-muscular system and connective tissue - 8,3 %, in the third place - diseases of skin and subdermal cellulose - 6,1 %.

While valuing the dynamics of primary oncology sickness rate among the population of the republic within 2004-2008 years, it is possible to note the sickness rate growth by 6,9 % for the whole of the republic. And in Grodno region, Minsk region and Vitebsk region this growth was found to be within the range from 2,8 % to 8,8 %. As for the individual regions in these areas, in Ostrovetsk region there has taken place reduction by 13,8 %, in Smorgon - reduction by 13,5 %, in Postavy - reduction by 5,3 %. In Oshmyany region there has occurred growth by 10,6 %, in Myadel region - growth by 55,8 %. The average factors for the sickness rate within the five-year period for this areas and regions were found to be within the range from 320,3 cases to 392,8 cases per 100,0 thousand of people, and only in Myadel region this factor constituted 469,1 cases per 100,0 thousand of people, which considerably exceeded the republican and regional levels. In 2004 the factors for the sickness rate in Vitebsk region, Postavy region and Minsk region were found to be above the average republican level, in 2008 year within all regions of Grodno region and Vitebsk region this factor was below the republican level. For Minsk region the factor for the sickness rate exceeded the republican level by 2,9 %, and in Myadel region it was above the republican level by 33,1 %.

4.9.3 Accident scenarios

Within the motivation framework of the NPP safety there were considered the following categories for the starting events:

- the maximum design-basis accident (MDA);
- the beyond design-basis accident (BDA) - (refer to point 5.1.1).

There have been analyzed 13 scenarios for meteorological conditions, corresponding to winter and summer seasons (meteorological data have been submitted by the RCRCEM).

There were calculated total efficient doses of radiation for the population (the doses received from the clouds, from precipitations, efficient inhalation doses), the doses of radiation for thyroid gland, received from inhalation and doses of radiation at the account of peroral consumption of radio nuclides with milk and leaf vegetables for the 1-st month after the damage (for the summer scenarios).

Maximum design-basis accident.

While carrying out model-based analysis the emission of radio nuclides into the surrounding ambience after the maximum design-basis accident of the PWR reactor will constitute 1,1 ×1014 Bq, from them: iodine-131 - $4{,}7\times10^{11}$ Bq, cesium-137 - $2{,}7\times10^{10}$ Bq.

The analysis performed over the doses for internal and external radiation under the worst meteorological conditions has shown, that the maximum total efficient dose will constitute 0,108 mSv (the dose received from the clouds - 0,021 mSv, the dose received from precipitations - 0,019 mSv, the efficient inhalation dose - 0,068 mSv), the dose of the thyroid gland radiation, received from inhalation will constitute 1,7 mGy.

The maximum doses of the radiation at the account of drinking milk polluted by cesium-137 will constitute millisievert units , while those, received at the account of leaf vegetables consumption - will constitute hundredth shares of millisievert. The maximum doses of radiation for thyroid gland to account of drinking milk polluted by iodine-131 will constitute tenths of milligray, to account of leaf vegetables - units of milligray.

Thereby, in the event of MDA there is no need in undertaking defensive measures, because the calculated forecasted doses of the radiation do not exceed the criterion for undertaking defensive measures (100 mSv over the whole body and/or 50 mGy on thyroid gland for the first 7 days following after the damage.)

4.10 Assessment of risk of impact on public health from air pollution produced by heat power plants with different fuels (NPP alternatives)

Assessment of risk of impact on public health was executed under the influence of polluting materials, conditioned by steam and gas thermal electric station (TES), which main fuel is natural gas, and dust-and- coal thermal electric station (TES) which main fuel is stone coal.

Hygienic estimation of the degree for the danger of contamination atmospheric air under simultaneous presence of several harmful chemical materials in the air was conducted according to the size of total factor for contamination "P", taking into account the level of maximum allowable concentration, the class of materials danger, the amount of polluting materials jointly present in the atmosphere.

The performed calculation of the degree for contamination the atmospheric air according to the maximum near ground concentrations of the polluting materials with provision for the background constitutes the value, corresponding to the allowable (I) degree of contamination the atmospheric air with the factor "P" values being 0,533 and 1,114 for TES on gaseous and solid fuels correspondingly.

According to gradation of the population health to the allowable level of the atmosphere contamination corresponds to the background level of sickness rate and such gradation of the population health, like "adaptation".

According to the scale of risks the level of carcinogenic risk is considered as acceptable (low priority, acting managerial system over the risk, no required additional measures).

At estimation of the polluting materials influence, possessing the mechanism with no threshold for making influence on health of the population, there were taken into consideration two main types of risk:

- individual cancerigenic risk - additional (to the background one) risk for the person to fall ill with oncology sickness during his life under the influence of concrete chemical material in the determined concentration;
- cancerigenic risk for the population - is the risk, reflecting additional (to the background one) number of cases of the malignant new growing tumors, capable to appear within the life length as the consequence of influence of the factor being under investigation.

Estimation of potential risk to the health of the population, received from the influence of chemical materials, possessing threshold (non-cancerigenic) mechanism of influence was conducted on the basis of calculation for the following factors:

- potential risk of reflex action;
- potential risk of chronic action;
- the factor of danger;
- the index of danger.

At calculation of potential risk, rendered from the reflex action, as its effect, there was valued not only the risk of sickness appearance, but also the probability of reflex reactions appearance (sensation of irritation, unpleasant scent and etc.) or the effects of psychological discomfort which was also estimated as health breach.

In both variants (steam-and-gas and dust-and-coal TES) the potential risk for development beside the population of reflex effects with immediate action of near ground concentrations of polluting materials with provision for the background has been valued as the acceptable one (Risk<0,02).

Potential risk of chronic action on the health of the population from the near ground concentrations of polluting materials with provision for the background is in the same way valued as the acceptable one (Risk<0,05).

The factor of danger for development of disadvantageous effects beside the population under a short period of influence is valued as minimum and low.

In the variant with steam-and-gas TES the index of danger from the development of disadvantageous effect on the part of breathing organs, cardiovascular and central nervous system under a short period of influence is valued as low (0,1<FD<1,0).

In the event of the dust-and-coal TES the index of danger from the development of disadvantageous effects under a short period influence on the part of central nervous and cardiovascular system is valued as low (0,1<FD<1,0), on the part of breathing organs - as the average one (1,0<FD<5,0).

The factor of danger for development of disadvantageous effects under chronic inhalation influence is valued as minimum in both variants.

The index of danger for development of disadvantageous effects on the part of breathing organs, central nervous system and cardiovascular system under chronic inhalation influence is valued as minimum (FD<0,1) in both variants.

The individual and population annual cancerigenic risk from the influence of benzopyrene concentrations on health of the population is valued as the acceptable one.

4.11 Assessment of impact of technogenic emergencies in the 30-km zone on the station operation

In the course of the performed investigations there were evaluated the risks, rendered from appearance of technogenic dangers within 30 km zone and the influence of their consequences on the station operation.

On the territory of Ostrovetsk region within the period from 2002 to 2008 years there have taken place 519 fires (349 - having technogenic nature and 170 - in the natural ecological system) (See the Table 25).

Table 25 – Statistical data for the fire amount

Types of fire	Amount per years, pcs.						
	2002	2003	2004	2005	2006	2007	2008
Wildfire	32	9	4	7	16	2	–
Peat fire	31	–	1	–	1	–	–
Combustion of herb	14	5	3	2	32	3	8
Technogenic fire	63	50	55	56	52	41	32
TOTAL	140	64	63	65	101	46	40

From the total number of technogenic fire, within the 30 km zone there have occurred 8 fires at industrial and agricultural objects, including one case with blast of dust-and-air media.

Within the 30 km zone there are located 143 industrial and agricultural objects presenting firing danger (See the table 26). From them - 11 explosive and 3 chemical dangerous objects.

Table 26 - List of industrial and agricultural objects

Type of objects	Amount of objects
Industrial objects	8
Cattle breeding complexes	60
Milk goods farms	64
Pig breeding complexes	10
Poultry breeding farms	1
TOTAL	143

Right in the 30-km zone there are superhighways P-45 and P-48 passing, as well as the railway pathway Molodechno-Vilnius with the stations of Gudogay and Soly. The most rapprochement of the automobile roads with the platform constitutes 4 and 5 km, of the railway - 22 km.

Also within 22 km from the platform there is passing the gas pipe for natural gas (methane - 95,6 %). The gas pipe with D=1000 mm, the distance between the cutting shutters in the gas pipe - 50 km, nominal pressure in the gas pipe - 55 atmospheres, the operation exploitation pressure - 32 atmospheres.

The objects pertain to firing-and-explosion dangerous enterprises, which are producing, keeping on storage, and transporting explosive products or products, which under the determined condition are gaining ability to inflammation or explosion.

To such objects, there must be referred, first of all, industrial enterprises, in which production there are used explosives and materials, having high degree of firing capability, as well as railway, automobile and pipe-line transport, as carrying the greatest responsibility during transportation of loads capable for firing.

Damages, which may take place at fire-and-explosion dangerous objects are characterized by the following striking factors:

- by the air shock wave (hereinafter – ASW) - appearing at miscellaneous sorts of blast, including those under explosive conversions of fuel-air mixtures, at blasts of reservoirs with overheated liquid and reservoirs being under pressure;
- by heat radiation of fires at oxidizing processes with different materials;
- by fragmentation fields, created with flying debris of different sorts, obtained from technological equipment of the objects and etc.

Into the basis for modeling the emergency situation there is laid causal relationship of two processes: the influence of striking factors upon the object and resistance of the same object to this influence.

For NPP there are provided the following degrees of danger according to the consequences of influence, made on the surrounding ambience from the processes, phenomena and factors of natural and technogenic origin (See the table 27).

Table 27 - Categorization of the processes according to the degree of danger

Process, phenomena and factor	Probable influence	Maximum borders of the parameters, according to which there is realized categorization for the degree of danger upon the surrounding ambience	Degree of danger according to the consequence after the influence
Fire due to external reasons	Dangerous factors of fire (smoke, increasing temperatures of the surrounding ambience, toxic products of combustion)	Equivalent area of surfaces, struck by fire, is more or equal to 10 km^2, spare stock of combustible materials provides combustion and influence on NPP more than within 2 hours	I
Ditto	Ditto	Ditto, but the influence on the platform around the NPP location is less or equal to 2 hours	II
Blast at the object	Air shock wave, flying subjects, smoke, gas, dust, accompanying fires	Pressure within the front of the air shock wave is more or is equal to 30 kPa	I
Ditto	Ditto	Pressure within the front of the air shock wave is less 30 kPa, but is more or equal to 1 kPa	II

,,	,,	Pressure within the front of the air shock wave is less 1 kPa	III
Emission of explosive, inflammable gases and aerosols into the atmosphere, blast of drifting clouds	Air shock wave, flying subjects, smoke, gas, dust, accompanying fires, shaking of the ground	Pressure within the front of the air shock wave is more or is equal to 30 kPa	I
Emission of explosive, inflammable gases and aerosols into the atmosphere, blast of drifting clouds	Air shock wave, flying subjects, smoke, gas, dust, accompanying fires, shaking of the ground	Pressure within the front of the air shock wave is less 30 kPa, but is more or equal to 1 kPa	II
Ditto	Ditto	Pressure within the front of the air shock wave is less 1 kPa	III
Emission of toxic vapors, gases and aerosols into the atmosphere	Increasing concentration of toxic gases and aerosols	Nominal parameters: exceed the maximum admissible values below the maximum allowed values	II III

Also for risk evaluation of the emergencies at fire- and explosion dangerous objects there were used probability values of mortality for individual elements of the economy object, its technological equipment, injury for the personnel and population.

Having valued possible sources of technogenic emergency situations within the zone of observation over the NPP there has been concluded that:

- under possible emergencies at objects being dangerous with firing, located within 30-km zone , the parameters of striking factors with maximum allowable values do not overrun the object borders;
- objects being dangerous with explosion, located within 30 km zone, may be referred to III group according to the danger degree of their maximum consequences influence after the possible damage (a blast) upon operation of the Belarusian NPP (the pressure within the front of the air shock wave is less 1 kPa);
- the automobile roads and the railway, passing near the platform, may be referred to III group according to the danger degree of the maximum consequences influence after the possible damage (a blast) upon operation of the Belarusian NPP (pressure within the front of the air shock wave is less 1 kPa);
- the gas pipe, passing near the platform, may be referred to III group according to the danger degree of the maximum consequences influence after the possible damage (a blast) upon operation of the Belarusian NPP (pressure within the front of the air shock wave is less 1 kPa);

The influence from emission of explosive, inflammable gases and aerosols into the atmosphere, blast of drifting clouds on the territory of the platform is excluded, the nominal parameters of the emission within the zone of the station is below the maximum allowed values, which corresponds to III degree of the danger. This is a process (the phenomena, factor), not representing danger and not being accompanied with appreciable consequences for functioning of the NPP.

At determination of the borders for possible danger, potential danger and safe regions it has been revealed, that the objects do not pertain to categories of civil defense, but present danger, which is limited by the radius of the surplus pressure action within the front of the air shock wave after the damage. The radius of the surplus pressure action within the front air shock wave during the damage is less the distance to the supposed accommodation of the NPP platform. Consequently, these objects do not present any danger for the place of accommodation of the Belarusian NPP platform.

The territories of the populated points do not pertain to groups for civil defense.

The safe regions form the territories, located outside the influence borders of the dangerous factors from firing- and explosion dangerous objects, as well as outside the influence borders from chemical dangerous materials, available at industrial objects, cattle breeding complexes, milk goods farms and poultry farms, located within the zone of observation.

Analysis over the estimation results for probability of the technogenic emergency situation appearance within 30-km zone shows, that the level of technogenic dangers at the considered territory constitutes 97,9 % from the average value along the whole republic and is acceptable.

The attracted power and facilities, are enough for liquidation of emergency situations within the zone of observation.

5. TRANSBOUNDARY IMPACT

5.1 Radioactive emission in case of a beyond design-basis accident

5.1.1 Results of modeling of radioactive pollution in case of a beyond design-basis accident during a warm season

For modeling of the radioactive pollution spreading within the atmosphere under **beyond design-basis accident** / **maximum design-basis accident** depending on the meteorological conditions there was used an automated system for making analysis and forecast of radiation situation RECASS NT (Roshydromet, Information Analysis Center (SE SPA "Typhoon")). The automatic system RECASS NT was received by RCRCEM within the framework for realization of the Program of the Union State "Improvement and development of the united technology for reception, summation, analysis and forecast, keeping and spreading hydro-meteorological information and the data about the natural ambience contamination (the second stage) for 2003-2006 years". The RECASS NT has been introduced and for many years was successfully used in Roshydromet, Information Analysis Center, at the Russian NPP: Leningrad, Volgodonsk, Novovoronezh, Kolisk, Beloyarsk, Bilibinsk, Smolensk, Kalinin, Kursk, as well as in RCRCEM Department for hydro-meteorology in Ministry of Natural Resources of the Republic of Belarus.

Calculation of radioactive contamination spreading under beyond design-basis accident / maximum design-basis accident has been performed with the use of the models for various spatial solution. These models are:

- meso-scale model – up to100 km (was used for maximum design-basis accident);
- trans-border model - ~ 10^3 km (was used for beyond design-basis accident).

These models calculate density fields for contamination of underlying surface as the result of dry/humid precipitation, being integrated according to the time of near ground concentration and the field of near ground concentration of radio nuclides within concrete moments of time. The calculations are terminated, when the cloud escapes from the source of the emission at maximum for the model distance or when the spare stock of radioactive material has decreased to 1 E-14 from the initial volume.

With the aim for operation of the models for carrying the polluting materials within the atmosphere there were used the data from the objective analysis and the numerical forecast for meteorological parameters over the standard geopotential surfaces from the forecasting centers of the Worldwide meteorological organization (WMO), received by the RCRCEM. These are accounting fields for meteorological parameters at the level of the ground (10 meters above the level of the ground for the wind components and 2 meters above the level of the ground for the temperature) and at standard geopotential surfaces - 1000 gPa; 925 gPa; 850 gPa; 700 gPa; 500 gPa. The results of making models for carrying the polluting materials within the atmosphere - these are the data for integral fallouts of radioactive materials on the underlying surface after 24 hours from beginning of the damage in the manner of spatial fields with the values in the grid elements with regular increment having the prescribed accuracy and discreteness. The received data were integrated into the media GIS MapInfo in the manner of thematic layer on a digital map of the territory of the Republic Belarus having the scale 1: 100000. For making models of radio nuclides carrying within the atmosphere there were used the data of forecasted fields for meteorological parameters at different periods of the year.

For calculation of radioactive contamination under meteorological conditions of summer term of the year there were considered 2 scenarios for beyond design-basis accident (having heavy consequences).

Scenario 1 included the following parameters:

- the period of making models - 24 hours;
- duration of the emission - 1 hour;
- composition of the emission - iodine-131, cesium-137;
- dynamics of the upper and bottom edges of the emission - 21-25 meters;
- the efficient diameter of the source – 3 meters;
- velocity of the output 1,8 m/sec,
- overheat - 30 ºC.

The emission of isotopes: iodine-131 - 1 E+14 Bq, cesium-137 - 1 E+13 Bq (the maximum emergency emission (MEE) for LNPP-2).

The calculation for radioactive contamination of the territory was produced with use of the transborder model. In the event of transborder contamination there was produced calculation of the contamination zones area (for different levels), falling on the territory of the adjacent states.

5.1.2 Modeling results analysis

Contamination of the territory of the adjacent state (the Republic of Lithuania) is possible along north-west and south-west directions of the radioactive emission trace under conditions of beyond design-basis accident . In table 21 there are listed results of calculation of the pollution of the Republic of Lithuania with Iodine-131 and cesium-137 under conditions of BDA with North-West emission trace.

Table 28 - Area of radioactive contamination

Iodine - 131					
Level of contamination, kBq/m^2	0,8-3,7	3,7-7,4	7,4-37	37-74	74-190
Contamination area, km^2	4366	1678	1371	77,3	2,4
Cesium -137					
Level of contamination, kBq/m^2	0,2-0,37	0,37-0,74	0,74-3,7	3,7-7,4	7,4-19
Contamination area, km^2	2320	1736	1436	89	4.1

It is shown in the table that the level of contamination of the territory of the Republic of Lithuania with cesium-137 will not exceed не превысит 19 kBq/m^2 (0,5 Cu/km^2), and the area of contamination will be 4,1 km^2. As a result of the carried out analysis the average value of the soil background contamination with cesium-137 is 1,7 kBq/m^2 (0,045 Cu/km^2).

5.1.3 NPP environmental impact

It should be noted that modern technical decisions in the sphere of security protection of project NPP-2006 (PWR-1200) provide lower levels of emergency emissions of NPP (Table 29, 30)

Table 29 - Maximum emergency emission of radio nuclides into the surrounding ambience through passive ventilation system of Novovoronezh NPP-2

Radio nuclide	Emission, Bq
Mo – 99	$4,75.\ 10^{12}$
Sr – 90	$1,09.\ 10^{11}$
Sr – 91	$1,89.\ 10^{11}$
Sr – 89	$1,34.\ 10^{12}$
Ru – 106	$6,91.\ 10^{11}$
Ru – 103	$2,08.\ 10^{12}$
I – 131 *	$3,45.\ 10^{12}$
I – 132 *	$4,28.\ 10^{12}$
Te – 132	$3,82.\ 10^{12}$
Te - 131m	$7,54.\ 10^{10}$
Te – 133	$1,21.\ 10^{12}$
Xe – 133	$7,49.\ 10^{15}$
Cs – 137	$4,00.\ 10^{11}$
Cs – 134	$6,40.\ 10^{11}$
Cs – 136	$9,94.\ 10^{10}$
Ba – 140	$3,68.\ 10^{12}$
La - 140	$2,90.\ 10^{12}$
Ce – 141	$5,77.\ 10^{11}$
Ce – 143	$2,93.\ 10^{11}$
Ce – 144	$4,38.\ 10^{11}$
Total	$7,52.\ 10^{15}$

* There is specified total Emission of molecular, aerosol and organic iodine

Table 30 – Release of radio nuclides into the surrounding ambience to account of bypass for beyond design-basis accident.
Height of the emission H = 0 m. Novovoronezh NPP-2

Radio nuclide	Emission, Bq
Mo – 99	$4{,}75.\ 10^{13}$
Sr – 90	$1{,}09.\ 10^{12}$
Sr – 91	$1{,}89.\ 10^{12}$
Sr – 89	$1{,}34.\ 10^{13}$
Ru – 106	$6{,}91.\ 10^{12}$
Ru – 103	$2{,}08.\ 10^{13}$
I - 131 *	$3{,}16.\ 10^{13}$
I - 132 *	$3{,}93.\ 10^{13}$
Te – 132	$3{,}82.\ 10^{13}$
Te - 131m	$7{,}54.\ 10^{11}$
Te – 133	$1{,}21.\ 10^{13}$
Xe – 133	$7{,}49.\ 10^{13}$
Cs – 137	$4{,}00.\ 10^{12}$
Cs – 134	$6{,}40.\ 10^{12}$
Cs – 136	$9{,}94.\ 10^{11}$
Ba – 140	$3{,}68.\ 10^{13}$
La - 140	$2{,}90.\ 10^{13}$
Ce – 141	$5{,}77.\ 10^{12}$
Ce – 143	$2{,}93.\ 10^{12}$
Ce – 144	$4{,}38.\ 10^{11}$
Total	$7{,}52.\ 10^{14}$

* There is specified total Emission of molecular, aerosol and organic iodine

The offered values for maximum emergency emission at Novovoronezh NPP are by two or three orders below the values, used in the calculation. Taking into consideration proportional dependency of the type "activity - density of contamination", it is possible to state, that contamination of the territory of the Republic of Lithuania by long living radio nuclides as the result after maximum emergency emission at the Belarusian NPP will be absent.

Really, let us conduct the process of verification for the EUR planned factors of ecological influence for NPP - 2006 (EUR Requirements, Volume 2, Chapter 1 - Requirements for safety. Appendix B, pages B8-B19). According to these requirements for 9 reference isotopes (^{133}Xe, ^{131}I, ^{137}Cs, ^{131m}Te, ^{90}Sr, ^{103}Ru, ^{140}La, ^{141}Ce, ^{140}Ba) there must be determined three main criteria (See the Table 31).

Table 31 - EUR Criteria of maximum influence

Name of criterion	Value, EUR	Calculation, tables 29,30
Criterion of the maximum influence for non-usage of emergency actions outside the borders, within 800 m from the reactor, B1	Less $5x10^{-2}$	3.7×10^{-2}

Criterion of the maximum influence for non-usage of postponed measures outside the borders, within 3 km from the reactor, B2	Less $3x10^{-2}$	$2,6 \times 10^{-4}$
Criterion of the maximum influence for non-usage of long-period actions outside the borders, within 800 m from the reactor, B3	Less $1x10^{-1}$	$4,3 \times 10^{-3}$

Estimation of the maximum influence in a part of the influence upon the economy is conducted by comparison of the Emission total amount at the level of the ground and high-altitude Emission during the whole Emission with reference values (See Table 32).

Table 32 - EUR Criteria of maximum influence

Isotope	EUR (Target index TBq)	Values of tables 29,30 (TBq)		
		Height, 79 m	Height, 0 m	Total
^{131}I	4000	3,45	31,6	35,06
^{137}Cs	30	0,4	4,00	4,40
^{90}Sr	400	0,1	1,09	1,19

From consideration of the tables 31, 32 it is obvious, that collection of safety active and passive systems, applicable in the NPP-2006 project completely provides performance of the requirements laid to the EUR ecological safety.

5.2 Forecast of possible transboundary impact of the Belarusian NPP on surface waters

Possible transboundary impact of the Belarusian NPP on the surface waters is expressed in possible changing the water mode of transborder and other water objects.

5.2.1 NPP construction

Since at construction of the NPP for the purpose of the works performance and economic-drinking water-supply there will not be realized taking of water from the surface water sources (the water supply will be provided from the underground water sources), in the given period there will not occur essential change in the quantitative factors of the water mode for Viliya river and other water objects. Within the specified period there will be realized pouring down of the rectified sewages into the river Viliya in the volume, not prevailing 1050 m^3/day.

5.2.2 NPP operation

After commissioning of the NPP into operation for production water-supply of the NPP for two energy blocks there will be realized water bringing from the river Viliya with consumption up to 2,54 m^3/sec. At accommodation of two energy blocks at consumption of water in the river, close to the average long-term value, extraction of water from the river will constitute not more, than 4 % from expenditure of water in the river. Under conditions of the shallow year and expenditure of water in the river, being close to the minimum average monthly summer-autumn and winter lowest water level

95 % of probability for exceeding (PE) under two energy units - not more, than 8,4 %. Under conditions of very shallow year and consumption of water in the river, being close to the minimum average monthly summer-autumn and winter lowest water level 97 % of probability for exceeding (PE) under two energy units - not more, than 8,7 %.

Maximum lowering of the water level in the transborder range of the river Viliya may constitute at two energy blocks and average long-term consumption of water up to 5 cm, under minimum consumption – up to 6 cm.

Forecast of the speed mode for the river Viliya at accommodation of the Belarusian NPP has shown minute reduction of the current average velocities (maximum - by 0,04 m/sec) within the region of the river below accommodation of water taking out and non-essential change in the transborder range.

Within the period of the NPP exploitation there will be realized water escape of the rectified used sewages into the river Viliya in the volume of 910,9 m^3/day with their allowable maximum increase up to 3600 m^3/day.

The forecast for water quality in the river of Viliya after arrival of the rectified sewages from the Belarusian NPP at its construction and after commissioning has shown, that at a distance up to 10,4 km from the place of the water pouring down there occurs practically full mixing with river waters (on the Belarusian territory and more than within 20 km from the Belarusian-Lithuanian border) with unessential transboundary impact upon the quality of water in the river Viliya and other water objects to account of minute (within the values of maximum admissible concentration) change of the water quality in the river in relation to the existing quality.

5.2.3 NPP decommissioning

For provision of ecological safety for the energy block, taken from operation, and for prevention of the negative influence upon the surface waters the de-assembly operations of the system for water-supply and water pouring down within the period of the NPP removal from exploitation are performed step-by-step with decommissioning of the NPP technological equipment. When performing the stipulated conditions the negative influence of the Belarusian NPP on the surface waters (including those of the nearby countries) will be minimized with quantitative and qualitative features of the surface waters, not worse, than within the period of the NPP exploitation.

5.2.4 Results of assessment of possible radioactive nuclide pollution of water streams and transboundary transfer of radioactive pollution

For making forecast of radio nuclides migration along the river Viliya and for estimation of forecasting concentrations in the river water at the transboundary range (the border with the Republic of Lithuania) there is used a RIVMORPH program complex for calculation of technogenic admixtures migration within fragments of the river systems. For comparison of the results there are performed calculations for migration of the radio nuclides dissoluble form with using the single-dimensional mathematical model for carrying contamination. As a whole, both mathematical models of migration have shown close results. In the generalized form the results of estimation for allowable radio nuclide contamination of the river Viliya and transboundary carrying of radioactive contamination for the most disadvantageous meteorological conditions under maximum precipitation of radio nuclides upon water surface were shown in the Figures 14 …16 and in the Table 33.

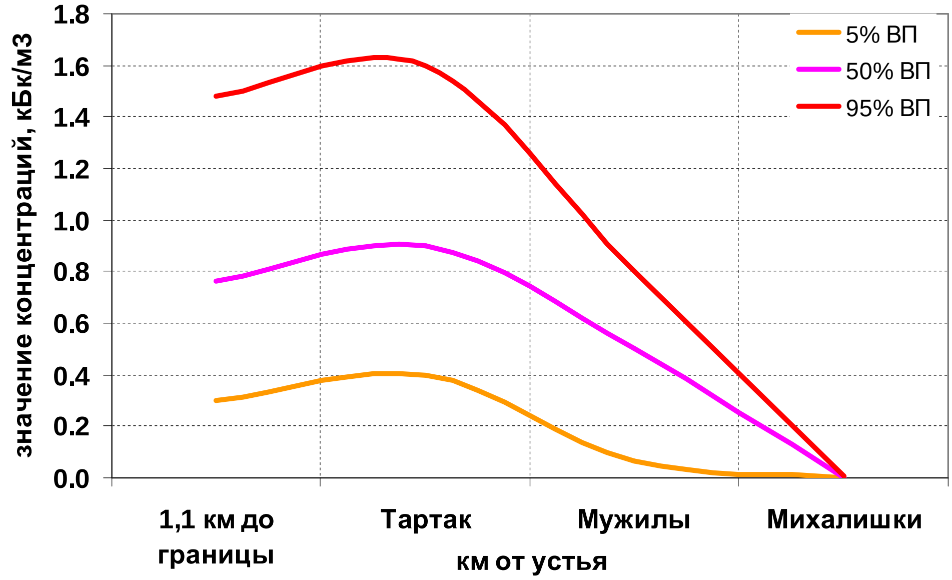


Figure 14 - Dynamics of changing concentration ^{90}Strontium along the river Viliya for different watering variants

Значение концентраций, кБк/м^3	Concentration value, kBq/m^3
1,1 км до границы км от устья	1,1 km to the border km from the mouth

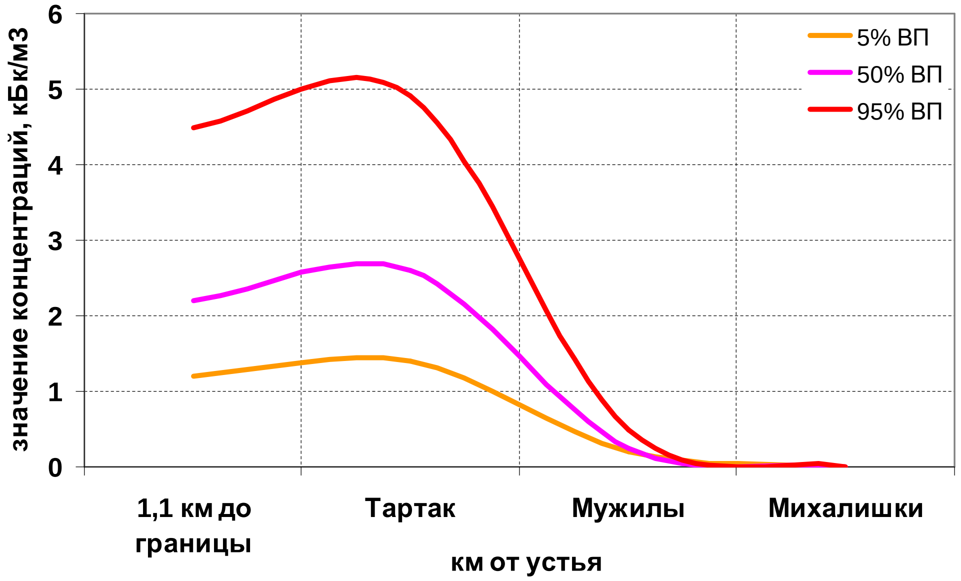


Figure 15 - Dynamics of changing concentration ^{137}Cs along the river Viliya for different watering variants

Значение концентраций, кБк/м^3	Concentration value, kBq/m^3
1,1 км до границы км от устья	1,1 km to the border km from the mouth

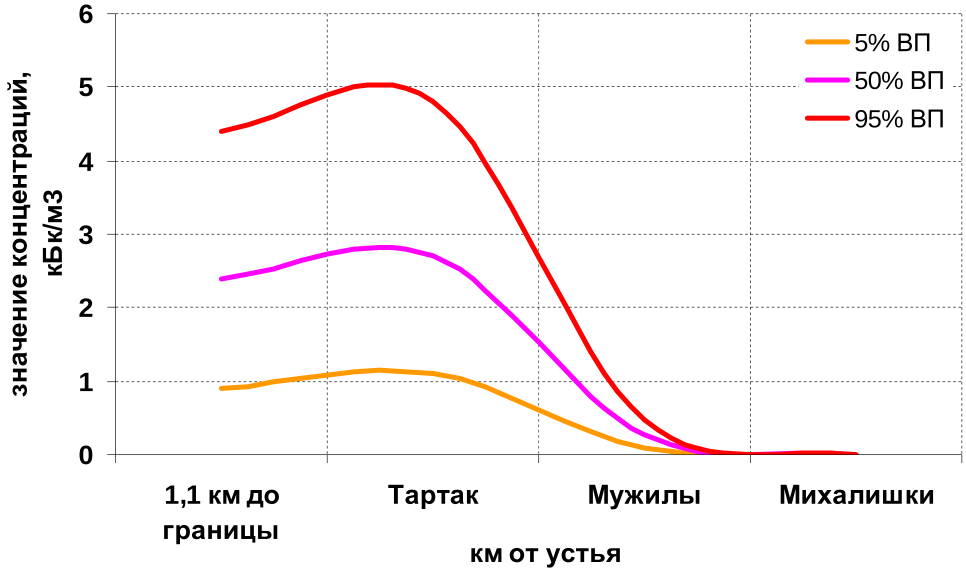


Figure 16 - Dynamics of changing concentration Iodine-131 along the river Viliya for different watering variants

Значение концентраций, кБк/м^3	Concentration value, kBq/m^3
1,1 км до границы км от устья	1,1 km to the border km from the mouth

Table 33 - Result of calculation for running time and maximum concentrations of radio nuclides

Variant of watering	Running time of the radio nuclides front to the range being 1,1 km from the border, hour	Maximum concentration in transboundary range being 1,1 km from the border, kBq/m^3		
		^{90}Sr	**^{137}Cs**	**^{131}I**
5 % supply	4,56	0,3	1,2	0,9
50 % supply	10,2	0,76	2,2	2,4
95 % supply	13,2	1,48	4,5	4,4

5.2.5 Conclusions on possible radioactive nuclide pollution of water streams and transboundary transfer of radioactive pollution

Analysis of the results from the calculations shows:

1. Reduction of concentrations in the torchlight of radio nuclides occurs to account of erosion of the spot with convection currents and diffusion within the transport water media.

2. Total concentrations of radio nuclides are defined basically by their dissolved form.

3. Advancement of radioactive spot in its tail part is retained to account of radio nuclides exchange between the bottom and water media. Full erosion of

radioactivity in its tail part occurs for 15-20 hours. The front edge of the spot advances at the speed of transportation media.

4. Full passage of the radioactive material main mass in dissolved form over the accounting region occurs within 100-120 hours from beginning of the water escape.

5. As may be seen from the presented data the maximum concentration of radio nuclides within the transborder range of the river Viliya (the settlement Bystrica) does not exceed the values for the level of interference for drinking water, recommended in the Radiation Safety Standards 2000 for drinking water: strontium-90 - 5 kBq/m^3 , cesium-137 - 11 kBq/m^3 , iod-131 - 6,3 kBq/m^3.

5.3 Forecast of possible transboundary pollution of underground waters

Carrying of polluting materials in the transborder aspect is conditioned by hydrodynamic situation (see Figure 17).

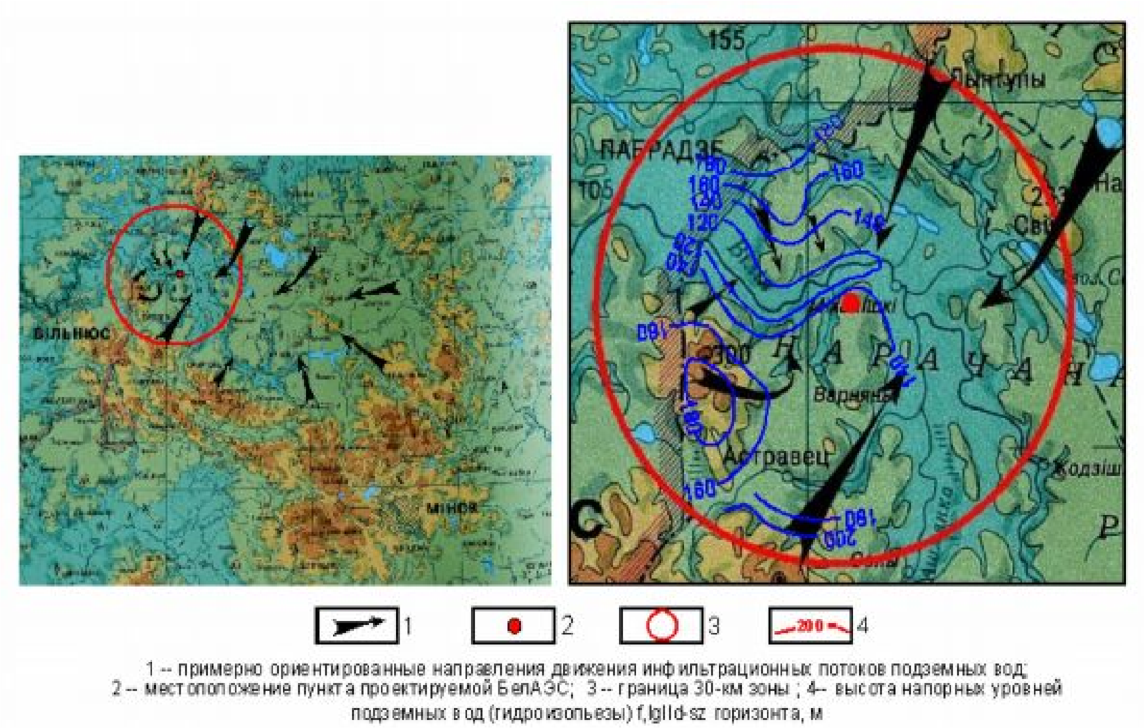


Figure 17 – Layout for creation of the hydrodynamic situation

1 – approximately oriented directions of motion for infiltration streams of underground waters	
2 – location of the point for the Belarusian NPP project	
3 – border of the 30-km zone	
4 – height of pressure levels in underground waters of the horizon	

For estimation of possible transboundary impacts there is designed a mathematical model, reflecting regional hydrodynamic layout of underground water streams within the transborder territory. While making analysis of hydro-geological conditions there are chosen three most water supplied horizons, located in the zone of active water exchange: Dnieper-Soj, Berezino-Dnieper and united before-Quaternary water carrying complexes, which constitute hydrodynamic situation within transborder territories and are used for the purpose of economic-drinking water-supply on the territory of the Republic of Belarus and the Republic of Lithuania .

Coming from the results of the studies over the conditions for shaping and transit of underground waters in Dnieper-Soj, Berezino-Dnieper and united before-Quaternary water carrying complexes along most of the territory within 30-km zone from the republic of Belarus aside the Republic of Lithuania is not tracked, but, it signifies, that transborder carrying of the polluting materials with underground waters is not forecasted.

5.3.1 Assessment of possible changes in hydrodynamic conditions on the territory with transboundary impact

5.3.1.1 Changes in hydro-dynamic conditions

The main technogenic factor, influencing upon changing position of the underground water level, is exploitation of the group water collection pipe for drinking water-supply. In this connection, the forecast for changing hydro-dynamic conditions, executed on the mathematical model has shown, that under existing and perspective water collection at water supply "Ostrovetskiy" reduction of the level (depression crater) on the territory, adjoining to the water supply, within the exploited water carrying horizon will not exceed the radius of 4 km. Thereby, water extraction of underground water by group water sources will not bring to the regional change, all the more, at the territories near the border. Water extraction, realized with single bore holes in rural settlements possesses periodic nature (the bore holes operation - 2-3 hours in a day) and has minute volume, in connection with which, on the adjoining territory there are not created depression craters, all the more, of regional type.

5.3.1.2 Risk of transboundary transfer of chemical pollution

Chemical pollution of underground water in the region of the Belarusian NPP accommodation may be created to account of drains from the systems, taking sewages away (being in domestic usage, after production processes and etc.). Spreading of contamination is conditioned by hydro-dynamic conditions of the territory since the polluting materials are moving together with flow of underground water. Due to the fact, that the distance from the place of the supposed accommodation for the Belarusian NPP is equal approximately to 23 km to the transboundary territory of the Republic of Lithuania and the river Viliya is the main drain stream for the underground waters over the territory of 30-km zone, which conditions the direction for the flow motion into the direction of its valley, advancement of polluting materials with flow of underground waters (both ground, and pressurized Quaternary and before-Quaternary) into the direction of the Republic of Lithuania is not forecasted. The additional studies of polluting materials migration has shown, that accommodation and operation of the NPP within the accounted period of exploitation may bring to creation of the chemical contamination halo in the first from the surface water carrying horizon, at that, spreading of contamination (neutral contaminant) up to the maximum allowable concentration level will not advance further than 2,5 km from the contour of the Belarusian NPP platform. Thereby, transborder chemical contamination of underground waters over the territory of the Republic of Lithuania while operating the Belarusian NPP is not predicted.

5.3.1.3 Risk of transboundary transfer of radioactive pollution

The executed studies of migration for radioactive materials from the platform and local sources has shown, that arrival of radioactive contamination into the river network within 30-km zone is practically excluded. The zone of influence from the local source of contamination for the underground water in the event of its location on the territory of the NPP platform is limited by the region of leakage of ground waters onto the day surface. In this connection transboundary carrying of radio nuclides together with the underground waters is not predicted.

5.4 Dose burden for population in case of a beyond design-basis population

The radio nuclides Emission into the surrounding ambience under the most heavy beyond design-basis accident will constitute $1,5\times10^{16}$ Bq, of them iodine-131 - $4,1\times10^{14}$ Bq, cesium-137 - $1,7\times10^{13}$ Bq, stronciy-90 - $1,5\times10^{12}$ Bq.

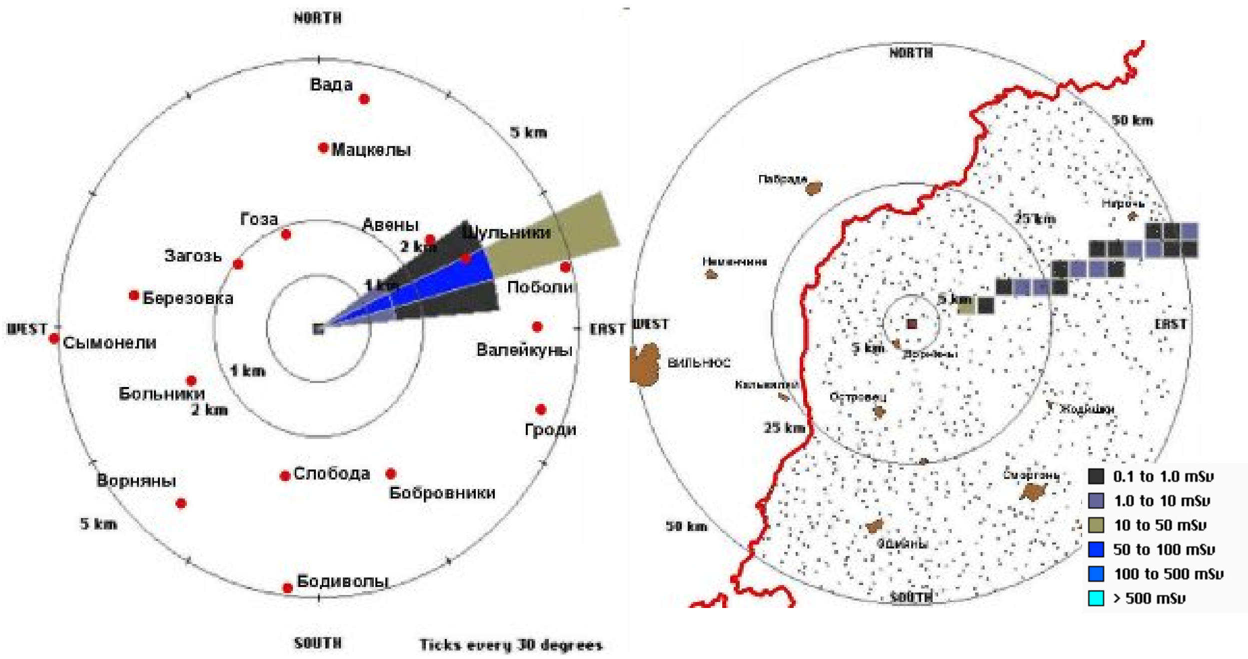


Figure 18 - Efficient doses of radiation over the population in near and far-field zone of NPP, mSv

Under the worst meteorological conditions the maximum total efficient dose will constitute 93,5 mSv (the dose, received from clouds - 3,5 mSv, the dose, received from precipitations - 11 mSv, efficient inhalation dose - 79 mSv) (See the Figure 18), dose of the radiation over the thyroid gland from inhalation will constitute 1500 mGy (See the Figure 19).

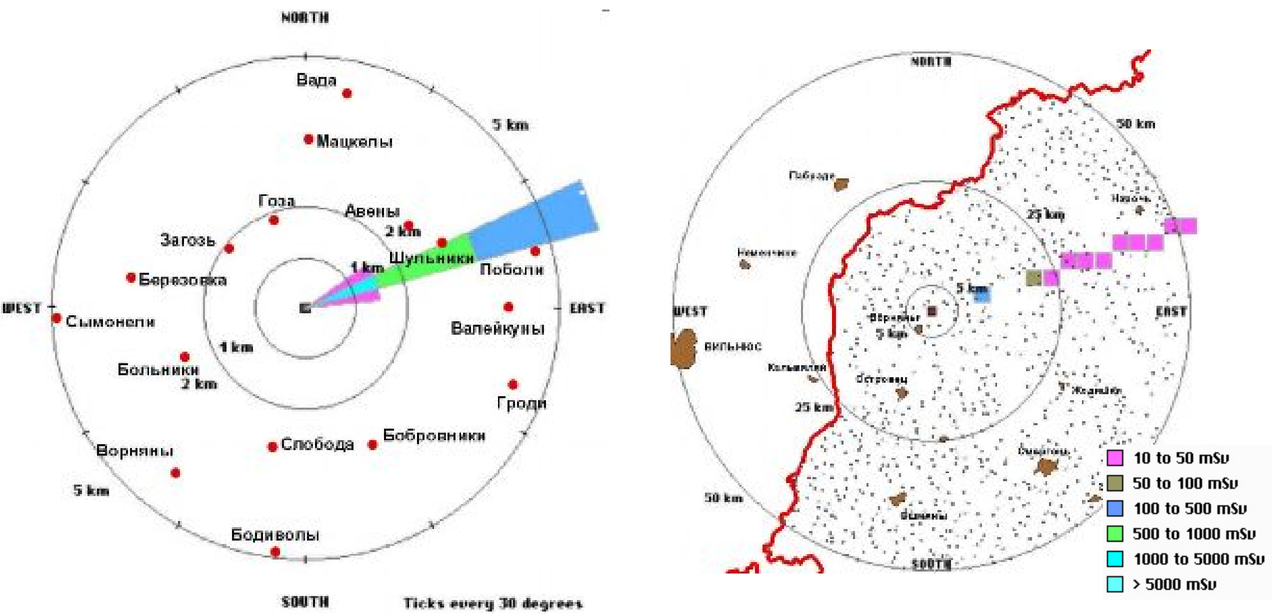


Figure 19 - Doses of radiation over the thyroid gland within 5-km and 50- km zones from the NPP, mSv (mGy)

The maximum dose for radiation at the account of drinking milk, polluted by Cs-137 will constitute 13,8 mSv, at the account of leaf vegetables consumption - 4,6 mSv. Maximum doses of radiation for the thyroid gland at the account of drinking milk, polluted by I-131 will not exceed 400 mGy, at the account of leaf vegetables consumption - 50 mGy.

5.4.1 Population protection in case of accidents

The international normative documents select the following zones of planning the emergency measures for protection of the population and their sizes:

- a zone, designed for measures of preventive protection (3 - 5 km) – is the zone around the NPP, in respect of which there are conducted actions for realization of urgent preventive measures in the event of nucleus emergency case for the reason of risk reduction for appearance of heavy deterministic effects outside the platform. The measures of protection within this zone must be taken before or soon after the radioactive materials Emission or during radiation on the basis of the situation, created at the NPP.

- a zone, designed for measures of urgent preventive protection (20 km) – is the zone around the NPP, in respect of which there are conducted actions, directed at realization of protection measures in the event of nucleus emergency case for the reason of stochastic effects prevention in such degree, in which this is practically realizable, by prevention of the doses in accordance with the international documents. The measures of protection within this zone must be executed on the basis of monitoring the surrounding ambience or in the behooving cases with provision for situation, created at the NPP.

- a zone, designed for restriction of consumption of the feeding products (300 km) – is the zone around the NPP, in respect of which there are conducted actions, directed at realization of countermeasures (for instance, agricultural), preventing the peroral arrival of radio nuclides with water and food-stuff of local production, and long-term protection measures for the reason of prevention of the great collective doses for radiation in that degree, in which this is practically realizable, by prevention of doses in accordance with the international documents. The measures of protection within this zone must be executed on the basis of monitoring the surrounding ambience and the products of feeding.

6. Environmental protection measures

In the process of the NPP construction, while planning the territory, moving masses of the earth, at storehouses of inert materials there is taking place filling the atmosphere with dust.

However this possesses local and short-period nature, and with provision for applicable actions on dust suppression, eventually, does not bring any changes into conditions of the surrounding ambience. There is planned to realize dust suppression at the account of installations of the type cyclone-dust separators, filters in the systems of pneumatic transport and aspiration, installation of aspirated local shelters in the places for overloading the filling materials, moistening of opened storehouses for filling materials in the summer time.

The enterprises for fabrication of metal constructions, pipe assemblies with undertaking painting, counter-corrosion, works of chemical protection are the source of emission with welding aerosols, manganese oxides, vapors of solvents, acids and alkalis. For reduction of bad materials concentration at the working places and their emission into the atmosphere there will be foreseen local ventilation and on necessity rectifying the emission products up to the maximum admissible concentration.

The concrete plant is a source for emission of the burned oil products and dust. It is planned to execute reduction of there materials emission by installation of the type cyclone-dust separators, of high-temperature fireboxes for complete incineration of technological fuel and smoke pipe, providing necessary height and dilution of the emission.

The enterprises of automobile transport, building machines and mechanisms are producing, basically, oxide of carbon, oxides of nitrogen and sulphur, aerosols of lead, hydrocarbons and others.

There is planned to reach reduction of the emission at the account of optimum scheme for moving the transport and machines, by regulation of the engines for achievement of normative factors for emission making.

All the afore-mentioned objects, polluting the atmosphere, are found within the territory of the construction base and industrial platform and their influence, including noise, are not beyond the scope of the NPP territory and do not exceed possible values.

At execution of construction works for creation of temporary buildings and buildings for construction base and the priority works at industrial platform of the NPP there will are provided overtaking construction of the networks and cleaning accessories for faecal precipitations and industrial-downpour sewer-pipes.

The open pit of loam and sandy-gravel mixture and mould boards of soil are situated on the territories, located far from water basins at a distance more than 1 kilometer, and do not influence upon condition of water defensive zones.

Bringing away the surface waters from the territory between the platforms, of automobile and railway roads will be realized by the following complex of actions:

- by transverse bringing away the surface waters along the planned surface of the earth bed and ballast layer into the direction of longitudinal water pouring down;
- by construction of gutters, ditches, longitudinal and transverse pallets;
- by construction of small artificial structures in lowered places.

The rectified sewers and non-polluted waters will be directed into the adjoining water reservoirs.

Thereby, it is possible to establish, that significant changes in the mode of the natural sewer within the industrial platform of the NPP will not take place.

The objects for re-cultivation are the territories of the building base, mould boards and quarries. After completion of the period for exploitation of the temporary buildings they are dismounted, there are executed planning works, providing surface sewer. Along the whole re-cultivation territory after its planning there is produced stowage of the soil masses, possible fertilizers and sowing of herbs.

After working off of the quarries and mould boards of soil there is provided re-cultivation of their territory with execution of works for its improvement. For this purpose there is performed planning of the area with laying of escarpments, fastening of soil layers from opening, sowing of herbs.

The soil, being taken off within the process of construction in the places of building location, is stored in a temporary mould board, located not far from the industrial platform, and is used hereinafter for re-cultivation and equipment with services and utilities.

Organization of the works designed for linear structures (automobile and railways, pipe lines for technical water-supply) provides maximum exploitation for passage of the automobile transport places of construction for linear structures.

The broken adjoining bands are planned, sprinkled with building soil, beforehand taken out from the construction places and are seed by herbs. The building waste and rubbish are driven to the field for industrial waste.

With provision for existing trends in the growth for the rest industry in this region, manifestation of negative factors for intensive recreation influence upon the vegetation already today there is rising before the society and the nature defensive departments the question about all-round estimation of its recreation potential, as well as estimation of the recreation influence on their condition and stability of vegetable communities.

In connection with high agricultural assimilation of the grounds within the 5-km zone, chosen for accommodation of the platform for construction of the NPP, the main changes in the natural vegetable cover will occur in the adjacent with the platform territories with large unique timber arrays, located within the radius of 10 km from the construction site and concentrated mainly along the river Viliya. That is why the primary tasks for the enterprises of timber facilities and nature defensive services, aimed for guarding and rational exploitation of vegetation within the zone of the NPP construction, will be constituted of the following:

- increasing of sanitary and health improving functions, landscape-aesthetic properties, stability and improvement of woods for the reason of creation of convenient circumstances for mass rest of the population;
- reinforcement of the measures aimed at guarding the timber landscapes, most valuable in natural attitude, of relic structures, monuments of the nature and the regions, having great defensive and cultural-historical importance;
- preservation of the biological variety in the timber ecosystems;
- undertaking of actions for prevention of degrading for timber plantings as the result of recreation influence;
- reinforcement and the further improvement of measures aimed at guarding woods from firing.

The most expedient form of organization and conduct for the economic facilities in the recreation woods is development of landscape-planning, organizing, timber managerial and nature defensive actions on the basis of special timber arrangement. The executed functional zone making, enables to define the main trends of differentiated conduct for timber facilities.

Within the zone of active rest the main means, recommended for prevention of recreation influence upon the wood and for localization of anthropogenic influence, are:

1. Breaking up resting people into small units by means of roads construction, paths arrangement and improvement of the territory.

The most important element of this system for actions is arrangement of roads and paths with hard covering which will enable to stabilize the routes for motion of resting people and to bring a considerable part of the load to such roads and paths. For the reason of breaking up resting people into small units and for reduction of the load upon the main recreation territory it is necessary to execute involvement into the recreation exploitation of additional wood areas and plantings, not used before for arrangement of rest in view of their insufficient recreation value. By undertaking of corresponding timber conducting actions (chopping, looking after, cleaning of rubbish, drainages of excessively moistened areas, taking care over the upper ground layer and etc.) such plantings are prepared for acceptance of people, who have arrived for rest.

2. Creation of attractive and stable biological complexes on the basis of realizing complex of economic and arrangement actions. The main means for timber landscape and landscape creation, are the landscape chopping (for shaping, reconstruction, planning, shaping edges of the forest, as well as chopping in sub-growth and undergrowth parts of the forest) and landscape planting (reconstruction, defensive, decorative). For shaping optimum landscape-planning and three-dimensional spatial system of plantings it is necessary to execute development of special projects. Herewith high prime cost of the mentioned actions is attracting attention to itself. This forces to consider attentively over determination of practicability for their undertaking and for selection of the priority objects. In the first place by these actions there must be embraced the territories, adjoining to the institutions of rest and medical treatment, to access roads, promenade and tourist routes, coast zones, and edges of the forest.

In the wood areas with powerfully broken timber it is possible to undertake specialized actions, directed at increasing stability and reconstruction of the degraded recreation woods. The most economically efficient timber facility action is the method for applying mineral fertilizers. Maximum ecological efficiency is achieved after fencing the degraded recreation plantings with simultaneous applying of mineral fertilizers. However the economical efficiency under the influence of these actions is far less, than those, under the influence of the fertilizer. The reason is great cost for fencing. The economical efficiency of the fencing without applying of mineral fertilizers is provided only within powerfully degraded areas, usually belonging to IV-th stage of digression. The more positive economic effect is achieved after applying a fertile upper layer in the degraded recreation woods.

Under conditions of moderate recreation exploitation (zone of mastering), the main actions are directed at as to increasing of stability and recreation value of plantings, so to preventing their possible overloading. Any special forms for arrangement of timber facilities for the reason of the landscape transformation are not provided. There must be paid only special attention to improvement of the territory, it is also possible to perform laying of individual promenade routes towards direction for the main mass of the resting people motion.

Within the reserve zone there are conducted usual wood managerial actions, directed at growing sound, firm and time-proof plantings with high aesthetic and sanitary-hygienic properties.

After termination of construction it is necessary to conduct re-cultivation of the territories with mould board and quarry, located on them. After withdrawal from exploitation of temporary buildings for the objects of construction industry, they are dismounted, there is executed planning, providing surface sewer. On the whole re-cultivated territory after its planning there is produced stowage of the soil ground, accessible fertilizers and sowing of herbs or creation timber cultures.

7 PROPOSALS FOR ORGANIZATION OF ECOLOGICAL MONITORING PROGRAM

Environmental monitoring at the site and in the supervised area is the basis of ecological safety of the Belarusian NPP. It must be performed within the frameworks of the National Environmental Monitoring System (NEMS) in the Republic of Belarus in accordance with the legislation:

- the Law of the Republic of Belarus “On environment protection”, dated July 17, 2002, No. 126-З;
- the Provision on the NEMS in the Republic of Belarus approved by order of the Council of Ministers of the Republic of Belarus, dated July 14, 2003, No. 949.

In accordance with clause 2 of the Provision on the National Environmental Monitoring System in the Republic of Belarus this system includes organizational independent following types of environmental monitoring performed on general principles:

- monitoring of lands;
- monitoring of surface waters;
- monitoring of underground waters;
- monitoring of atmospheric air;
- radiation monitoring;
- geophysical monitoring, etc.

General principles of the environmental monitoring are implemented by means of development and fulfillment of programs of supervising the state of environment and impact of natural and anthropogenic factors, standardization of data collection and procession, analysis and storage of information, provision of information exchange within the framework of the NEMS , development of forecasts of the environment state and impact of natural and anthropogenic factors, preparation and provision of information to state bodies, legal entities, citizens.

Representing “the complex system of supervision, assessment and forecast of changes in the environment state under impact of natural and anthropogenic factors”, the ecological monitoring in areas of location of nuclear power plants must consist of monitoring subsystems of main impact factors (radioactive, chemical substances, heat) and response of ecological systems (biological monitoring) on changing environment parameters.

Radiation monitoring at the industrial site of the Belarusian NPP in its CA and OZ will be carried out by radiation safety laboratories (RSL) and external dosimetry laboratories (EDL) and the Republican Centre of Radiation Control and Monitoring.

When the Program of ecological monitoring is developed in the area of location of the designed Belarusian NPP information is to be taken into account referring to specifications of agricultural lands, critical ecological systems and vegetation community, wherein monitoring is required on the top priority basis. These materials are contained in respective sections of the environmental impact assessment at the Belarusian NPP.

7.1 PROPOSALS TO PROGRAM OF ECOLOGICAL MONITORING IN AREA OF LOCATION OF DESIGNED BELARUSIAN NPP.

The Program is primarily intended for establishment of general requirements to the organizational structure and outlet data of ecological monitoring (structure, objects of the natural environment, nomenclature and errors in measurements of controlled parameters).

The main requirement to the organizational structure of ecological monitoring in the area of location of the Belarusian NPP includes provision of information receiving for substantiation of compliance of the forecast impact of effluents/discharges of radioactive and chemical substances from the designed NPP with the levels of the acceptable risk, comparison with the risk from the natural and technologic radiation background, from the background pollution of environment with chemicals, from effluents/discharges of other enterprises.

The effective dose value for population and respective risk factors are the main original data for evaluation of the radiation risk. Methodological approaches to chemical risk evaluation are based on principles adopted by the Health Care Ministry, the Ministry of Natural Resources of the Republic of Belarus, IAEA. Main original data for evaluation of the risk for population from pollution of the natural environment with chemicals include their concentrations in water, air, food and respective risk factors.

Taking into account that the hydrosphere is the final “reservoir” and the natural way of migration of atmospheric fall-out of radio nuclides and chemicals on the earth surface, supervision of the dynamics of concentrations of chemicals in the hydrographic network are required at the site close to the radiation monitoring control (in the protection and supervision area of the plant).

Ecological monitoring zone round the Belarusain NPP will be defined at the stage of architectural design. The network of supervision stations must be chosen with the account of the flow direction of controlled waste waters, the existing wind rose and availability of specially protected natural areas.

7.2 ORGANIZATIONAL STRUCTURE OF ECOLOGICAL MONITORING

Within the frameworks of the single system of ecological monitoring the monitoring of pollutants should be distinguished with its main task of supervision, assessment and forecast of pollution levels (radiation and chemical monitoring), as well as biote response monitoring (biological monitoring). It is intended for finding out the response reactions of components of land and water based ecological systems onto external impacts.

In the sanitary protection and supervision areas of the designed Belarusian NPP stations of permanent supervision of the contents of radio nuclides and chemicals in the natural environment (air, water, soil), components of land based (including agricultural and forest) should be organized, as well as exposition dose power and the absorbed dose in air must be measured.

Supervisions of the contents of radio nuclides and chemicals must be carried out at specially equipped supervision stations. Meteorological parameters (wind direction and velocity, air temperature, humidity, atmospheric pressure) must be supervised at the control station located in the sanitary protection area of the plant. When places of supervision stations location are chosen the necessity of receiving the representative information about the levels of atmospheric air pollution in the area of maximally possible impact on the population and environment is taken into account: at industrial site, in settlements and places of output of agricultural products, specially protected natural areas, etc. The obtained results of measurements must be sent to the centre of information collection and analysis. Supervisions of pollution of components of land-based ecological systems should be performed in permanent centres of of supervising the state of atmospheric air.

Biological monitoring of land-based ecological systems aimed at evaluation of impact of waste from the Belarusian NPP on critical components should be performed in the radius of 3 km and at the control station located beyond impact of discharges from the Belarusian NPP.

The monitoring volume of water ecological systems may be substantiated after 3 years of supervisions of the chemical composition, temperature and the volume of liquid effluents of the Belarusian NPP with the aim of the final development of the order of supervisions and the list of determined features.

Obtaining the representative meteorological information should be organized for identification of the source of probable pollution of the near-land atmosphere with radio nuclides and evaluation of dissipation of gas aerosol discharges from the Belarusian NPP located near radiation objects and influence of cooling towers.

7.3 REQUIREMENTS TO OUTPUT DATA OF ECOLOGICAL MONITORING

Types environment objects, the volume, place, sampling periodicity, nomenclature of controlled parameters are to be determined so that:

- to minimize probability of failure of discovering any changes in natural environments and components of ecological systems at the time of their occurrence;
- organizational, technical and methodological means would be sufficient for identification of low (background) concentrations of radio nuclides and chemicals in natural objects;
- to fulfill the quantitative assessment of contribution of effluents/discharges of the Belarusian NPP to changes of parameters of the ecological situation in the area of its location.

7.4 RADIATION MONITORING

Radiation monitoring must ensure information obtaining required for:

- identification and ranging of sources of technogenic radio nuclides in the natural environment (water, air, soil) and components of ecological systems (land-based, water and agricultural);
- assessment of contribution of gas-aerosol effluents of the Belarusian NPP to dosage loadings onto the population;
- identification of areas of the biggest impact of effluents and discharges of the Belarusian NPP on environment mainly contributing to the radiation dose for the population;
- determination of regularities in the long-term dynamics of pollution of natural environments and ecological systems during operation of the Belarusian NPP;
- evaluation of doses of external and internal radiation of the population, uncertainties of evaluations of dosage loadings and radiation risk.

Collection of information about natural environment pollution with radio nuclides must be performed in the process of the current monitoring of atmosphere, hydrosphere, components of land-based ecological systems, including agricultural, forest and water ones.

Data for effluents/discharges of radio nuclides and chemicals are to be provided by companies in accordance with orders.

In compliance with the Program the analysis of pollution of natural environments (air, water, soil) and biote with gamma emitting radio nuclides (technogenic and natural) is mandatory. The gamma spectrometry analysis is the most informative method, and it allows to determine concentrations of the vast majority of radio nuclides of both origins in a wide power range (50-2000ceV) with an error not exceeding 15-20%.

For reduction of uncertainties during evaluation of dosage loadings the monitoring program stipulates regular (once per 4-5 years) information obtaining about specific/volumetric activities of tritium, strontsium-90, plutonium isotopes, as well as natural radio nuclides of the uranium-thorium row in natural environment components.

The monitoring results should be complemented with the estimate of dissipation of carbon-14 and tritium discharges and dosage loadings according to models verified in compliance with regional data. Storage, analysis, provision of information must be carried out with the aid of a data bank and asset of applied software.

Organizational, technical and methodical means must be sufficient for identification of low (background) concentrations of radio nuclides in natural objects on the level of global precipitations.

The radiation monitoring objects are:

- natural environment (air – aerosol and gas components, atmospheric precipitations, surface and underground waters, drinking water, soil);
- components of land-based ecological systems (multiannual herbs, conifers, moss, mushrooms, berries, wood substrate, milk, cereals and other agricultural local products);
- components of water ecological systems of rivers and lakes in the supervision area (plankton, water plants, bottom sediments, fish, suspension);
- absorbed dose, explosion dose power.

The list of radio nuclides controlled in the natural environment is determined according to the nomenclature of radio nuclides emitted by local radiation objects during their normal operation (carbon-14, tritium, inert radioactive gases, cesium-134, 137, cobalt-60, manganese-54, iodine-131, strontsium-89, 90, thorium-232, uranium-238, radium-226, polonium-210), the list of radio nuclides forming the technological (tritium, cesium-134, 137, strontium-90, plutonium-239, 240, thorium-232, uranium-238, radium-226) and natural (thorium-232, uranium-238, radium-226, potassium-40, radon-226) radiation background, as well as probable dosage loadings onto population in case of hypothetic accidents (iodine-131, gamma-spectrum).

7.5 CHEMICAL MONITORING

The chemical monitoring tasks in the area of the Belarusian NPP location are as follows:

- determination of levels and dynamics of pollution with chemical substances of air, water, components of land and water based ecological systems;
- determination of contribution of effluents/discharges of the Belarusian NPP to pollution of the nature with chemicals.

Sources of environment pollution in the area of the Belarusian NPP location may include storages of radioactive waste, boiler plants, other industrial enterprises, places of household waste storages, automobile transport, surface wash-out of fertilizers from agricultural lands situated in water collecting basins of water projects.

The chemical monitoring objects are: near-land air, surface and underground waters, flora and fauna, as well as local food products.

The list of chemicals to be controlled includes:

- petroleum products and heavy metals (Fe, Al, Cu, Mn, Zn, Pb, Co, Mo, Cd, Ni, Cr, Sr, V, Hg);
- polycyclic aromatic hydrocarbons and heterocyclic compounds; polychloride dioxins and biphenyls;
- non-organic pollutants (sulfur, nitrogen oxides);
- surfactants;

- nitrogen and phosphorus;
- chlorides, sulfates, salt content in the soil.

On the whole, the list of controlled chemicals is determined on the basis of the data of enterprises about effluents/discharges to the environment.

The chemical monitoring of surface waters stipulates obtaining the information about the hydrochemical mode and quality of natural waters: pH, chlorides, sulfates, salt content, suspended substances, nitrogen and phosphorus forms, oxygen, carbon, biological and chemical consumption of oxygen. Sampling for contents of the said pollutants in water environment objects is undertaken in discharge channels of enterprises, rivers of the water collecting pool. Sampling points in the air and land-based environment are determined in points of permanent supervision in accordance with the wind rose and landscape.

For supervision of the background state of the water reservoir a station is to be chosen which excludes obvious impacts on water quality, such as discharges from enterprises or agricultural complexes, discharges of sources, bottom deepening works, etc. Sampling places and periodicity of sampling of atmospheric components and land-based environment are the same as in the radiation monitoring system, in particular, for analysis of contents of heavy metals a quota of the general sample is provided.

Analysis of samples from natural environment samples is to be carried out in a stationary analytical laboratory by means of generally accepted methods.

The analytical equipment must ensure the required sensitivity for determining the concentration of chemicals on the level of the natural contents in natural objects.

Delivery of chemicals along with waste waters of enterprises should be controlled with the aid of supervision posts equipped with automatic waste water control systems.

Apart from a stationary basic analytical laboratory and supervision stations, portable and mobile laboratories should be available for for chemical control of water quality and atmosphere pollution.

7.6 BIOLOGICAL MONITORING

The biological monitoring must be oriented to tracking the state of biological systems of various organization levels: populations of individual indicator-types, biocenosa (by dynamics of structural and functional features).

The biological monitoring is aimed at evaluation and forecast of changes in the state of land-based and water ecological systems. Being supported on the data of radiation and chemical monitoring, the biological monitoring makes it possible to assess the biote reaction to anthropogenic loading.

Monitoring of the land-based ecological systems is based on complex field studies of their state, including determination of the current and dynamic levels of the state of agrocenosa, soil cover, vegetation (phytocenosa), fauna, determination and analysis of contents of radio nuclides, heavy metals and other probable pollutants in components of land-based ecological systems.

Studies are performed on selected permanent trial areas and at control sections during three years with the aim of the final development of the order of supervisions and the list of determined features.

During the first 3 years supervisions of hydrobiological parameters of the state of water objects must be organized and performed. Besides, supervisions of of parameters of the state of bottom sediments must be organized. The location of supervision stations must be chosen with the account of morphological peculiarities, impact of waste waters of the Belarusian NPP, as well as the data about the system of water use and other accompanying volumes of economic activity.

The hydrobiological studies include: study of quantitative parameters of hydrobiocenosa (phyto-, zoo- and bacterioplankton, bentos, peryphyton, macrophytes, ichthyofauna); study of migration features of hydrobiontes; determination of the sanitary and hygienic state of the water object.

For assessment of the current chemical composition of bottom sediments and its changes bottom sediment samples are to be chosen by layers. Technological and natural radio nuclides, heavy metals are to be determined in the selected samples. Sampling of suspensions and bottom sediments id to be undertaken once per 4-5 years.

For specifying the mechanical composition in the surface layer and according to the profile of bottom sediments the grading features, volumetric skeleton mass, natural humidity, density and capacity of individual layers of bottom sediments. For assessment of the speed of sedimentation processes and accumulation of sediments in water concentration of suspensions is to be determined at various hydrometeorological conditions, their distribution by the water profile and line, changeability during a year and a season.

The final development of the order of supervisions and the list of determined features of the state of nature environments, components of land-based and water ecological systems is carried out according to the supervision results during the first three years after station launch.

Apart from the aforesaid works of ecological monitoring of land-based and water ecological systems near the Belarusian NPP supervisions of the level and dynamics of radio nuclides and chemicals in underground waters are conducted

8. SUMMARIES

Development of civilization is inevitably connected with growth of energy. The electric energy branch is one of the industries for public economy, which is capable to render variable types of influence upon the surrounding ambience, rendering for it contamination with remainders of production, spending huge amount of natural resources - of fuel, land and water.

The Republic of Belarus faces a complicated situation with provision of the energy safety due to a predominant big share of natural gas in power consumption of the Belarusian power system.

Introduction of nuclear fuel to the power balance and construction of a NPP will essentially influence provision of the required conditions of the energy safety of the Republic of Belarus, which allow:

- to realize diversification of the thermal electric resources,
- to save valuable organic fuel facilities, first of all of oil and gas, for their usage as raw materials,
- to reduce the emission of hotbed gases rendered from thermal electric stations (TES),
- to raise the economical efficiency of the fuel-energy complex (TES),
- to develop dynamically usage of non-traditional energy sources, requiring reserve making of the electric power,
- to provide firm development of the economy and the society.

Thereby, commissioning of the Belarusian NPP will assist to increasing of well-being of the population of the Republic of Belarus.

The Belarusian NPP will be designed on the basis of the Russian project NPP-2006, which corresponds to the modern requirements and standards of the radiation and nucleus safety and is not worse according to the stipulated parameters similar to the NPP project from the western countries. The said project complies with the IATA recommendations in a series of publications for NPP safety and requirements of the European operating organizations to designs of nuclear plants of a new generation with power blocks having increased capacity based on light water reactors.

Assessment of the influence, rendered by the Belarusian NPP to the surrounding ambience within composition of two energy blocks, was conducted on the grounds of requirements laid in the acting normative documents of the Republic of Belarus:

- Instructions about the order of undertaking environmental impact assessment by the planned economic and other activity in the Republic of Belarus, is approved by the Resolution of Ministry of Natural Resources of the RB of 17.06.2005, No 30;
- Technical code of conventional practice 099-2007 (02120/02300) "Accommodation of atomic stations (AS). Manual for development and contents of the motivation for ecological safety of atomic stations".

Technical requirement for development of the report about "Environmental impact assessment (EIA)" in composition with "Motivations for making investments into construction of the NPP in the Republic of Belarus" and the letter of coordination from Ministry of Natural Resources of the Republic of Belarus are enclosed in Appendices A and B.

In preparation of the EIA there participated specialized scientific and research, prospecting, design-making organizations, having many-year experience of work, and namely:

The designer of the NPP - Republican unitary enterprise "Belnipienergoprom".

Co-executors of the EIA:

The Republican unitary enterprise "Central Research Institute for Complex Use of Water Resources" (CRICUWR, RUE)

SE "Republican Centre for Radiation Control and Environmental Monitoring (RCRCEM)"
SE "Republican Hydro-Meteorological Center"

The state scientific institution "Institute for Nature Exploitation of the National Academy of Science of the Republic of Belarus" (SSE "Institute for Nature Exploitation of the National Academy of Science of Belarus ").

The scientific-research part – the Research and development Department of the Belarusian State University (SRP-R&D Dept. (BSU) (Scientific-Research Laboratory of hydroecology the Belarusian State University)

RSPC "Hygiene", SE of Ministry of Health of the Republic of Belarus

RSRUE "Institute for Radiology"

Scientific-Research Institute "Fire safety and problems of emergency situations" of the Ministry for Emergency Situations of the Republic of Belarus.

In accordance with the Edict of the President of the Republic of Belarus of November 12. 2007, No 565 "About some measures for construction of the atomic electric power stations" expertise consideration over the materials after prospecting works at the stage of the platform selection was conducted by Kiev institute "Energoproekt".

For determination of predicted estimations of possible influences, conditioned by construction and commissioning of the Belarusian NPP, the studies were realized according to the following main trends:

- physical-and-geographical division into regions;
- meteorological and aerial-climatic conditions, including determined degrees of representative capabilities for averaged parameters relative to location of the NPP;
- study of geo-morphological and aerographic conditions of the relief, physical-chemical characteristics and landscape-geo-chemical structure of the ground for the reason of estimation for possible creation of fields for primary and secondary contamination, zones of "bringing-out, transit and accumulation" or vertical carrying of technogenic elements;
- total and seismic features, analysis of the processes and phenomena of the geological ambience for determination of mutual influences against the foundations of buildings and structures of the NPP;
- analysis of the air ambience condition with separation of the background contaminations and the level of contamination with the emission rendered from the energy blocks of the NPP;
- water-balance parameters and quality of surface waters (physical-chemical, hydro-biological, ichthyologic and sanitary-hygienic characteristics) with the aim to achieve the forecasted estimations for possible pouring down;
- estimation of technogenic influence upon the quality and spare stocks of the ground waters and water carrying horizons, used for drinking and domestic water supply;
- estimation of the condition for vegetable and animal world, including reserve objects, from the position of possible changing for their composition, population, the degree of their exhaustion or degradation;
- calculation of forecasted estimations for radiation influence upon agricultural ecosystems and population, determination of the degree of its admissibility relative to the influence upon human health. There were accordingly investigated the main food and biological circuits;
- the retrospective and the forecasted estimations of the NPP influence on the health of the population;
- analysis of the condition and forecast of the change, rendered for the technogenic ambience;
- analysis of possible emergencies at the NPP and objects of the observation zone with the aim of determination for the risk degree of the origin and processing of the specified event, and also their consequences.

When preparing materials of the EIA there was used stock and archive information, complemented with real life examinations with further calculation, analysis and totalizing on the base of specific methods with the corresponding direction.

The forecasted accounting estimations have been realized with usage of the modern computer codes, applicable in the countries with the developed atomic technology, programs, methods and criteria, recommended by leading organizations of the Republic of Belarus, as well as international organizations: IAEA, MKP3 and other.

According to the results of the studies over the NPP influence on the surrounding ambience there has been installed:

1) The NPP does not influence negatively upon the geological ambience, and the technical solutions, including for consolidation of the reactor compartment and other important buildings and structures, provide their stability under all types of influence, stipulated by the standard rates (seismic capabilities, shock wave resistance and etc.)

2) Total area of the demanded land field, necessary for creation of the NPP buildings constitutes 449,94 hectares (including 350,36 hectares of farmlands, the lands of the timber fund - 88,80 hectares), the expenses, compensating their withdrawal, are completely taken into account in the project.

3) Production water-supply of the NPP will be realized to account of bringing away the water from the river Viliya with consumption up to 2,54 m^3/second. At accommodation of the two energy blocks under expenditure of water in the river, close to average value within many years, bringing away of water from the river will constitute not more, than 4% from consumption of water in the river. Under shallow and very shallow conditions at exploitation of the two energy blocks - not more, than 8,7%. The maximum reduction level within the area of the river Viliya below accommodation of water extraction pipes may constitute at average values within many years of water expenditure up to 7 cm (up to 5 cm in the transborder range), under minimum expenditure – up to 11 cm (up to 6 cm in the transborder range). Coming thereof, the deficit of water resources in the river Viliya is not predicted.

4) Growth of the underground water consumption up to 1050 m^3/day will be provided to account of artesian water extraction pipe.

5) Under standard conditions of exploitation:

- the main radiation influence upon the surrounding ambience rendered from gas-and aerosol emission during exploitation of the energy block is conditioned by inert gases to account of the external radiation. The maximum average per year concentrations of radio nuclides in the air for the referent NPP are received at a distance of 1,5 km from the station (for xenon-133 - 0,5 Bq/m^3; for cryptone -85 - 0,015 Bq/m^3; argon-41 - 0,02 Bq/m^3). Non-exceeding of the efficient dose equal to 1 mSv/year for the population is reached at concentration of these radio nuclides in the atmosphere, not more: for xenon -133 - 9,8 kBq/m^3; cryptone -85 - 20 kBq/m^3; argon-41 - 0,36 kBq/m^3 which by 103 – 106-fold exceeds the maximum accounting concentrations for radioactive noble gases;

- the maximum additional radioactive contamination of the ground surface with cesium-137 within 50 years of the NPP exploitation will not exceed 1 Bq/m^2. The real (for 2009 year) contamination with cesium-137 of the territory, adjoining to the NPP, constitutes 600 - 2100 Bq/m^2;

- during operation of the NPP the level of radiation background will not increase. The power of exposition dose in the region of the NPP at a height of 1m from the surface of the ground is located within 0,10 - 0,17 μ Sv/hour.

- chemical materials, thrown out by the auxiliary buildings (boiler, workshop and etc.), do not render harmful influence upon the population, since their maximum concentration near the ground with provision for background contamination even within the border of the NPP constitutes up to 0,5 of the maximum admissible concentration.

The technological emission from the NPP will not affect negatively on the ground, surface and ground waters, vegetable and animal world:

- in the NPP project there will be provided actions on biological rectification of water in the living settlement, prevention of pouring down from the flood sewer into the river Polpa to account of its exploitation for technological necessities in the NPP after the corresponding rectification;

- the NPP operation will not influence upon the condition of the underground waters in 30-km zone; the quality of water (its chemical and bacteriological factors) in the artesian water extraction pipes of central domestic water-supply does not depend from the NPP operation ;

While making estimation of the influence made from the Belarusian NPP on the surrounding ambience there are performed investigations over the health of the population within the region of observation. There is given a general characteristic for primary sickness rate among the adults and baby population, oncology sickness rate.

Thereby, commissioning of the Belarusian NPP will not affect negatively the health of the population. At the same time commissioning of the energy blocks of the Belarusian NPP is of great importance for solution of social, economic and ecological tasks in Grodno and the northwest part of the Republic of Belarus providing additional employment during building and exploitation of the Belarusian NPP, restraining growth of tariffs for electric energy.

After construction of the Belarusian NPP there will be also solved such important and actual tasks for the urban settlement Ostrovets:

- increasing the number of the population up to 30 thousand people;
- construction of a closed well for water supply, rectification structures and station for iron deleting, which will reflect on the quality of drinking water;
- enlargement of the working places quantity, industrial potential and investment attractiveness of the region;
- improvement of the automobile roads quality and extension of the transport relationship for the settl. Ostrovets with large cities of the Republic of Belarus (Minsk and Grodno);
- development of the system for thermal supply of the town;
- increasing of the life quality.

Under standard conditions of the NPP exploitation all types of the remaining influence upon the components of the surrounding ambience will not exceed the ecological admissible level.

The buildings and constructions of the Belarusian NPP will be designed and built with provision for extreme natural influences. The conditions for location of the NPP platform exclude the possibility of external technogenic influence from other object of economic activity (fire, explosive wave, volley emission of harmful gases), which may bring about breach of the mode for normal exploitation.

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10. ABBREVIATIONS

NPP - nuclear power plant
AMS TP - automatic managerial system over the technological processes
ASTRC - automatic system for technological radiation control
PWR – pressurised water reactor
HES - hydroelectric station
ZCA - zone of the controlled access
OZ – observation zone
CE - coefficient of efficiency
EIA - environmental impact assessment
ОДК - three-dimensional admissible concentration
SPNA – specially protected natural area
DBA – design-basis accident
VGI - vapor-gas installation
MAC – maximum allowable concentration
OBE – operating base earthquake
RAL – republican allowable level
RP – reactor plant
CA – control area
TDE - thermal discharge element
SPS – shipping packaging set
TES - thermal electric station
FES - fuel energy system

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Annex 1

Figure 10

ЯППУ с РУ В 392-М	Nuclear steam producing unit with switchgear B 392-M
состояние топлива	state of fuel
газонеплотные твэлы 0,2 %	gas loose
дефектные твэлы 0,02%	defective
теплоноситель первого контура	heat carrier of the first contour
активность, Бк/кг	activity, Bk/kg
продукты деления (ИРГ-67%, йоды 17%)	division products (inert radioactive gases – 67%, iodine- 17%)
продукты коррозии	corrosion products
тритий	tritium
герметичный бокс основного оборудования	tight box of the main equipment
протечка неорганизованная	non-organized leakage
0,1 т/час	0.1 t/h
активность воздуха, Бк/м3	air activity, Bk/m3
продукты деления	division products
контур очистки	cleaning contour
продувка постоянная	continuous blowing through
протечка ГЦН	leakage of main circulation pumps
пробоотбор организованной протечки	organized leakage sampling
вывод теплоносителя	heat carrier outlet
1060 т/год	1060 t/year
протечка ВО – второй контур,	leakage BO – to the second contour
1 кг/ч	1 kg/h
второй контур	second contour
активность пара	steam activity
продукты деления (ИРГ-87%, йоды 12%)	division products (inert radioactive gases – 87%, iodine- 12%)
продукты коррозии –	corrosion products
тритий –	tritium
выше кровли	above the roof
выброс	discharge
выброс, ГБк/год	discharge, GBk/year
в первый контур	to the first contour

бак останов блока боксы вспомогательного оборудования работа на мощности здание турбины пар на турбину активность воздуха, Бк/м3, ниже ДУАнас жидкие среды воздух технологические сдувки границы строгого режима протечка ГЦН контур очистки дебаланс в первый контур во второй контур	tank block stoppage auxiliary equipment boxes operation on power turbine building steam to turbine air activity, Bk/m3, below allowed specific activity liquid media air process blow-offs strict mode borders leakage of main circulation pumps cleaning contour disbalance to the first contour to the second contour

Figure 11

ЯППУ с РУ В 392-М	Nuclear steam producing unit with switchgear В 392-М
состояние топлива	state of fuel
газонеплотные твэлы 0,2 %	gas loose
дефектные твэлы 0,02%	defective
теплоноситель первого контура	first contour heat carrier
активность, Бк/кг	activity, Bk/kg
продукты деления (ИРГ-67%, йоды 17%)	division products (inert radioactive gases – 67%, iodine- 17%)
продукты коррозии	corrosion products
тритий	tritium
продувка постоянная	continuous blowing through
пробоотбор организованной протечки	organized leakage sampling
вывод теплоносителя	heat carrier outlet
фильтры	filters
здание турбины	turbine building
из уплотнений турбины	from turbine seals
пар на турбину	steam to turbine
продувка парогенератора	steam generator blowing through
морская вода	sea water
эжектор	ejector
конденсатор	condenser
контур конденсатоочистки	condensate cleaning contour
контур очистки LCQ	LCQ cleaning contour
воды регенерации	regeneration waters
сбросная камера	discharge chamber
в парогенератор	to the steam generator
протечка неорганизованная	non-organized leakage
контрольные баки	control tanks
обозначения	designations
жидкие среды	liquid media
границы строгого режима	strict mode borders
отводящий туннель основной системы охлаждающей воды	outlet tunnel of the main system of cooling water
содержание радиоактивных веществ ниже ДУАнас для открытых	contents of radioactive substances below for open reservoirs

водоемов	